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Physicochemical Properties of Water and Soil Affecting the Socio-Economic Conditions in Regions of National Capital Territory of Delhi

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ABSTRACT

The physicochemical properties of soiland water samples lifted from Rithala industrial cum residential area presented a very disturbing picture. Different sites were selected for the study and the criteria considered for the selection included Rithala Industrial Area (RIA) and Rithala Residential Area (RRA). Heavy Metal ions including Cadmium (Cd), Lead (Pb) and Chromium (Cr) etc. and other parameters e.g., pH, electrical conductivity, have been determined and have been compared with standard guideline values recommended by WHO to see the quality and suitability of soil and water. The study exposes the critical influence of various anthropogenic activities like industrialization and urbanization on the physicochemical properties of soil and water. The soil samples lifted from the sites near the industries were found to be extremely polluted. The current investigation indicated that some RRA water samples were comparatively safer and fit for human consumption while others were not fit for human consumption but permissible for irrigation purposes. The socio-economic studies have indicated a nearly complete shift in choice of livelihood from farming due to coming of new industries in the last 2-3 decades. Tremendous pressure on the natural resources is causing ecological degradation resulting in the water bodies getting vanished from the areas and the sites are reduced to dumping grounds.

Keywords: Desertification,Heavy Metal Ions, Industrialization, Livelihood, Socio-Economic Scenario, Toxicity Profile, Urbanization.

INTRODUCTION

Development and pollution due to waste emissions as a result of haphazard industrialization are inseparable as they are two sides of the same coin. The resulting pollutionhas potential to cause irretrievablechanges in the environment and hence is posing a majorthreat to sustainable development. As the carrying capacity ofthe environment is limited and certain ecosystems aremore susceptible to adverse environmental impacts than others, theunplanned and haphazard location of industries might considerably escalate the risk to the environment. Keeping this aspect in mind, a comprehensive study of physicochemical properties of water and soil affecting the socio-economic scenario of Rithala industrial cum residential area of National Capital Territory of Delhi was carried out.

Rithala is situated in the rural-urban peripheral of the North West Delhi District, in Delhi (Figure-1). It is an upcoming industrial cum residential area. Its latitude is 28.720726 and longitude is 77.107126.

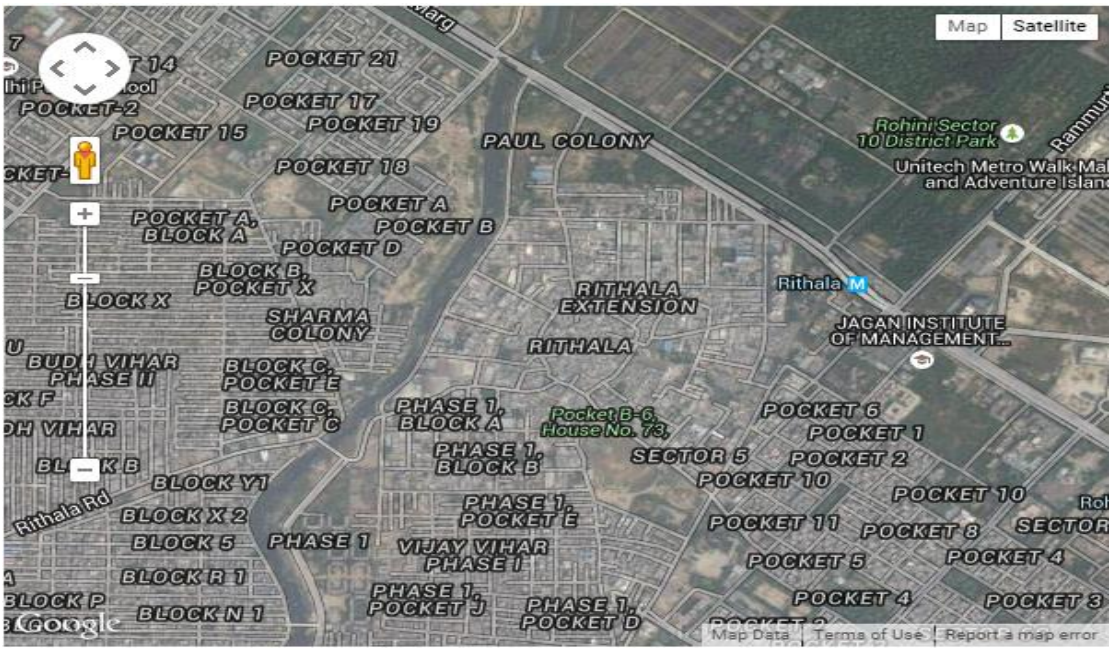

Figure-I: The Study Area (Google Map)

Climate

Rithala has a typical hot and dry climate. The mean temperature for December and January, the coldest months, is 15°C and 12°C, and for May and June, the extreme hot months, it is 32.2°C) and 93°F (33.8°C) in the shade.

