Water Management in Drought – Prone Mineral - Rich Districts - An Approach

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***Abstract*- Scarcity of water resources has made it inevitable to search for other options that can be converted into resources for use in the times of distress. In mining affected areas, the dug wells and bore wells generally go dry due to deep excavations for mining. In such areas, rainwater accumulated in abandoned mine pits, is one such option that can be effectively converted into readily available water supply resource. The quality of water accumulated in abandoned mine pits studied is observed to be suitable for drinking and domestic use after necessary primary treatment followed by disinfection.**

***Index terms*- Drought, Water scarcity, Water Quality Index, Abandoned mine pit water, Pit water quality, Public water supply**

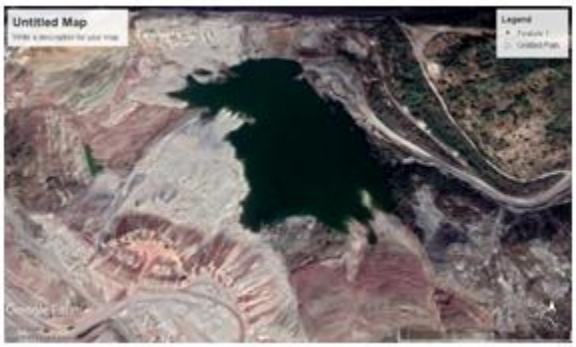
INTRODUCTION

It has been realized by all countries that global warming is responsible for disturbed spatial distribution of rainfall in all the countries including India. Water management practice in India has to keep pace with vagaries of monsoon for its uses as drinking, agriculture and industrial water. Simultaneous drought conditions in some areas and excessive rains in a few others have become a regular feature in India. Public drinking water supply has to be assured under all conditions. Availability of water for irrigation and industrial uses is important for economics of country. Both water quantity and quality have to be assured by the Concerned Authorities. Common water supply sources to urban areas are rivers or lakes or irrigation reservoirs. Rural areas depend on tube wells or hand pumps. Most surface water resources (rivers/ rivulets) are either receptors of sullage/ grey water from habitations or wastewater from industries along the banks or of mine pit water in mining areas. These sources may not be in a position to ensure water supply during summer/ drought period.

PURPOSE OF THE PAPER

In mineral - rich States, mining is a dominant activity. Coal, iron, limestone, stone- metal etc. are being mined by both opencast and underground mining methods. In such areas there are a number of abandoned mine pits. One of the impacts of open cast mining is creation of “craters” which many a times cannot be backfilled for various technical reasons. These “abandoned mine” pits, over the years, get converted into storage of large volumes of water. Typical abandoned mine pits with stored water in some open cast coal and limestone mines are shown in following Plate 1.

Durgapur coal mine, Chandrapur



Makardhokda OC coal mine, near Umrer

Pauni OC coal mine

Naokari OC limestone mine, Chandrapur

Plate1

An attempt has been made in this paper to propose an approach to verify if these hitherto neglected sources of water can be taken as "sources" for water supply. A review of water quality in mining dominated areas has been published by Sujata Thergaonkar1 et al. Purpose of this paper is to suggest to decision-makers to arrive at long term strategy so that water supply can be assured during drought in future. Situation in Chandrapur district of Maharashtra during pre -monsoon period of 2019 has been taken as an example. Similar conditions are likely in mining areas of other States. In this district, coal (open cast and underground) and open cast limestone/ dolomite and stone-metal mining are predominant.

APPROACH

1. First, details of existing drinking water supply schemes in Chandrapur district were collected.
2. Secondly, a review of water quality reported in reference 1 was considered since it would help to arrive at appropriate water treatment, if required.
3. Availability of infrastructural facilities e.g. power, road network, pumps etc. within active mining or abandoned mine areas were collected.

FINDINGS

- There are 203 piped supply, 171 tube well supply, 4078 dug wells and 4514 hand pumps in Chandrapur district. Rivers Wardha, Wainganga and Penganga and lakes Asola Mendha, Andhari, Thargaon, and Dongargaon are surface water sources and a few medium size irrigation dams serve as drinking water supply sources. Most rural water supply schemes use tube well and dug wells as water supply sources. These sources are vulnerable to drought conditions.
- Overall Mining Water Quality Criteria Indices (OMWQCI) coal/ limestone/ dolomite, stone-metal mines for mining –sector -wise average water quality is included in Table 1. Averages of OMWQCI by Hortons and Weighted Arithmetic Method are included in Table 2.

