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# Comparative assessment of heavy metals in soil, weed species and waste water after used for irrigation in industrial zones of Ichalkaranji city

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## Abstract

*The toxic heavy metal concentrations in soil, weed species and waste water used for irrigation in industrial zones of Ichalkaranji were investigated. The industrial zone polluted soils showed higher levels of toxic heavy metal soil contamination as compared to non-industrial zones agricultural soils. The toxic heavy metal concentration in soils is above the maximum permissible levels for Hg (Mercury), Cd (Cadmium) and As (Arsenic) respectively. The heavy metal content of effluent, Panchaganga River and groundwater in industrial zones of Ichalkaranji were also investigated. The distribution of heavy metals reported similar patterns in weed species in the industrial zones of Ichalkaranji.*

**Keywords:** Metal toxicity, Heavy metals (Hg, Cd and As), water pollution.

## Introduction

An Earth crust contains many natural heavy metals. Heavy metals also released from various industry. Heavy metals include Mercury, Cadmium, Arsenic, Molybdenum, Chromium etc. They cause soil as well as water pollution. After industrial revolution heavy metals causes serious impact on the environment which is adversely effects on plant, animal as well as human. Waste water released from various industries used for irrigation purposes. From long back ago, many developing and developed countries such as Germany, United Kingdom (UK), China and India use waste water for irrigation purpose[1]. The waste water contains toxic heavy metals like Hg, Cd, and As at high concentration in receiving soils. The main purpose of this study is to compare metal content of soils, weed species and waste water used for irrigation in industrial zones of Ichalkaranji, with the maximum permissible levels set by the WHO. The results are expected to create awareness among the public on the safety of drinking water, consuming vegetables and crop plants grown in such areas.

To best of our knowledge, no any reports are available on heavy metal toxicity and its content in ground water, river and waste water released from industries in this particular area.

## Materials and methods

**Study Area:** The study area of present investigation is different industrial zones of Ichalkaranji. Ichalkaranji is the Manchester city of India which is located in the 10 km south east of railway station of Hatkanangale tahsil in Kolhapur district of Maharashtra state.

**Samplings:** The fresh soil, water and weed plant species were collected from six different sites around the industrial zones of Ichalkaranji (Table-1). All these samples are analyzed and tested in research laboratory. From these samples pH, electrical conductivity, moisture content as well as concentration of heavy metals were determined and recorded in Table-2. The different plant weed species are collected, washed, processed to detect heavy metals and recorded in Table-3. The heavy metals studied at all sampling sites compared with WHO standards.

## Results and discussion

The data analyzed for industrial zone soil and one sample from unpolluted soil is represented in Table-2. The results revealed that, all sampling sites are contaminated with heavy metal and values are obtained goes to exceed permissible limits. The toxic heavy metal concentration at different sites increases by the application of polluted water continuously during irrigation due to leaching of heavy metals[2]. The higher concentration of heavy metal detected in the top layer up to 25 cm depth[3]. The pH of soil is near neutral at all sites. The pH is highest of 7.90 at site no. 2 and 6 and minimum pH 7.35 at site no.3. The organic carbon ranges from 10.0 to 12.0 in the soil. The soil organic carbon is the not only provides site for metal directly, it will also combine with soil minerals and increases the sorption sites[4]. Accumulation of toxic heavy metals at the top is due to complication with organic carbon at neutral pH[5].

It has been noticed that the Cd concentration is higher among Hg and As in industrial zone. The average toxic heavy metal concentration is144 Cd mg /kg, 134 Hg mg/kg and 130 As mg/ kg. The toxic heavy metal concentration at non-industrial zones was 38 Cd mg/kg, 30 Hg.mg/kg and 28 As mg/kg. The six different zones of Ichalkaranji city show different toxic heavy metal concentrations. Hence the metal concentration is high in industrial zones compared with non-industrial zones.

The percentages of heavy metal in different plant weed species in industrial zones of Ichalkaranji are above the WHO maximum permissible level were recorded in Table-3. The different plant weed species contain different accumulation of toxic heavy concentration.

Waste water released from six different sites, Panchaganga river water and ground water at different sites contain toxic heavy metals like mercury, and cadmium and arsenic were depicted in Table-4. The concentration of cadmium metal is higher as compare to mercury and arsenic metal. The highest metal concentrations present in waste water released from six different sites of Ichalkaranji. This result reveals that Ichalkaranji faces the water and heavy metal pollution. Thus there is a need of proper management to minimize the toxic level of these metals.

