Scientific Journal Impact Factor (SJIF) : 3.518
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

ASSIMILATED EXPLORATION OF CLIMATE CHANGE, LAND-USE CHANGE AND ENVIRONMENTAL DEGRADATION – A CASE STUDY OF ALWAR INDUSTRIAL AREA OF DELHI-NCR

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Abstract-Two essential components of ecosystem i.e., land and water are our most valuable resources, but the way and magnitude to which they are exploited contributes to the menace of climate change. The land use pattern has changed drastically over the time. It is the prime requisites for the preparation of an effective land use policy needed for the proper design and management of any area. The haphazard growth of the area has ignored this aspect. There is a complete lack of integration in resource assessments and policy-making leads to inconsistent strategies and inefficient use of resources. An attempt has been made here to postulate a new paradigm for resource assessments that may help to overcome existing short comings and a better resource management. With this objective toxicity profile and socio-economic scenario of Alwar district of Delhi-NCR has been studied. The concentration of heavy metal ions is particularly very high in certain industrial areas of the region.

Keywords-Land use analysis, socio-economic scenario, resource management, Award, Industrialization, urbanization, heavy metal ions, toxicity profile.

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I. INTRODUCTION

Urbanization can be depicted as the degree at which the urban population of the area is escalating. In the recent past, there has been a vital change in utilization pattern of land and land cover all over the globe because of the ever increasing demands of the mounting population. It may be attributed to fast changing socio-economic scenario including modernization, industrialization and globalization. Up gradation and relocation from rural areas to urban regions is dominating and this appeals in enormous masses because of the approachability to various necessary services including educational establishments, transportation, shopping malls, parks and other recreational activities. Land use practices of a region are affected by various factors especially physical and chemical environments, socioeconomic factors and needs of the masses. All this has put huge stress on natural resources of the concerned area thereby causing wide scale environmental degradation[1].

In order to arrive at right decisions and to minimize the negative impacts of urbanization, industrialization and consequently the impeding Climate change, it is it is important to capture the magnitude of effects up on the environment. This socio-techno approach would help in the sustainable development of the urban populace and ecosystem in general. Keeping this aspect in mind a case study was conducted on the Alwar district in Delhi NCR region. This region is already threatened by the menace of Desertification[1].

II. STUDY AREA

Located about 160 km south of Delhi, Alwar is a city and administrative nerve center of Alwar District in Rajasthan. The whole district is part of National Capital Region (NCR). Alwar is sited in

north-east Rajasthan between 27°04'N and 28°04'N latitudes and 76 °07'E and 77 °13'E longitudes with a total area of 8,380 square kilometres thereby covering about 2.45% of the total area of the State. It is bordered on the north and north-east by Gurgaon District of Haryana and Bharatpur District respectively. Rewari District of Haryana is present on north-west. In south-west, Jaipur District is present and Sawai Madhopur District borders Alwar in the south[2] (**Figure 1**).

