RESEARCH ARTICLE

Recent investigations of few specific heavy metals in water reservoirs of Bhandardara, Ahmednagar, Maharashtra, India

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ABSTRACT

Bhandardara dam also known as Wilson dam about 185 km away from Mumbai.is situated in Ahmednagar District, Maharashtra, India 190 53' 75'' N and 730 96' 74'' E. It is the largest earthen dam in the country and amongst the oldest dams in Asia. Wilson Dam or Bhandardara Dam is at Bhandardara with a height of about 150 m. The dam is constructed to provide irrigation and drinking water to Ahmednagar region. Monitoring and Assessment of water has become environmental need due to contamination by mankind. One of the most unfortunate crisis of 21st century is the constraints in the availability of safe and pure drinking water which is the basic resource of our life. Most of the fresh water bodies get contaminated due to heavy metals effluents. The main threats to human health and animal biodiversity from heavy metals are associated with exposure to lead, cadmium, arsenic etc. Present investigations are carried out to analyse certain specific heavy metals required to establish and notify the quality and sustainability for varied purposes. Our observations suggest the presence of certain heavy metals in these water samples with significant concentration of some elements at few sites.

Keywords: Bhandardara, Heavy metals, dam, lead, cadmium, arsenic.

INTRODUCTION

Our survival on earth depends on three basic resources – water, air and fertile soil. Water is the most important component as it is the basic need medium for the origin of life. It occupies 71% of the earth's surface and is partly termed as the mother of life. Is a universal solvent and is referred to as liquid gold. About 97% of all water on earth is salty and most of the remaining 3% is frozen in polar icecaps. The atmosphere, rivers, lakes

and underground stores hold less than 1% of all freshwater and this has to support the human population and other associated activities on earth. The demand of water consumption rose six-fold between 1990-1995 more than double the rate of human population growth (Dwiwedi and Dwiwedi, 2010).

The quality of air, water and soil has never been static. It varies from place to place and also from time to time and is largely regulated by the biotic and abiotic agencies which come across or interact directly and indirectly. Different health agencies have prescribed standards for different categories of water; eg. US Public Health Service Drinking Water Standard (USPHS, 1962), World Health Organisation (WHO, 1992), Indian Council of Medical Research (ICMR, 1962), etc. Standards are essential because the quality of water directly affects human health. The standards are periodically revised to take advantage of new treatment techniques and to make use of the new test methods (Patiram *et al.*, 2007).

Regular monitoring of Physico-chemical characteristics is very important since a relationship can be established between the various parameters that gives us the status of the area (Raut *et al*., 2013). Water parameters signify the quality of water and its assessment helps me to prevent any further deterioration and ensure that it is also aesthetically adequate. According to Hubertz and Cahoon (1999), the variations in parameters can be useful in finding the sources of pollution and its effective management. Hydrological parameters also govern the distribution of the animals/ organisms and hence used in understanding the correlation with the environment (Quadros, 1995).

Nestled among the Sahyadri Hills is the quaint hill town of Bhandardara, standing at an attitude of 750 m above the sea level and situated in Taluka Akole, District Ahmednagar, Maharashtra. It is at latitude 19^0 32' 43" N and longitude 73^0 45' 30" E. The temperature varies around 22^0-40^0 C in summer and 7^0 – 33^0 C in winter with an annual rainfall of 5469 mm in the Ghats and 3225 mm on the dam. Bhandardara is still untouched by rapid commercialization and offers some of nature's most spectacular views (Gazetter, 2003).

Bhandadara dam was inaugurated by the H. E. Governor of Bombay in 1926 and is one of the oldest dams constructed by the British to provide water and to facilitate irrigation in the regions of Ahmednagar. It was built in 1910 on Parvara River that also resulted in creation of Arthur Lake. The length of the dam is 507m with the total catchment area of 122 sq. km with live storage capacity of 312.63 MCM and dead storage capacity of 8.50 MCM. The spillway discharge capacity from radial gates is 1500 cumecs while from open bar is 2550 cumecs. At the base of Wilson Dam, there is a garden with numerous trees and a stream of spilled water emerging from the gates of the dam.