**Table-1:** Study area for industrial soil, weed species and waste water used for irrigation

| Site | Name of site | Name of industry |
|---|---|---|
| Site No-1 | Parvati Industry | Manapasnad Textile Processors Pvt.Ltd. |
| | | Ramgopal Birla Textile Pvt.Ltd. |
| | | Jubilee Fabrics Pvt.Ltd |
| | | Ichalkaranji Textiles Processors |
| Site No-2 | Deccan area | Radha Kanhaiya Textile Processors |
| | | Raghunanadan Processors Ltd. |
| | | Sawant Processors |
| | | Shantinath Fabrics (P) Ltd |
| | | Amit Weaving Mills |
| Site No-3 | Khanjire estate | Shri Amit Processors |
| | | Pareek Processors |
| | | Arvind Processors |
| | | Yashwant Co-op.Processors |
| | | Swadeshi Dying and Bleaching Mills Ltd. |
| Site No.-4 | Laxmi Industry | Mahalaksmi Co-op Yarn Process LTD. |
| | | Mahesh Textile Processors |
| Site No.-5 | Gaonbhag | Marda Processors |
| | | Paint Industry |
| | | Bleaching Industries |
| Site No.-6 | Market area | Laxmi Co-op .Processors Ltd. |
| | | Oil-Indusrty |
| | | Dyes Industry |

**Table-2:** Physio-chemical and heavy metal concentration in soil (mg/kg) along industrial zones in Ichalkaranji

| Parameters | Depth (cm) | Parvati Industry | Deccan area | Khanjire estate | Laxmi industry | Gaon bhag | Market area | Average | Non-industrial zone |
|---|---|---|---|---|---|---|---|---|---|
| pH | 0-25 | 7.40 | 7.90 | 7.35 | 7.80 | 7.40 | 7.90 | 7.6 | 7.07 |
| Organic Carbon | 0-25 | 12.0 | 10.0 | 12.0 | 10.2 | 10.8 | 12.0 | 11.13 | 0.55 |
| EC | 0-25 | 0.34 | 1.47 | 1.40 | 0.35 | 1.38 | 0.35 | 0.88 | 1.15 |
| Moisture Content (%) | 0-25 | 3.72 | 2.85 | 3.2 | 2.95 | 2.65 | 3.12 | 3.08 | 5.08 |
| Water Holding Capacity (%) | 0-25 | 35 | 42 | 32 | 35 | 40 | 34 | 36.3 | 68 |
| N | 0-25 | 109.7 | 108.2 | 10.8.9 | 110.5 | 108.5 | 10.9.6 | 109.2 | 219.52 |
| P | 0-25 | 102.2 | 99.4 | 105.5 | 101.2 | 105.2 | 104.2 | 102.9 | 45 |
| K | 0-25 | 3292 | 3323 | 3125 | 3325 | 3222 | 3033 | 3199 | 210 |
| Hg | 0-25 | 136 | 140 | 125 | 133 | 140 | 130 | 134 | 30 |
| Cd | 0-25 | 147 | 145 | 140 | 148 | 145 | 139 | 144 | 22 |
| As | 0-25 | 120 | 140 | 120 | 129 | 130 | 145 | 130 | 28 |

**Table-3:** Heavy metal accumulation in different weed species of industrial zones of Ichalakranji

| Sr.No | Name of Weed Species | Hg $mgkg^{-1}$ | Cd $mgkg^{-1}$ | As $mgkg^{-1}$ |
|---|---|---|---|---|
| 1 | *Ipomea carnea* | 66.18 | 73.97 | 78.75 |
| 2 | *Lantena camera* | 78.75 | 85.70 | 70.97 |
| 3 | *Cynodon dactylon* | 66.12 | 62.52 | 53.60 |
| 4 | *Abutilon indicum* | 120.00 | 135.20 | 114.12 |
| 5 | *Alternaria crassa* | 45.52 | 49.60 | 58.73 |
| 6 | *Phragmitis species* | 15.0 | 19.4 | 16.25 |
| 7 | *Bulrush species* | 23.52 | 18.9 | 50.96 |
| 8 | *Typha species* | 4.6 | 5.8 | 15.0 |
| 9 | *Amaranthus species* | 60.56 | 75.30 | 80.60 |

