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Freshwater Selenium Evaluation and Studies by Spectrophotometer of Isapur Water Reservoir Maharashtra India

Lolage Yogesh Popatrao* and Bhosle Arjun Bapurao

School of Earth Sciences,

Swami Ramanand Teerth Marathwada University, Nanded 431606, Maharashtra, India

*Corresponding Author E-mail: lolage.yogesh@gmail.com

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ABSTRACT

Isapur water reservoir is an earth fill dam, located on Penganga river of Yavatmal district, Maharashtra state, India. The reservoir was constructed in 1982, with an aim to provide water for irrigation purpose. Yavatmal district is known for rock forms like shales, slates, sandstones and limestone etc. These rocks along with anthropogenic sources like industrial and agricultural runoff acts as important source for heavy metals in the surrounding areas.

Selenium is a naturally occurring bio-accumulative pollutant, nutritionally important in micro quantity, but at higher concentrations, can be lethal to all life forms. The separating line for selenium between dietary requirements and toxic concentration level is quite thin, so it has become an essential health concern. It enters in surface water through natural, anthropogenic activities, gets accumulated in tissues of aquatic plants and animals.

Selenium contamination in water and sediment was evaluated in the selected sampling locations during June, 2012 to May, 2013. Objectives behind these investigations were to determine the sources of selenium in the aquatic system of this reservoir and to aware the society from probable impacts of selenium ions of this aquatic body as well surrounding environment. Four water and two sediment sampling locations were selected at entry and exit points of dam, from which the samples were collected.

The maximum selenium level were observed during monsoon, 2012 (0.014 mg/L) and lowest during summer 2013 (0.012 mg/L). In case of sediment analysis the maximum and minimum selenium level noted were 19.0 and 9.0 mg/kg in monsoon and winter respectively

Selenium concentration was higher at sites where water is entering into the dam containing surface runoff, compare to other sites. Sediment and water analysis has proven that agricultural runoff and geological rocks may be the basic sources of selenium into the reservoir.

Key words: *Reservoir Water, Selenium, Irrigation, Agricultural runoff, nutritionally important, Bio-accumulative pollutant.*

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INTRODUCTION

Bioaccumulation is timely incremental increase in levels of particular substance at different tropic levels. These substances bio-accumulates in the food chain and could prove toxic to whole ecosystem. The rising levels of heavy metal concentration in the environment are the growing concerns[12]. Persistent, non-degradable character of this pollutant, mainly heavy metal in an aquatic ecosystem has become significant concern for water quality and probable health risk associated with it[14]. Human health is totally dependent on clean and healthy surroundings. Environment is getting polluted rapidly due to increasing pollution of water, air as well as soil. Effects of these polluted surrounding has now became worldwide concern. Water pollution due to heavy metal has been emerged as rapidly growing and promising crisis nowadays[11].

Selenium is an essential micronutrient as well as potential toxin to biotic community. Selenium is required for plants and animals in trace quantity, but range separating dietary requirements and toxicity levels of selenium are comparatively narrow[15]. Selenium is a fundamental component of seleno-protein and plays a key role in human health[24]. It can be present in organic and inorganic form with many oxidation states like (IV, VI, 0, -II). It gets attached to water molecules in dissolved from or sediments, acts as major sink of selenium in particulate matter[4].

Selenium in trace amount is added in several commercial fertilizers[3]. The chronic exposure of heavy metals like selenium can have several adverse health impacts. It is a naturally occurring chemical element required as micro nutrient for the human health[18] plants and animals[8,27]. The ample supply of selenium is vital for optimal health[21].

Selenium is essential for cellular defenses for body against the oxidative damage. It is also required for correct functioning of structural proteins. It can be found in soil, sedimentary rocks, shales, phosphate and coal deposits. Igneous rocks show abundance of selenium, but sedimentary rocks shows maximum concentrations. Heavy metal pollution studies for aquatic environment including water and sediment had been undergone through many researchers to investigate the quantitative bioaccumulation of pollutants. They examine the presence of heavy metals like Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, and Zn etc. in water bodies[1,2,6,7,9,10,19.]