The Bhandardara region is inhabited by local tribes and others comprising a total population of more than 15000 in and around its periphery of about 10 to 11 villages. The locals directly or indirectly depend upon its resources including the waters for their daily routine activities, irrigation, drinking etc. The utilized water is absolutely raw and barely treated and therefore the need arises to assess the parameters of water.

Heavy metals are a group of metals and metalloids with atomic density greater than $4g/cm^3$ and are devoted to the widespread contaminants of terrestrial and freshwater components. Heavy metals occur naturally in the earth's crust found in soils, rocks, sediments, water, organism etc. Many heavy metals are toxic to organisms even at low concentration. The toxic heavy metals entering the ecosystem may lead to geo-accumulation, bioaccumulation and biomagnification (Gajbhiye *et al*., 2012). Heavy Metals like Fe, Cu, Zn, Ni, Co and other trace elements are important for proper functioning of biological system and their deficiency or excess could lead to number of disorder (Ward, 1995).

MATERIALS AND METHODS

Collection of Water Sample:

Fresh water sample is collected randomly at regular intervals of three-four months from 5 different sites of Bhandardara Dam. The samples were collected in plastic cans of 5liters capacity without entrapping any air bubbles. The samples were kept in refrigerator and maintained at 4°C. Recent scientific instruments and procedures with high efficiency and efficacy were utilized for all practical purposes.

Heavy metal determination:

The collected water sample was acidified immediately with 2 ml HNO_3 at the site. The heavy metal content and concentration in water samples were analysed by AAS. The sediment samples were dried at room temperature 32 °c and later grinded with pastel and mortar. These materials were further sieved through 0.2 mm mesh

size filter and then stored in clean poly bags till analysis. According to the standard methods, acid digestion of sediments was carried out. All the reagents utilized for practical purposes were of AR grade. The glassware's and polypropylene were thoroughly cleansed with acid cleansing reagents and later rinsed with distilled deionised water.

RESULTS AND DISCUSSION

Nickel: A minimal concentration of Ni is required by larger mammals to produce erythrocytes however, its higher amounts can lead to mild toxicity (Tirkey *et al*., 2012). It is also used in fertilizers and enters groundwater from farm runoff. The primary source of Nickel content in drinking water is due to the leaching from metals that come in direct contact with drinking water. Nickel may also be present in few of the ground waters as a result of dissolution from nickel ore bearing rocks (WHO, 2005). A limited exposure to Ni is not known to cause any health concerns, but long term exposure can give rise to decrease in body weight, causing damage to heart and liver and also skin irritation. The average values for all sites are 0.154 mg/l which is above the limit prescribed by WHO.

Iron: Iron is necessary for plant and animal metabolism. Higher concentration of Fe and its subsequent overload in humans is uncommon but may occur due to certain genetic defects. Such cases of Iron overload results in oxidative degradation of lipids, its destruction if intercellular and extracellular proteins & DNA damage. Iron is the second most abundant metal in the earth's crust, of which it accounts for about 5%.Elemental iron is rarely found in nature, as the iron ions Fe2+ and Fe3+ readily combine withoxygen- and sulphur-containing compounds to form oxides, hydroxides, carbonates, and Sulphides. Iron is most commonly found in nature in the form of its oxides (Elinder 1986; Knepper and Iron, 1981) Water shows very less concentration of iron prescribed by WHO and Indian standard. The average value found for all five sites are 0.0401 mg/l.