History

Village Rithala was created in 1384 AD. It has grown over five to six times in size after acquiring of its farming land by the Delhi Development Authority (DDA) in the early 80s. Earlier it was known by the name Lathi Wala. Rana Rajpal Singh of Sumal Gotra of Tomar Chandervanshi Rajputs was founder of this village (1-3).

Present scenario

Basically Rithala is now an industrial area. There are number of industries such as Agro industries, Kitchen equipment industries, Textile machinery parts industries.

METHODOLOGY

Soil sample collection

Soil sampling was done by collecting portions of soil using a soil auger of length 15 cm at each location. The samples were put into polyethylene bags, labeled and taken to the laboratory for pre-treatment and analysis. Sampling was carried out within this environment from different locations around Delhi-NCR. Soils samples were collected in triplicate from each location. Control samples were collected from sites away from industries.

Preparation of soil samples, treatment and chemical analysis

Samples were air-dried at normal laboratory temperature. Soil samples were ground using pestle mortar and sieved to pass through 2 mm sieve and stored safely for chemical analysis.

Heavy metal ions concentrations

The samples were then digested using the microwave digestion procedure for total Chromium (Cr) concentration using Scientific microwave Anton PaarMultiwave 3000[4]. Concentrations of chromium ions in the extracts were analyzed with AAS (acetylene air flame) (Perking Elmer A Analyst -100) with addition calibration. Data presented in the investigations is an average of twelve replicates with a standard deviation.

Electrochemical properties

Electric conductivity (EC) and pH were measured in water suspensions and in 0.01 M $CaCl_2$. (*Elico CM* 180 and *Elico LI* 127).pH of the soil is one of the main parameter for determining the extent of pollution. So we prepared the standard solution of soil by weighing 20 g in 100 mL of the water as described in methods approved by NPDES. Solution prepared was kept on the magnetic stirrer for about 2 hours prior to each reading. pH meter was used for this parameter. Set of three readings were obtained. Conductance was calculated by preparing standard solutions of the samples by the methods approved by NPDES. Conductometer was used for this purpose. Set of three reading was obtained and samples were kept for constant stirring on the magnetic stirrer for almost 2 hour prior to each reading (5).

Analysis of water samples

Water samples were treated by the pH meter to get the set of three reading for pH of the samples. These samples were analysed by the conductometer to get the set of three reading for conductivity of the samples

RESULTS AND DISCUSSION

Toxicity Profile

Natural and anthropogenic sources of soil contamination are widely spread and variable (6). The concentration of heavy metal ions in water and soil matrix of Rithala study area are presented in Figure-II. As can be seen here the levels of lead and cadmium in water and soil are well above the permissible limits. This higher concentration of lead in the soil could be due to its sources such as illegal dry cell batteries, sewage effluents, overspill of wastes etc. thereby causing its bioaccumulation in plant via uptake from the soil and ensuing entry into the food chain leading to bio magnification due to its non-biodegradable nature. Lead is known to cause lead poisoning in humans as well as chronic neurological disorders in growing kids. There is an urgent need of remediation. Uptake rate of lead vary among and within species and is highly related to soil pH. Bioavailability of lead is higher in soils with lower pH (7). Our studies reveal that the soil pH in this area is generally weakly acidic thus increasing the risk of bioavailability. It is reported that lead is absorbed by root hairs and stored mainly in cell walls and only 3% of lead absorbed via the root will accumulate in the shoot. For this purpose the pH and conductivity of these samples were determined. The results are presented in Figures-III and IV. Cadmium is a highly lethal metal not known to have any favorable and useful effects for plants and animals. Many of the Cadmium compounds are also known to be carcinogenic (ATSDR, 2006) (8, 9). After entering the body via the gastrointestinal tract after eating food products grown on contaminated soil, it can lead to disastrous results. The permissible limit of Cd in the soil is 0.8mg/kg and 0.02 in plants. Permissible level in drinking water is 0.003ppm.