Selenium and Human Health:

Epidemiologic investigations have revealed that continual exposure to selenium compounds is linked with many adverse health problems in humans. Selenium is responsible for wide range of health concerns in human including dermatitis, hair loss, gastrointestinal disturbances and hepato-toxicity due to over exposure of selenium compounds. Selenium gets released into water by natural sources through weathering of rocks and by anthropogenic activities such as mining, irrigated agriculture, coal-fired power plants[22].

MATERIAL AND METHODS

Study Area:

Isapur dam is an earth-fill dam on river Penganga constructed in 1982 with geographic coordinates Lat. 19°43'40"N and Long. 77°26'12"E. Main purpose behind construction of this dam was to provide water for irrigation to surrounding areas. It is situated in Yavatmal district of Maharashtra state on river Penganga, a sub river of the holy river Godavari[17].

Sampling Programs:

Water, sediment samples for selenium estimation was collected for all three seasons during June 2012 to May 2013. Four water sampling sites and two sediment samples (Table 1) were collected once in a month. The details about selected sampling sites are shown in Fig. 2. Water samples were taken in pre-cleaned polyethylene water bottles. Large size polyethylene zip bags were used to bring sediment samples. These sealed and correctly labeled samples were brought to the laboratory for systematic analysis for the present work undertaken.

Methodology:

Selenium, from collected water and sediment samples was estimated by widely used and accepted 3,3' Diamino Benzidine Method on UV double beam Visible spectrophotometer (SHIMADZU UV 1800) at wavelength of 420 nm. Prior analysis, samples were acid digested. Results obtained were expressed as mg/L and mg/kg of selenium for water and sediment samples.

Fig. 1: Google image showing the geographical location of Isapur dam

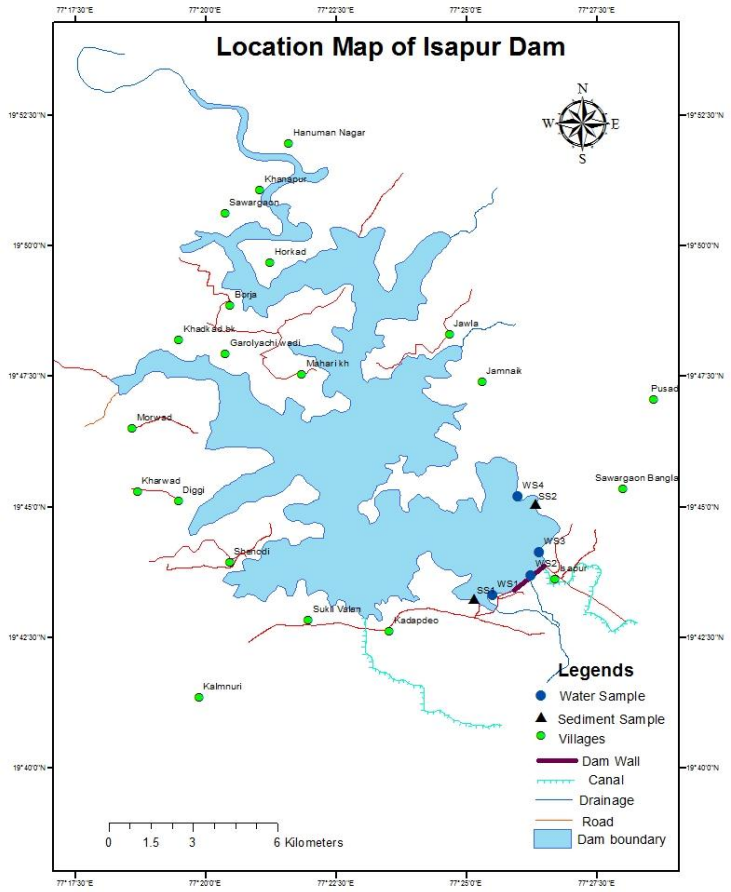

Fig. 2: Map showing selected sampling locations of Isapur water reservoir

Table 1: Geographical locations of the selected water and sediment sampling sites

Sample	Geographical Coordinates	
	Latitude	Longitude
Water Sample 1	19°43'33"N	77°25'50"E
Water Sample 2	19°43'45"N	77°26'12"E
Water Sample 3	19°44'10"N	77°26'10"E
Water Sample 4	19°44'55"N	77°26'14"E
Sediment Sample 1	19°44'27"N	77°26'30"E
Sediment Sample 2	19°43'33"N	77°25'36"E

RESULTS AND DISCUSSION

Analyzed water and sediment samples have shown considerable seasonal variations for selenium concentration. An average selenium level recorded in monsoon, winter and summer are 0.01175, 0.0085 and 0.0107 mg/L for four water samples respectively whereas, in case of sediment analysis selenium level recorded as 16.3750, 11.3750 and 14.8750 mg/kg respectively for selected two sediment samples. Yearly average values are shown in the Table 1. The positive correlation can be observed between water and sediment results.