Lead: Presence of lead in the environment is due to natural sources and anthropogenic activities. Exposure of lead can be enrouted through contaminated drinking waters, food, air, soil, dust from old paintings etc. containing Pb. The higher concentrations of lead exposure may result in biochemical alteration in humans which in turn may lead to toxicity affecting the synthesis of haemoglobin, adverse effects on kidneys, gastrointestinal tract, joints & reproductive system and causing acute or chronic damage to the nervous system. Lead accumulates in the bones and teeth, where it has a biological half-life of 20 years (Frances, 2008). The Pb concentration in water of Bhandardara dam is above the permissible limit for drinking water prescribed by WHO suggesting a high anthropogenic activity surrounding the dam. The average concentrations for all the sites are 0.496 mg/l.

Copper: Copper is essential component for human health& is necessitated in our daily nutritional diet and is generally complemented within vitamin supplements and fortified foods (Copper Development Association, 2013) and may also be present in most domestic waters. It is vital for human life, but its higher doses may lead to anaemia, liver and kidney damage, stomach and intestinal irritation etc. Average values for all five sites are 0.0005 mg/l which is very less as compared to value prescribed by International and Indian Standard.

Arsenic (As): Arsenic in drinking-water (primarily inorganic) as arsenate and to a lesser extent arsenite was evaluated as carcinogenic to human on the basis of sufficient evidence for an increased risk for cancer of the urinary bladder, lung and skin (Steinmaus, 2002). Arsenic enters the environment through herbicides, wood preservatives, and mining industry. It Causes damage to skin, eyes, and liver, may also cause cancer (Steinmaus, 2005). Contaminated arsenic waters utilised for drinking, preparation of foods and irrigation can pose a greater threat to public health and life. Long-term exposure to arsenic through potable waters and food may cause cancer and skin lesions. It has also been associated with altered developmental effects, cardiovascular disease, neurotoxicity and diabetes. Average values for all five sites are 0.0492mg/l.

Cobalt: Cobalt is widely dispersed in the environment in lower concentrations that may enter the biological systems from both natural sources and human activities. Cobalt occurs naturally in soil, rock, air, water, plants, and animals and may enroute through and settle on land from windblown dust, seawater spray, volcanic eruptions, forest fires etc. and may also additionally enter into surface water from runoff and leaching (ATSDR, 2004). Acute exposure to high levels of cobalt by inhalation in humans and animals results in respiratory effects, causing a significant decrease in ventilatory function, congestion, edema, and hemorrhage of the lungs. Average values for all five sites are 0.0766 mg/l.

Table 1: Seasonal variation For Year 2012

Sites	Iron	Lead	Copper	Arsenic	Cobalt	Nickel	Chromium	Manganese
Site 1 (Bhandardara dam corner)								
*	0.0640	0.346	0.0008	0.021	0.0648	0.1114	0.003	0.08
**	0.0752	0.424	0.0012	0.045	0.0798	0.1245	ND	ND
***	0.0568	0.287	0.0005	0.016	0.0523	0.0976	ND	ND
****	0.0638	0.323	0.0006	0.019	0.0632	0.1008	0.003	0.1
Site 2 : (Panjare)								
*	0.0671	0.628	0.0006	0.0381	0.1156	0.1593	0.003	0.1
**	0.0696	0.735	0.0009	0.0475	0.1259	0.1643	0.003	0.11
***	0.0574	0.568	0.0004	0.0298	0.0967	0.1216	ND	ND
****	0.0656	0.620	0.0007	0.0365	0.1073	0.1477	ND	ND
Site 3 : (Ghat ghar)								
*	0.007	0.609	0.0004	0.0634	0.0435	0.2143	ND	0.14
**	0.01	0.698	0.0007	0.0734	0.0564	0.2387	ND	0.1
***	0.004	0.513	0.0005	0.0578	0.0388	0.1899	ND	ND
****	0.006	0.567	0.0002	0.0612	0.0411	0.1980	ND	ND
Site 4: (Samrad)								
*	0.0019	0.568	0.0003	0.0869	0.0777	0.1727	ND	0.14
**	0.0025	0.629	0.0008	0.0956	0.0891	0.1897	ND	0.2
***	0.0009	0.485	0.0001	0.0756	0.0673	0.1564	ND	ND
****	0.0013	0.546	0.0002	0.0812	0.0732	0.1687	ND	ND
Site 5 : (Spillway)								
*	0.0675	0.346	0.0006	0.0439	0.0844	0.1357	0.004	0.11
**	0.0691	0.410	0.0010	0.0568	0.0987	0.1468	ND	0.11
***	0.0545	0.295	0.0003	0.0357	0.0752	0.1087	ND	ND
****	0.0643	0.333	0.0004	0.0411	0.0821	0.1288	ND	ND