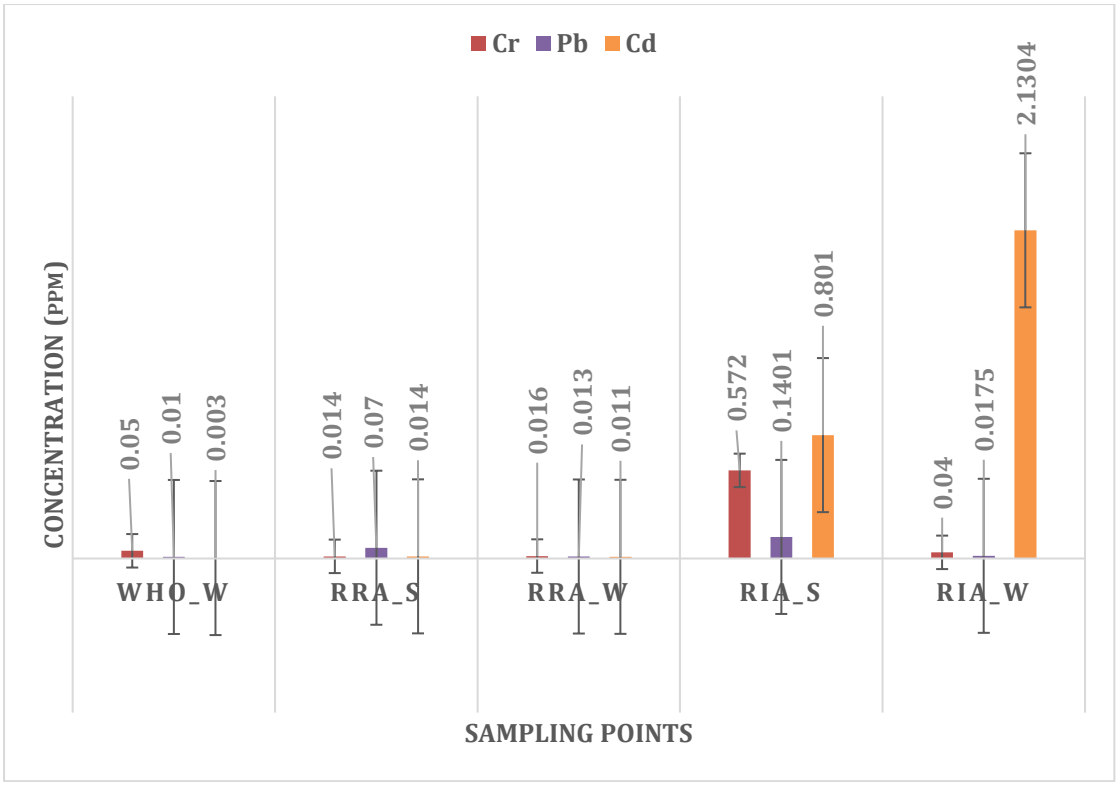

Figure-II: Concentration of heavy metal ions (ppm) in soil and water samples of Rithala Residential Area (RRA) and Rithala Industrial area (RIA)