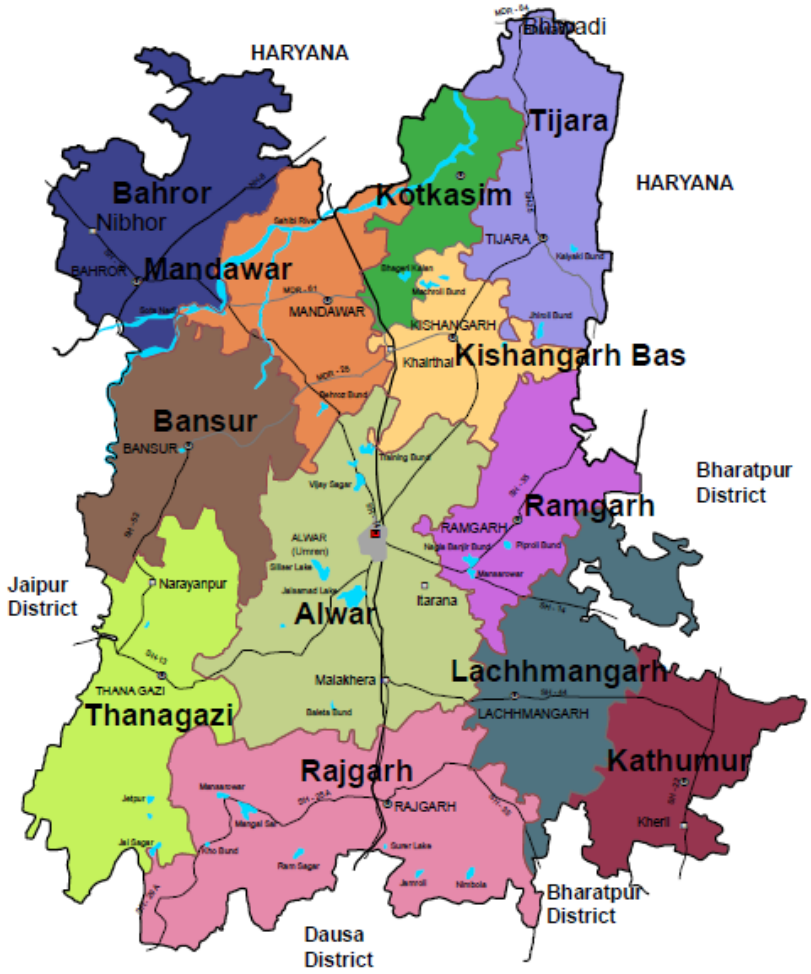

Figure 1: District Alwar of Rajasthan (SOURCE: Survey of India)

Demography of the Study Area[3]

Total population of the District is 36, 741, 79 out of which 17,351, 53 are females and 19, 390, 26 are males[2]. Based on the census 2011 reports, around 60% of the total main work force is involved in agriculture, out of which 52% are cultivators and rest are agricultural labourers (**Table 1** and **Figure 2**).

Table 1: Main workforce in Alwar

Population	Persons	Males	Females
Total Worker	1,708,542	994,171	714,371
Main Worker	1,179,461	835,940	343,521
Main Worker – Cultivator	608,718	387,212	221,506
Main Worker - Agricultural Labourers	95,586	57,388	38,198
Main Worker - Household Industries	21,588	14,314	7,274
Main Worker – Other	453,569	377,026	76,543

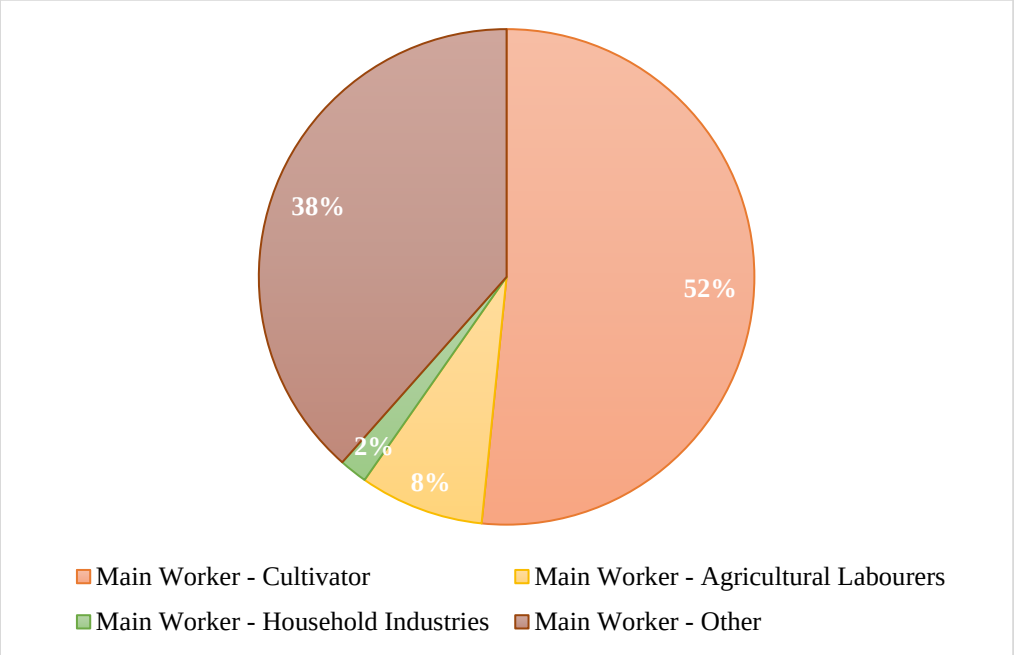

Figure 2: Main workforce in Alwar

Marginal work-force and non-workforce is predominated by females (cf. Table 2 and Figure 3)