The highest selenium level were observed during monsoon, 2012 (0.014 mg/L) at WS_1 and lowest concentration at site WS_4 during summer as 2013 i.e. 0.012 mg/L. In case of sediment analysis the maximum and minimum selenium level noted were 19.0 (SS_1), 9.0 mg/kg (SS_2) in monsoon and winter respectively (Table 1).

Results from analysis of water and sediment are shown in Table 2.

Table 2: Selenium level observed during June, 2012 to May, 2013

Season	Month	Water Sample (mg/l)				Sediment Sample (mg/kg)	
		Site 1	Site 2	Site 3	Site 4	Site 1	Site 2
Monsoon	June	0.014	0.013	0.012	0.012	19	18
	July	0.014	0.012	0.011	0.011	18	18
	August	0.012	0.013	0.011	0.011	16	15
	September	0.011	0.011	0.01	0.01	14	13
Winter	October	0.011	0.01	0.01	0.009	13	12
	November	0.009	0.009	0.008	0.008	12	11
	December	0.009	0.007	0.007	0.007	10	9
	January	0.01	0.008	0.007	0.007	13	11
Summer	February	0.011	0.009	0.008	0.008	14	12
	March	0.011	0.01	0.01	0.009	14	13
	April	0.012	0.011	0.011	0.011	16	15
	May	0.013	0.012	0.013	0.012	18	17
Average		0.011	0.010	0.010	0.010	14.750	13.667
Maximum		0.014	0.013	0.013	0.012	19.000	18.000
Minimum		0.009	0.007	0.007	0.007	10.000	9.000

Note: Selenium level for water as expressed in mg/L and for sediment in mg/kg.

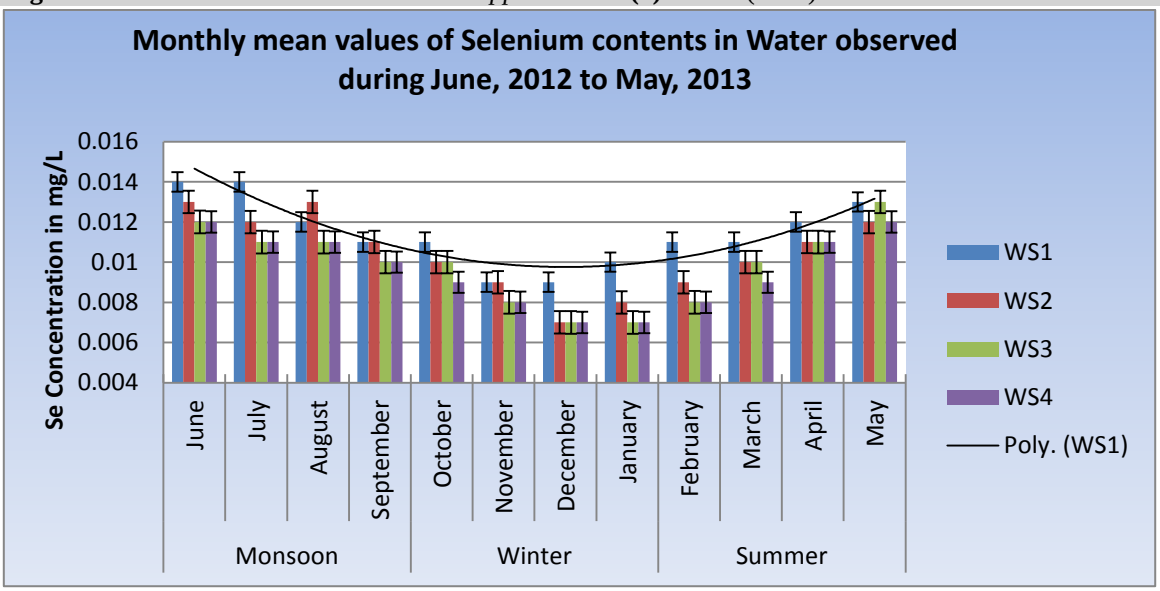

Fig. 3: Monthly mean values of selenium content in water (mg/L) noted during June 2012 to May 2013

