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VI.1. DISCUSSION

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VI.1 DISCUSSION

The Somni Nala Basin water resource quality evaluation results indicate that the surface and ground waters both are unfit for drinking except one borewell water of village Aundhi and one from Aunri village. The waters in general are however found good quality water for irrigation.

VI.1.1 Groundwater as drinking water

The safe drinking water is the first priority of any society and therefore quality parameters of water resources of Somni Nala Basin are compared with the safe limits of WHO and IS Drinking water standards. The results present a grim picture and disqualifies major number of water samples for drinking use. The main parameters responsible for water contamination are physical parameters like colour and turbidity and dissolved constituents like iron, phenol, flouride, cadmium, chromium, cyanide and lead.

Among surface waters, the effluent mixed Somni stream waters are highly concentrated in colour, turbidity, iron, phenol, flouride, cadmium, cyanide and lead. The other streams and tank waters show high concentrations of turbidity, TDS, Cadmium and chromium. As such, surface waters in total are unfit for drinking purpose. The villagers are aware of this fact and therefore use borewell waters for drinking purpose.

Amongst groundwaters, the concentration of parameters like phenol, cadmium, cyanide and lead have made about 92% of pre monsoon
ground waters unfit for drinking. About 95% of post monsoon groundwaters are disqualified due to the presence of high turbidity, total hardness, calcium, iron, phenol, nitrates, cadmium and chromium.

The cyanide and lead contaminants which showed up in pre monsoon ground waters are either not detectable or show concentrations within the permissible limit (of drinking water standards) in post monsoon ground waters. This difference in water quality has occurred due to recharge of rain water during monsoon season.

Following ARDC Norms (1979) and considering infiltration factor 10% of normal rainfall (for hardrock area like limestone terrain), about 2370 hm water is replenished to ground water of the basin every year. The quantity of this recharged water is capable of diluting the concentration levels of lead and cyanide of pre monsoon ground waters so as to bring them within permissible limits. The other effects of monsoon recharge are manifested in the quality of ground waters which have shown high concentration levels of turbidity (POGW 10 and 18), total hardness (POGW 1 and 8). The infiltrating monsoon water loaded with \( \text{CO}_3 \) and \( \text{HCO}_3 \) dissolve more calcium from rocks of limestone aquifers (Karanth, 1994).

The physical and chemical parameters which have exceeded the permissible limits of safe drinking water are not all toxic in nature. The parameters like turbidity, total hardness, calcium and iron do not risk
human health directly. Some parameters like iron do carry aesthetic value and its high concentrations affect the appearance and taste of the drinking water.

The other parameters such as phenol, nitrate, cadmium and chromium may be regarded as health risk parameters of which phenol and chromium are generally not found in concentrations as high as to cause ill health to the public. The cadmium and nitrates are proved toxic parameters and as such high concentration of these parameters are not tolerated in drinking water.

V.1.1 a Sources of contaminants:

The contaminant plumes of Cadmium, Nitrate, phenol and chromium have been worked out in the present study. The sources of these parameters are evaluated in the following:

(A) Geological source

Phenols are commonly associated with petroliferous rocks (Thurman, 1985). It occurs in groundwater as contaminant from industrial wastes. Cadmium occur in Pb-Cu-Zn sulphide ore minerals associated with plutonogenic hydrothermal or volcanogenic hydrothermal mineralizations (Smirnov, 1983). Since these hydrothermal mineralization activities have not taken place in this region therefore, cadmium source can not be accounted for from the rocks of basin area.
Nitrate is a very minor constituent of rocks (Karanth, 1994). Therefore its source cannot be from the rock formations of the area.

The main geological source of chromium is mineral chromite which is common in ultramafic rocks. The sedimentary rocks of Chhattisgarh region have derived mostly from granites and therefore possibility of presence of chromite as detrital mineral in sandstones of basin is feeble. Hence, chromium concentration in ground waters cannot be from the rocks of basin area.

(B) Atmospheric Source

Atmospheric oxygen and nitrogen are combined by electric discharge during lightning and dissolve in rain water. The average content of nitrogen in rain water is reported to be 0.2 ppm (Riffenbarg, 1962).

The worldwide annual emission of cadmium from natural sources is approximately $8.43 \times 10^5$ Kg (Niriagn, 1979) and from industries $7.19 \times 10^6$ kg (Moore and Ramamoorthy, 1984). The average concentration of cadmium in rain water is reported to be $50\mu g/l$ (Moore and Ramamoorthy, 1984).

The industrial activities like production of refractory bricks, coal combustion and chromium-steel production contribute chromium to the atmosphere. The particulate matter contain up to 3000 mg/kg chromium (Jawarski, 1980). Besides metal industries, fertiliser plants are also the source of wind blown chromium. The fertilizer such as phosphate are
known to contain chromium between zero and 1000 mg/gm (Swain, 1962).