Table 2: Marginal workforce in Alwar

Population	Persons	Males	Females
Marginal Worker	529,081	158,231	370,850
Marginal Worker – Cultivator	290,173	77,505	212,668
Marginal Worker - Agriculture Labourers	121,186	34,016	87,170
Marginal Worker - Household Industries	12,974	3,578	9,396
Marginal Workers – Other	104,748	43,132	61,616
Marginal Worker (3-6 Months)	400,586	104,346	296,240
Marginal Worker - Cultivator (3-6 Months)	209,223	39,981	169,242
Marginal Worker - Agriculture Labourers (3-6 Months)	97,187	26,654	70,533
Marginal Worker - Household Industries (3-6 Months)	10,024	2,612	7,412
Marginal Worker - Other (3-6 Months)	84,152	35,099	49,053
Marginal Worker (0-3 Months)	128,495	53,885	74,610
Marginal Worker - Cultivator (0-3 Months)	80,950	37,524	43,426
Marginal Worker - Agriculture Labourers (0-3 Months)	23,999	7,362	16,637
Marginal Worker - Household Industries (0-3 Months)	2,950	966	1,984
Marginal Worker - Other Workers (0-3 Months)	20,596	8,033	12,563
Non Worker	1,965,637	944,855	1,020,782

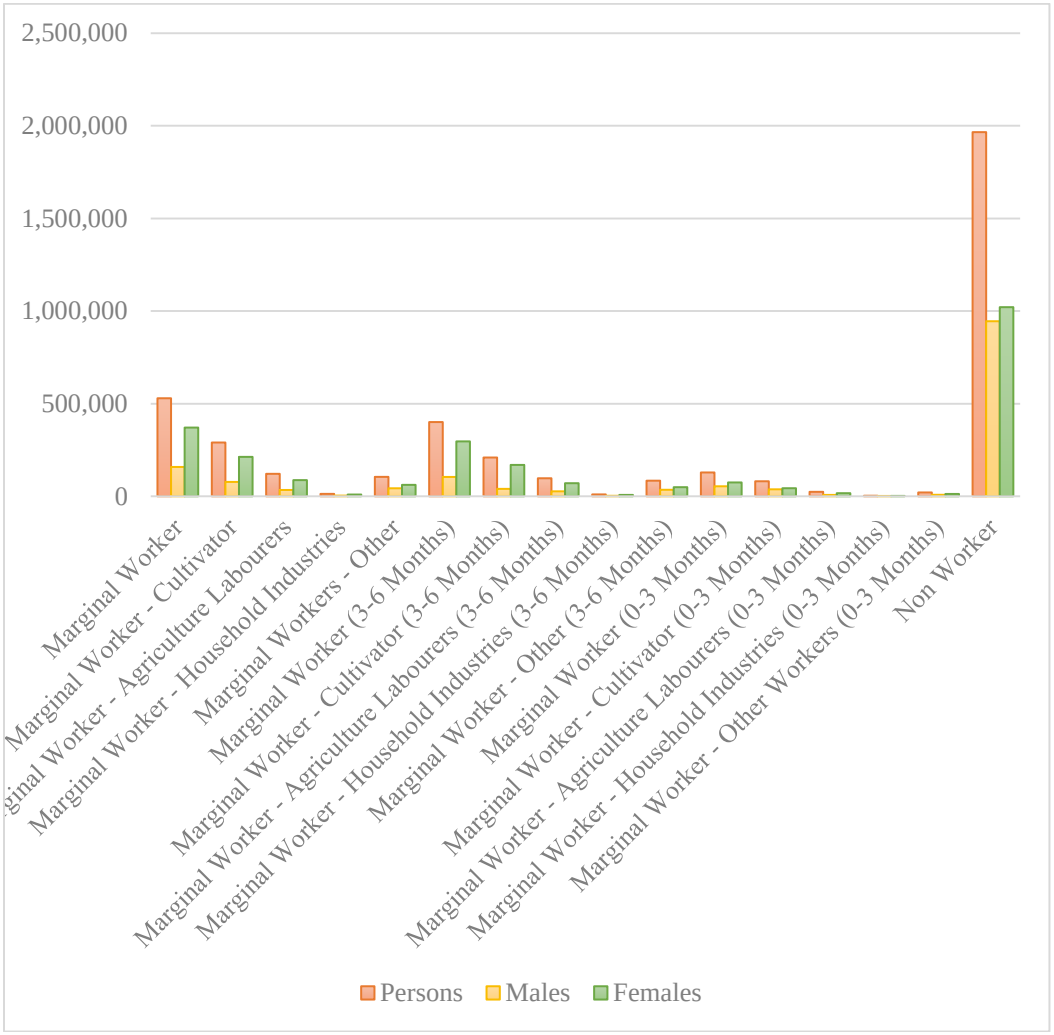

Figure 3: Marginal workforce in Alwar

- **Climate**

The climate of Alwar is semi-arid and extremely hot in summer and very cold in winter. The duration of monsoon season is of very. By the middle of November, the winter sets in and continues up to the beginning of March. Thereafter the summer season follows and prolongs up to the end of the June. The south-west monsoon lasts from July to mid-September. The intervening period from mid-September to mid-November constitutes the post monsoon season. 577.7 mm is the annual average rainfall[1].

- **History**

Formerly it the capital of the princely state of Alwar. In British India it was spelt as “Ulwar” and hence was retained in last position in alphabetically ordered lists. The then king changed the spelling to "Alwar" to bring it to the top. Following the independence of India in 1947, Alwar acceded unto the dominion of India. Merger with three neighboring princely states of Bharatpur, Dholpur and Karauli happened on 18 March 1948 to form the Matsya Union. On 15 May 1949, it was integrated with other adjoining princely states and Ajmer to form the modern Indian state of Rajasthan. Main communities residing here are the Jats, Ahirs, Meos, Khanzadas, Rajputs and Gujjars[4].

➢ **Present scenario**

Alwar is fairly rich in mineral wealth. It is one of the industrially developed Districts in Rajasthan. There were around 100 large, 10 medium and 9500 small scale industries in the District[2]. Some of the small scale industries are listed in **table 3** and **figure 4**.

Table 3: Type and number of small scale industries in Alwar[2]

Type of Small Scale Industries	Number
Agriculture based	1127
Forest based	1477
Mining based	686
Textile based	537
Engineering industries	2376
Chemical industries	658
Animal Based	1580
Building material	484
Others	575