**Table-4:** Heavy metal content of effluent, Panchaganga River and groundwater in industrial zones of Ichalakranji

| Sample from sites | Depth In meter | Mercury ($mgL^{-1}$) | Cadmium ($mgL^{-1}$) | Arsenic ($mgL^{-1}$) |
|---|---|---|---|---|
| Waste water relesed from six different sites | | | | |
| Parvati Industry | - | 17.4 | 24.9 | 19.4 |
| Deccan Area | - | 23.2 | 30.7 | 25.5 |
| Khanjire Estate | - | 21.3 | 25.5 | 21.0 |
| Laxmi Industry | - | 14.3 | 20.4 | 17.6 |
| Gaonbhag | - | 16.3 | 27.8 | 21.5 |
| Market Area | - | 18.3 | 26.4 | 18.3 |
| Average | - | 18.4±1.4 | 25.9±1.5 | 20.5±1.2 |
| Non-Industrial Zones | - | 4.9 | 6.3 | 7.5 |
| Panchaganga River Water | | | | |
| Parvati Industry | - | 3.69 | 8.4 | 2.275 |
| Deccan Area | - | 6.6 | 14.7 | 1.45 |
| Khanjire Estate | - | 4.5 | 9.3 | 1.65 |
| Laxmi Industry | - | 2.2 | 4.4 | 1.89 |
| Gaonbhag | - | 5.65 | 11.3 | 2.01 |
| Market Area | - | 3.5 | 9.2 | 2.50 |
| Average | - | 4.3±0.7 | 9.55±1.5 | 1.9±0.17 |
| Non-Industrial Zones | - | 0.13 | 1.044 | 0.1033 |
| Ground water at different ichalkaranji sites. | | | | |
| Parvati Industry | 55 | 1.571 | 3.8 | 2.13 |
| Deccan Area | 67 | 1.35 | 3.5 | 1.925 |
| Khanjire Estate | 40 | 1.658 | 2.6 | 3.56 |
| Laxmi Industry | 70 | 1.52 | 4.1 | 3.4 |
| Gaonbhag | 110 | 0.8076 | 2.88 | 2.9 |
| Market Area | 90 | 1.21 | 3.5 | 1.6 |
| Average | - | 1.35±0.14 | 2.58±0.36 | 3.3±0.25 |
| Non-Industrial Zones | 150 | 0.253 | 1.2 | 1.53 |
| Parvati Industry | - | 0.001 | 0.01 | 0.01 |
| Deccan Area | - | 0.01 | 0.01 | 0.01 |

The Hg concentration in *Abutilon indicum* is *higher* (120 Hg.mg/kg) with decreasing concentration seen in *Lantena camera* (78.75 Hg.mg/kg), *Ipomea carnea* (66.18 Hg.mg/kg), *Cynodon dactylon* (66.12 Hg.mg/kg), *Amaranthus species* (60.56 Hg.mg/kg), *Alternaria crassa* (45.52 Hg.mg/kg), *Bulrush species* (23.52 Hg.mg/kg), *Phragmitis species* (15.0 Hg.mg/kg) and *Typha species* (4.6 Hg.mg/kg). *Ipomea carnea L.* plants showed promise for the removal of Hg from contaminated wastewater[7, 8].

The Cadmium concentration in *Abutilon indicum* is higher (135.20 Cd.mg./kg) with decreasing concentration seen in *Lantena camera* (85.70 Cd.mg/kg), *Amaranthus species* 75.30 Cd.mg/kg), *Ipomea carnea* (73.97Cd.mg/kg.), *Cynodon dactylon* (62.52 Cd.mg./kg), *Alternaria crassa* (49.60 Cd.mg/kg and 58.73 As.mg/kg), *Phragmitis species* (19.4 Cd.mg/kg) *Bulrush species* (18.9 Cd.mg/kg), *Typha species* (5.8 Cd.mg/kg) and *Bulrush species* (50.96 As.mg/kg.). According to some researchers the different plant species have accumulator for cadmium and used for phytoremediation[10,11].

Arsenic concentration in *Abutilon indicum* is higher (114,12 As.mg./kg.) with decreasing concentration seen in *Amaranthus species* (80.56 As.mg/ kg.), *Ipomea carnea* (78.75 As.mg/ kg.), *Lantena camera* (70.97 As.mg/ kg.), *Alternaria crassa* (58.73 As.mg/ kg.), *Cynodon dactylon* (53.60 As.mg/ kg.), *Bulrush species* (50.96 As.mg/ kg.), *Phragmitis species* (16.25As.mg/ kg.) and *Typha species* (15.0 As.mg/ kg.). Some plant species have accumulator of arsenic[12].

## Conclusion

The toxic heavy metal concentration damages the physical structure of agriculture soil. The maximum level of heavy metals concentration in soil and water will be serious impact on environment. Water samples from different sites of industrial zones have also been found to be containing all toxic heavy metals above permissible limits. The concentration of heavy metals such as Hg, Cd and As present in all studied samples. Overall findings indicated that, waste water of the effluents, groundwater and river water of the study sites were not better and should not be used for irrigation without prior treatments. The plant weed species like *lantena camera, Ipomea carnea, cynodon dactylon, Abutilon indicum, Amaranthus species, Alternaria crassa, Phragmitis species, Bulrush species and Typha* species have better accumulation of Hg, Cd and As remediation and may used for phytoremediation.

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