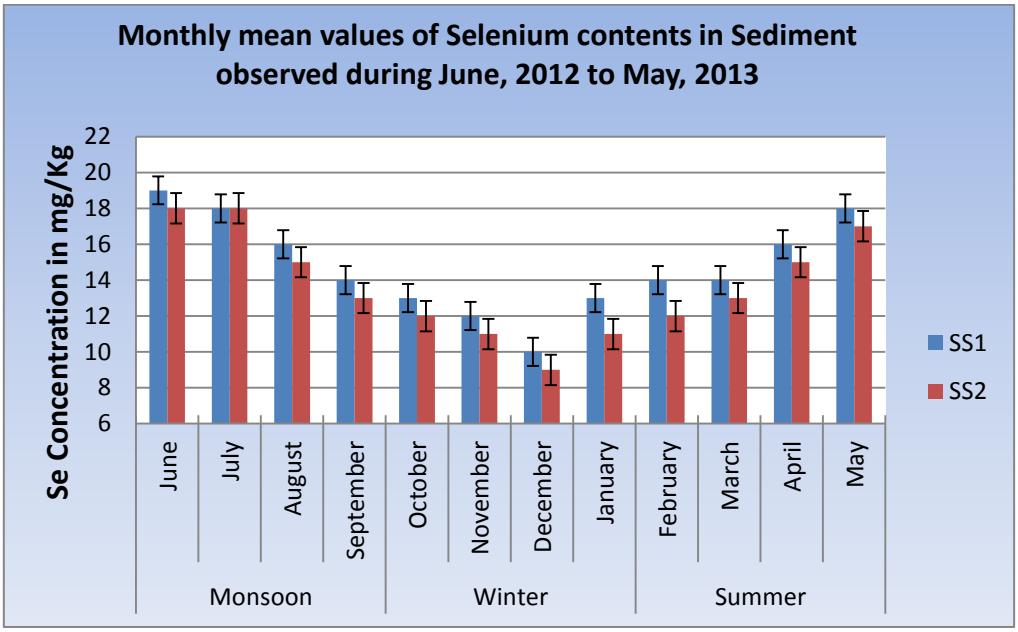

Figure 4: Monthly mean values of selenium content in sediments (mg/kg) observed during June 2012 to May 2013

Peters *et al.*[16], measured the selenium concentration in sediment and benthic in fauna from lake Macquarie, Australia. They observed that sediments act as a significant source for selenium concentration in aquatic food web. Frankenberger and Arshad (2001), worked on selenium bioremediation from contaminated water and sediments. They noted that the selenium is a pollutant of agricultural irrigation and drainage waters in the western US causing wildlife mortalities and grotesque deformities.

Welsh and Maughan[25], studied the selenium contamination in biota, water and sediments from lower Colorado river Valley, USA. They observed that selenium level at irrigation return flows was less than the concentration that can be toxic to fishes. Vinceti *et al.*[23], observed an adverse health effects of high levels selenium compounds

exposure in humans, including effects on endocrine function, predominantly on synthesis of thyroid hormones.

They also noted adverse effects like hepatotoxicity, gastrointestinal disturbances, dermatologic effects, such as hair loss, nail loss and dermatitis. Thomas *et al.*[20], made an evaluation to assess the selenium levels in water, sediment, invertebrates and fish collected from river basin Solomon, north-central Kansas. The observed average selenium in water and sediment was 6.75±5.56 µg/L and less than 1µg/g respectively; Mane *et al.*[12] found the concentration of Se from Sudha dam water and sediment of Bhokar area. They found that selenium level was 0.009 mg/l and 0.012 mg/gm for water and sediment respectively.

CONCLUSION

During monsoon, winter the dam water and sediment showed higher level of selenium contents. Agricultural runoff and geological sources are the contributing factors for selenium concentration in this dam. An average values are well below the permissible limits mentioned by WHO[26]. Trend line suggests that the maximum accumulation of selenium in water, sediment has occurred during summer due to evaporation effect and in monsoon due to surface runoff adding selenium into water body through various natural and anthropogenic sources.

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