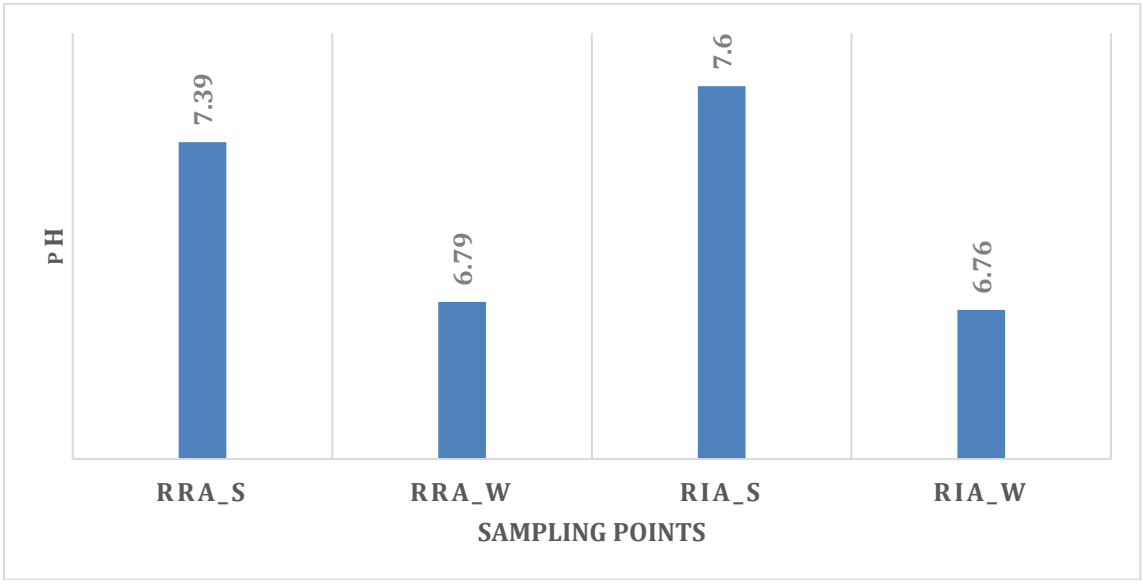

Figure-III: Physiological parameter (pH) in soil and water samples of Rithala Residential Area (RRA) and Rithala Industrial area (RIA)

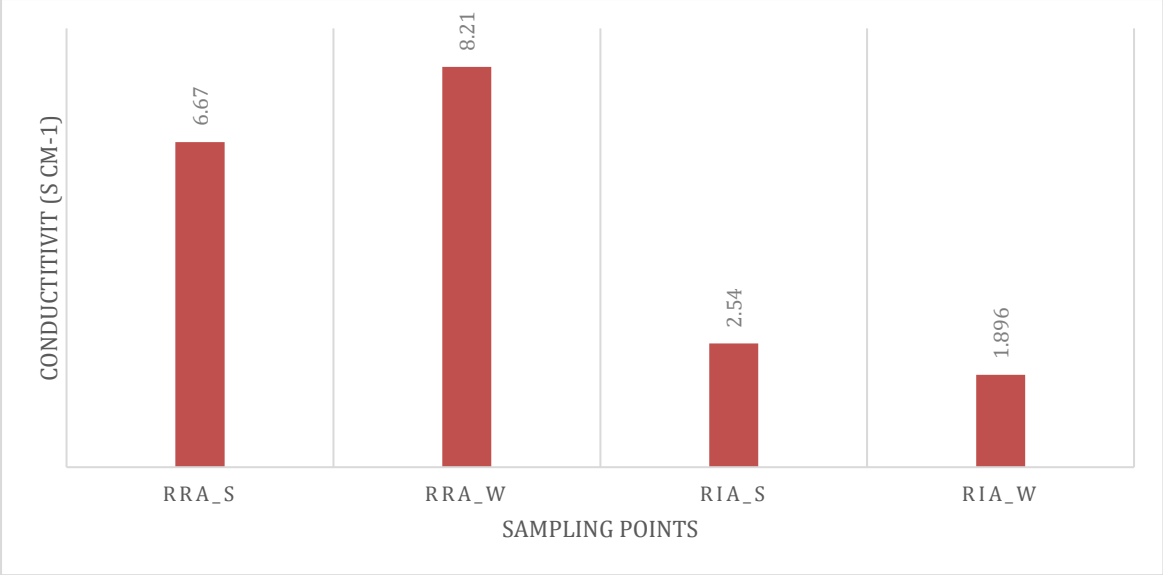

Figure-IV: Physiological parameter Conductivity (S cm^{-1}) in soil and water samples of Rithala Residential Area (RRA) and Rithala Industrial area (RIA).

In the samples lifted from the industrial sites it is 0.8 ppm in soil and 2.13 ppm in water. This water is not fit to drink but can be used in industries.

Chromium can exist in valences from -2 to 6 but is present in the environmental samples like soil and water, it is mainly present in the trivalent or hexavalent state. Hexavalent chromium generated as industrial and mining effluents discharged into the environs. Trivalent chromium (Cr [III]) is the most common naturally occurring state present in most soils and rocks as small amounts of chromic oxide (Cr_2O_3). Cr (III), is considered an essential nutrient for good health in moderate intake (10, 11). Though the permissible limit of Chromium for plants is 1.30mg/kg recommended by WHO, and investigations reveal that these are within safe limits but constant monitoring has to be carried out so that the alarming levels are not reached (12).