(C) Industrial Source

Steel industries are widely known to dispose off phenol, cyanide and ammonia (which oxidises to NO₃) through plant effluents (Sunderesan, Subrahmanyam, 1980). The effluent mixed Sommi stream water contains phenol in the range of traces to 4.92 ppm and nitrate NT to 45.9 ppm.

The main industrial source of chromium is Tannery (Sunderesan and Subramanyam, 1980), Stainless steel, electroplating, pickling, refractory brick manufacturing units (Moore and Ramamoorthy, 1984) and Fertilizer plants (Swain, 1962). The chromium concentration in effluent mixed stream water is in between NT and 0.08 ppm.

Cadmium is released in production of metal like copper, lead and zinc. Other industrial sources are Electroplating, pigments. The cadmium concentration in effluent mixed Sommi stream water is in between NT and 0.04 ppm.

V.1.1 b Contaminant Plumes, Toxicity and Remedial Measures:

(A) Phenol Plume

Phenol is highly soluble organic compound in water (82000 mg/l at 15°C, Fetter, 1990). It flows along with water and also get
dispersed in groundwaters. The phenol plume occupies northern and western part constituting 75% of total basin area (Fig.V.7). Its concentration up to 1.66 ppm in ground waters must effluent mixed stream waters in the area.

**Toxicity** : High concentration (10 to 30 gms) doses of phenol are toxic. It is easily absorbed through the skin on direct contact. It causes digestive disorders and central nervous system effects (Dowson and Marcer, 1986).

**Remedial measures** : The phenol is highly biodegradable. It reaches groundwater during monsoon recharge and is not traceable in pre monsoon groundwaters. The concentration up to 1.66 ppm (maximum) in groundwaters is too low to cause ill effects on public health. The phenols may be removed by filtering drinking water through Active char and Activated Charcoal.

**(B) Nitrate Plume**

Nitrates are contributed to groundwaters by many sources viz. Industrial effluents, sewage waste, decaying organic matter and fertilizer application. The nitrate plume in the area is restricted to small part of the basin (about 4.75% of the total basin area) near village Aundhi and Somni (Fig.V.8). The source is localised and may be any one or more than one cited above.
Toxicity: Methemoglobinemia is the widely known health problem in newly born babies whose feeding formula contain high concentration of NO\textsubscript{3} (Karanth, 1994).

Remedial measures: Nitrate management studies conducted by Keeny (1982) demonstrates that rate of loss of NO\textsubscript{3} from soils depend on the volume of water that moves downward. As such, by controlling irrigation and fertilizer application, nitrate contamination can be reduced.

(C) Cadmium Plume

The cadmium concentration in pre and post monsoon ground waters is found persistent. The plume covers about 58% of basin area engulfing northern part mostly (Fig. V.9). The dispersion pattern indicate that the source is from B.S.P. effluent water. The cadmium concentration found in other surface waters (stream and tank waters) suggest that source is also from the setting of dust particles.

Toxicity: Cadmium is toxic and known to cause damage to liver and Kidney. The outbreak of itai - itai disease in Japan is well known. Low doses of cadmium causes heart disease and hypertension (Moore and Ramamoorthy, 1984).

Remedial Measures: Removal of cadmium from wastewaters may be done by the following methods.

1. Precipitation - as calcium sulphide by passing H\textsubscript{2}S gas.
2. Filtration - through active carbon.

3. Coagulant use - alum or ferric sulphate.

These methods are however not economical. No feasible and economic technique for cadmium removal from wastewater is available in India so far.

(D) Chromium Plume

Chromium is one of the least toxic of the trace elements. \( \text{Cr}^{6+} \) is more toxic as compared to \( \text{Cr}^{3+} \) present in waters. The contaminant plumes are in patches and scattered in the area (Fig. V.10). Therefore, the source of chromium in groundwaters may be from setting of dust or application of fertilizer in the area.

The wind data of the area, after analysing for dominant frequency, suggest that wind frequency dominates in SW direction (Fig. II.6A & B). However, frequency of wind in east direction is not less specially in the months of January, October and November (Fig. II.6A & B). Under these circumstances, Fertilizer Industry (DMC) situated in the north and BSP in the west both may be the source of wind blown dust containing chromium.

Toxicity: Chromium (\( \text{Cr}^{6+} \)) is slightly soluble and calcium chromates specifically are the potent carcinogen (Moore and Ramamoorthy, 1989). In low doses it is also known to cause hypertension.
Remedial Measures: The high chromium levels in drinking water can effectively be removed using coagulants like alum. The waste water treatments for chromium removal on commercial level are, however, not successful (Camp and Mercer, 1974).

VI.1.2 Groundwater as Domestic use water:

The quality classification proposed by Sawyer and McCarty (1967) has been referred in the present work for assessing the suitability of groundwater for domestic use. The groundwater classification results indicate that about 42% pre monsoon and 2.9% post monsoon ground waters are useful for domestic use. The major number of ground water samples are classified as very hardwater and therefore uneconomical for household cleansing.