*Season 1- Jan-March; ** Season 2- April-June; *** Season 3 –July-September; **** Season 4 -October–December; ND- Not detected

Table 2: Average value for Year 2012

Sites	Iron	Lead	Copper	Arsenic	Cobalt	Nickel	Chromium	Manganese
Site 1 Bhandardara dam corner)	0.0649	**0.345**	0.0007	**0.025**	0.0650	**0.1085**	0.003	0.09
Site 2 (Panjare)	0.0649	**0.637**	0.0006	**0.0379**	0.1113	**0.1482**	0.003	0.1
Site 3 (Ghat ghar)	0.006	**0.596**	0.0004	**0.0639**	0.0449	**0.2102**	ND	0.12
Site 4 (Samrad)	0.001	**0.557**	0.0003	**0.0749**	0.0768	**0.1718**	ND	0.17
Site 5 (Spillway)	0.0638	**0.346**	0.0005	**0.0443**	0.0850	**0.1300**	0.004	0.11
International Std.	0.3 mg/l	0.01 mg/l	2 mg/l	0.01 mg/l	0.2mg/l	0.02 mg/l	0.003 mg/l	0.5 mg/l
Indian std.	0.3 mg/l	0.1mg/l	0.05mg/l	0.05 mg/l	0.2 mg/l	0.05 mg/l	0.05mg/l	0.1mg/l

Chromium: Chromium is a metal occurring in natural deposits as ores with other elements, commonly occurring in water soluble forms of chromates and dichromates. In spite of chromium being present in nature mostly as a chrome iron ore & also with minimal concentrations in soils and plants, it is rarely noted in natural waters. The two largest sources of chromium emission in the atmosphere are the chemical manufacturing industries and combustion of natural gas, oil, and coal for varied purposes. The principal use of chromium is in metal alloys such as stainless steel; protective coatings on metal; magnetic tapes; and pigments for paints, cement, paper, rubber, composition floor covering etc. & its soluble forms are utilised in wooden preservatives. The short-term exposure to chromium potentially causes skin irritation or

ulcerations (Basketter, 2000) and the long-term studied effects are damage to liver, kidney, circulatory and nerve tissues (Dayan *et al*., 2001). Average values for all five sites are 0.003 mg/l.

Manganese: Manganese is a naturally-occurring element that can be found ubiquitously in the air, soil, and water. Manganese is an essential nutrient for humans and animals. Adverse health effects can be caused by inadequate intake or over exposure. Although manganese is an essential nutrient at low doses, chronic exposure to high doses may be harmful. The health effects from over-exposure of manganese are dependent on the route of exposure, the chemical form, the age at exposure, and an individual's nutritional status. Regardless, the nervous system has been determined to be the primary target organ with neurological effects generally observed. Health effects reported by Kawamura *et al*. (1941) included lethargy, increased muscle tonus, tremor and mental disturbances Average values for all five sites are 0.11 mg/l.

CONCLUSION

Our studies reveal that waters of Bhandardara dam which are directly utilized without any treatment by the local tribes for varied purposes including drinking may be of concern due to elevated levels of few heavy metals. The long term undesirable adverse effects of heavy metals toxicity and its sources needs to be assessed in this tribal belt. Present studies reveal serous ill effects due to heavy metals and its synergistic action may be potentially hazardous to human health, plants and environment.

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