Table 1- Mine pit water quality

Parameters	Mine types			
	Coal	Limestone	Dolomite	Stone metal
pH	6.5-8.0	7.3-8.6	6.7-7.9	7.5
Conductivity, µS	1151	1016	818	615
TDS	886	948	613	362
Total alkalinity*	273	239	310	191
P alkalinity*	0	0	0	233
MO alkalinity*	273	239	310	0
Bicarbonates*	330	283	390	233
T. Hardness*	364	310	391	189
Ca Hardness*	173	186	241	143
Mg Hardness*	233	112	161	46
Calcium as Ca^{++},	69	80	91	57
Magnesium as Mg^{++},	54	34	43	11
Chloride as Cl^-,	19	104	76	36
Sulphates as SO_4^-	91	51	46	14
Total Iron as Fe,	0.5	0.12	0.1	0.15
Fluoride	1.0	0.5	1.0	0.8
Nitrate as NO_3,	20	-	1.5	-
Ionic strength, meq/L	12.4	11.3	12.8	6.2

N.B. All values as mg/L except otherwise stated; *as CaCO3

Table 2: Average of OMWQCI

Sector	Average OMWQI	Quality of water for uses of water as per OMWQCI as per criteria for Drinking, Irrigation and Industrial purposes
Coal	27	Good
Limestone	50	Good
Dolomite	58	Fair
Stone quarry	57.5	Fair

It can be concluded that open cast mine- (coal, limestone, stone quarry) pit water can be used for domestic and industrial purposes after conventional

treatment. Treatment for agriculture purposes is not required.

SUGGESTIONS

Following is suggested in view of above findings. It would help in tackling of water–shortage problem in fringe areas of mines in future:

- Mark locations of residential colonies or habitations or vulnerable villages with reference to mine pits on a map. Road network is usually available in properly developed mining areas.
- Estimate the quantity of water requirement lean period for domestic and agriculture use as per CPHEEO3 recommendations.
- Collect data about pit dimensions from mine-authorities and calculate the storage capacity and actual volume of water present in mine pits.
- Treatment: It would be necessary to decide a treatment strategy depending on
- Water quality,
- Quantity to be treated;
- Mode of supply/ transportation of water since laying distribution system would be uneconomical.

TREATMENT ALTERNATIVES ARE GIVEN BELOW

1. Package water treatment plant of the type shown in Plate 2 can be useful since power and road network in usually available in mine areas. In absence of power, diesel operated or solar pumps can be used to lift water from mine pit to treatment plants. Such plants include conventional treatment processes like coagulation, flocculation, settling and filtration. These can be located at any suitable mine pit. Such modular units are commercially available.
2. Modern process like reverse osmosis (R.O.), ultra-filtration, de-fluoridation-electro chemical units etc. can be added if required (Plate 3). Reverse osmosis (R.O.) Plate 4 units can be used for water with high dissolved solids. Such units can be mounted over a vehicle as shown in Plate 5. Vehicle -mounted unit will treat mine pit water and transport it to the consumer-sites. Such a unit comprises of a centrifugal pump (1HP) coupled to shaft drive of the three wheeler automobile with chain drive. It will also have a 500L SS tank. Such mounted units are commercially available.
3. Systematic surveys can help authorities to look into feasibility of providing prefabricated modular treatment plants like those shown in Plates 3-6. The one shown in Plate 6 is reproduced from an information pamphlet of Water division of SERAM Engineering Co. displayed on Google.

Plate 2: Package treatment plant

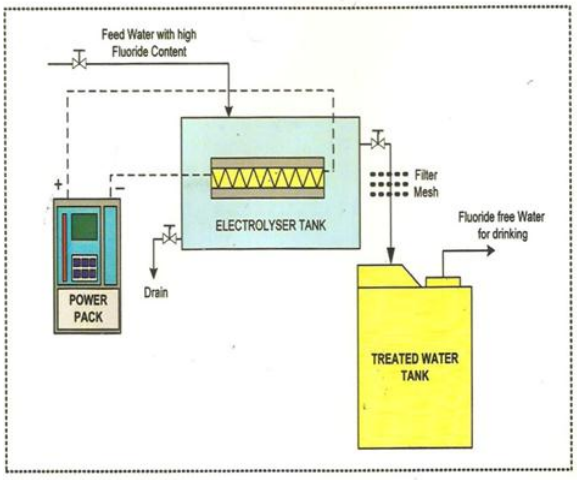


Plate 3: Fluoride removal by electrochemical method

Plate 4: R.O. plant

Plate 5: Mobile R.O. unit

Plate 6: Prefabricated modular water treatment plant

4. Water supply to consumers: Authorities have to rely on tanker water supply during drought from locally available sources in which quality of water cannot be vouched. Therefore, it would be advisable to rely on mine pit water, wherever available. Mine pits act as water-harvesting structures which is why water is always present in abandoned coal/limestone/stone metal/ manganese, iron ore open cast mines in most mining areas.

REFERENCES

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