It is a common case of having hard groundwaters in the aquifers of limestone terrain (Todd, 1980).

VI.1.3 Groundwater as Irrigation water:

The groundwater quality evaluation for irrigation use has been done by referring three classification methods viz. Percent Sodium (Table V.6), US salinity Graph (Table V.7) and Boron concentration (Table V.8). The post and pre monsoon groundwaters of the Sonni Nala Basin qualify as good quality water for irrigation.
VI.1.4 Water Quality Degradation:

In the present work, the levels of degradation of water quality has been decided on the basis of suitability of waters for various uses.

One borewell sample (PRGW 5, village Aundhi) of pre monsoon and one (POGW 19, village Aunri) of post monsoon are only found suitable for drinking. The rest all are unfit for drinking due to high concentration of other pollutants (Table VI.1)

Table VI.1 Levels of Degradation, their criteria and classification of water

<table>
<thead>
<tr>
<th>S. No</th>
<th>Level of Degradation</th>
<th>Criteria</th>
<th>Surface Water</th>
<th>% of Water Samples</th>
<th>Ground Water</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Somni Stream</td>
<td></td>
<td>Pre Monsoon</td>
<td>Post Monsoon</td>
</tr>
<tr>
<td>1.</td>
<td>Not Contaminated (Not degraded)</td>
<td>Suitable for drinking (\text{Irrigation &amp; domestic})</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2.</td>
<td>Contaminated a) Not suitable for drinking but suitable for domestic</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>42% (91.47% not suitable for drinking)</td>
</tr>
<tr>
<td></td>
<td>b) Not suitable for domestic</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td>c) Suitable for irrigation</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>3.</td>
<td>Highly Contaminated</td>
<td>Not suitable for drinking domestic &amp; irrigation</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

As such about 8.3% pre monsoon and 4.16% post monsoon ground waters are classified as non contaminated in the basin area.
The criteria used to designate waters as contaminated are water not suitable for drinking but suitable for domestic and irrigation purpose. The surface waters are found 100% suitable for domestic and irrigation purposes but, 58% pre monsoon and 71% post monsoon ground water samples are found not suitable for domestic purpose.

The criteria used to designate waters as highly contaminated are waters not suitable for drinking, domestic and irrigation purpose. It is found that 100% waters are suitable for irrigation and therefore highly contaminated category is not applicable to waters of Somni Nala Basin.

VI.2 CONCLUSIONS

Based upon geomorphological geological, hydrogeological water pollution studies carried out in Somni Nala Basin, the following important conclusions are drawn:

1. The Somni Nala Basin is underlain partly by shales and partly by Karstified limestones of Raipur group. The underlying formations show structurally weaker planes trending NE directions.

2. The groundwater flow direction, in general, is NE. The contour spacing indicate the flow gradient more or less uniform in basin area.
3. The groundwater level fluctuates between post monsoon and pre monsoon and the fluctuation is maximum in peripheral part and minimum in central and eastern part near the mouth of the basin.

4. About 2370 hm water is recharged the groundwater from rainfall annually.

5. The Sonni Nala receives Bilai Steel plant effluent water and therefore the stream water is badly affected to the extent that no aquatic biolife is seen to flourish in the stream water. The stream water is found not suitable for drinking on account of high levels of colour, odour, turbidity, iron, phenol, cadmium, chromium and cyanide. The other surface waters present in Pahandor and Amlidih streams and Morid and Bendri tanks are although not affected by any factory effluent water but are found not suitable for drinking due to high concentration levels of Turbidity, cadmium, chromium detected in the water.

6. The pre monsoon ground waters are found not suitable for drinking except sample No. PRGW 5 of Aundhi village. The pre monsoon ground water in general contain high levels of phenol, cadmium, cyanide and lead. These waters are found suitable for irrigation but 58% samples show high level of total hardness and therefore they are not suitable for domestic purpose.
7. The post monsoon ground water are found not suitable for drinking excepting one of Anniv village because of the presence of high levels of Turbidity, Total Hardness, Calcium, Iron, Phenol, Nitrate, Cadmium and Chromium. These waters are suitable for irrigation but 71% samples have shown high levels of total hardness and therefore classified as not suitable for domestic purpose.

8. The surface waters of Somni Nala Basin have achieved second level of degradation i.e. they are not suitable for drinking but suitable for domestic purpose.

9. About 8% of pre monsoon and 4% of post monsoon ground waters are not degraded at all but about 38% pre monsoon and 29% post monsoon ground water have achieved first level of degradation i.e. not suitable for drinking but suitable for domestic purpose.

10. As 100% waters of Somni Nala Basin are suitable for irrigation, no water is found highly contaminated achieving III degradation level i.e. water not suitable for drinking, domestic and irrigation.

11. The source of Phenol, cadmium and possibly Nitrate and chromium in groundwaters of Somni Nala Basin is mainly from Bhilai steel plant effluents.