Socio-Economic Profile

Rithala is a small scale industrial center. The village is populated with a mix of people from all income groups. The settlement is divided into Old Rithala (Pre 1940) and New Rithala (Post 1940).As people from Rajasthan, Panjab, Uttar Pradesh, Bengal and Bihar are now settled in this village, the languages one can hear are more diverse than most of other villages in the Delhi area (1-3).

Change in Land use pattern

Desertification defined as the persistent dilapidation of arid and semi-arid ecosystems by variations in climate and human activities is one of the greatest environmental challenge affecting today (13). To study the effect of desertification caused due to industrialization, and the resulting pollution a detailed and exhaustive questionnaire was prepared and the students conducted the primary survey in study area. The results of the survey are presented in Figure-V.

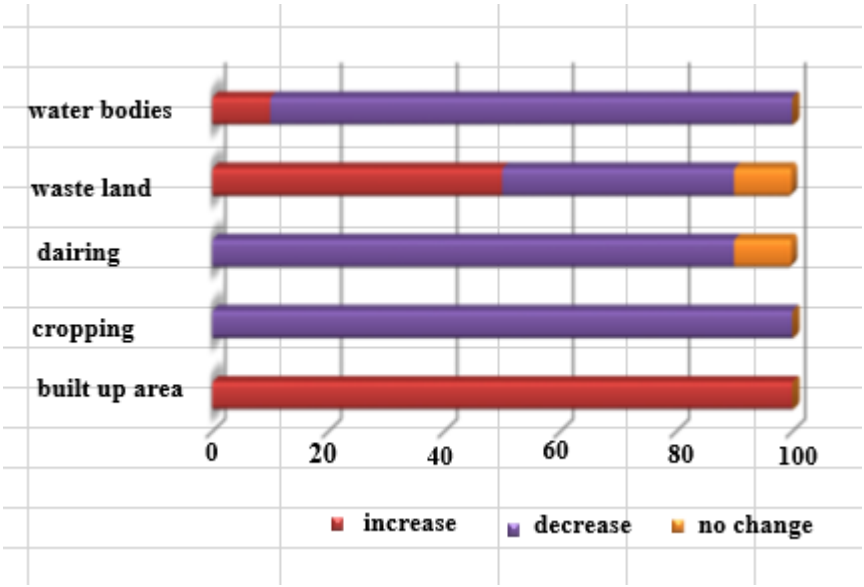

Figure-V: Land use Analysis of Rithala

In general, Delhi-NCR is considered to be a very dynamic socio-economic segment. Human population and natural resources (viz., land, water and air) considered two associated elements in a single structure have been affected by climatic or socioeconomic disturbances in the study area and Rithala is no exception in this. Fluctuations in the climatic conditions like dry spells, erratic rains have contributed to the overall scenario. There has been enormous pressure on the natural resources of the study area with increase in migrant population and over exploitation due to technological advancement in the past two decades. Socio-economic disturbances have been affected by demographic, political, market and technological changes that enable or disenable access to these natural resources. Rithala has witnessed changes in land use mainly due to cultural, political and socioeconomic factors, more than from the direct impact of climate. Agricultural (l) and has been acquired by the government and converted to industrial establishment. Such political and socio-economic disturbances in combination with climatic fluctuations have become the main drivers of desertification. Unchecked environmental degradation has happened in the region due to discharge of toxic industrial effluents into the water bodies and later on to avert the checks and raids directly into the pits thereby polluting the ground water as a result of leaching. All this has caused the physical destruction of the soils and in some cases severely modified their physical, chemical and biological properties. These findings are corroborated by the considerable changes in livelihood patterns. There is significant decrease in choice and compulsion for cropping and dairying as livelihood(14). All this has deteriorated the environment and this is evident from the physico-chemical studies of the water and soil samples collected from the area (14).

CONCLUSIONS

Though these heavy metals were found in soils and plant in this socio-economically dynamic study area, it is worthy of note that chromium levels were below WHO permissive levels. However lead and cadmium were found to be above the WHO standard maxima. The values are below the tolerable levels and hence can be used for industrial purposes but in very higher concentrations plants may pose danger to consumers of plants around these areas. Also continuous usage of farmlands for growing crops even if less in number could lead to bioaccumulation of these metals and their subsequent entry into the food chain with the associated health risks being established. Thus, there is need for chemical/bioremediation of

this environment and compliance of environmental norms to avoid diffusion of Chromium to man through the food chain (15-19).

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