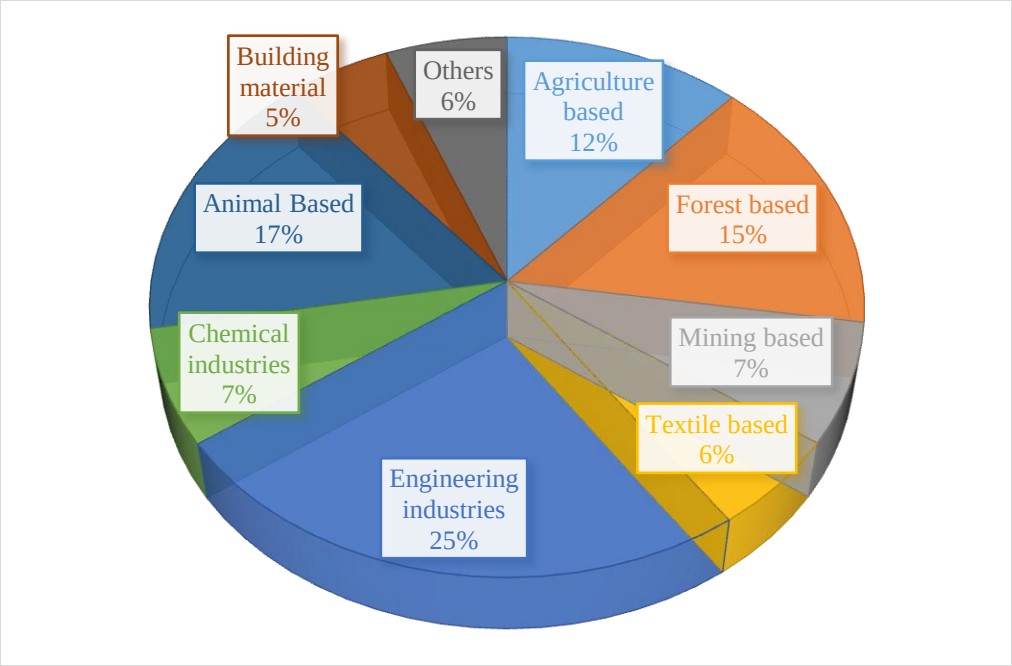

Figure 4: Type and number of small scale industries in Alwar

Hazardous waste emitted from certain industries present direct and long term threats to human beings, animals, plants, and the environment. About 4000 tonnes of hazardous waste is generated each day in Alwar. The origin of pollution begins with the story of industrialization and urbanization. The hasty changes in the land use pattern and random and disorganized growth of city are matter of major concern. In the present work an attempt has been made to scrutinize the chronological land use pattern changes in Alwar, which is one the fast growing district Delhi-NCR[2].

III. MATERIALS AND METHODS

➢ 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 also collected about Himalayan region.

➢ 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 Paar Multiwave 3000*[5]. 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[6].

➢ Analysis of water samples

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

➢ Methodology for primary survey

As industrialization and urbanization had a major effect on land use pattern, environment and human health a questionnaire was framed which helped in taking inputs from the local people about their assessment of the environmental degradation. Primary field survey concerning geographical aspects was carried out to evolve critical interaction areas, specific area needs, ecosystem needs.

IV. RESULTS AND DISCUSSION

Climate change will have its impact on the way the society is going to function (IPCC, 2007)[7]. This in fact is affected by industrialization and urbanization which stress the natural resources. It is imperative to examine the land use analysis and toxicity profile of the study area.

Land use analysis

Environment involves water, air, land and the interrelationship that exists between water, air, land, and human beings, other living creatures, plants and microorganisms. The information on all such aspects is an important tool for any decision making process for environmental management. There are also very complex associations between ecological degradation, climate change and land use change.

Anthropogenic factors like industrialization, urbanization and agricultural activities have been a driving forces in contributing to each of these glitches. In a number of occasions actions to limit emissions to address one problem will have effects on others as well. Two associated elements i.e., human population and natural resources including land, water and air in a single configuration, have been affected by climatic or socioeconomic disturbances in the study area and Alwar is no exception in this[8]. Variations in the climatic conditions like dry spells, erratic rains have contributed to the overall scenario. There has been enormous stress 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. Alwar has perceived changes in land use mainly due to cultural, political and socioeconomic factors, more than from the direct impact of climate.

Land use analysis has revealed that agricultural land has been acquired by the government and converted to industrial establishments (**Figure 5)**. Such political and socio-economic disturbances in combination with climatic fluctuations have become the main drivers of desertification. Unrestrained environmental degradation has happened in the region due to release of toxic industrial effluents into the water bodies like "Siliserh Lake". All this has caused the physical destruction of the soils and in some cases severely altered 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 (Kumar, P. 2009)[9]. Even the land under cultivation has become polluted due to overuse of fertilizers and pesticides. All this has deteriorated the environment and this is evident from the physico-chemical studies of the water and soil testers collected from the area[7]. Moreover there has been substantial decrease in number of waterbodies in the area. The forest cover has reduced substantially (cf. **table 4)**

Table 4: Land utilization in the year 2010-11

S.No.	Land utilization	Hectare
i.	Total Area	8,38,300
ii.	Forest cover	79,574
iii.	Non Agriculture Land	1,29,636
iv.	Cultivable Barren land	5,04,049

Figure 5: Land use analysis of Alwar

Toxicity Profile

There is a lot of variation in the wide spread natural and anthropogenic sources of soil and water pollution (Tahir et al, 2007)[10]. The concentration of heavy metal ions in water and soil matrix of Alwar

study area are presented in **table 4** and **figure 6**. As can be seen here the levels of lead, chromium 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 emissions of wastes from the industries, sewage effluents etc. thereby triggering their 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 poisoning in humans leads to chronic neurological disorders in most vulnerable growing kids. There is an urgent need of remediation. Uptake rate of lead varies among and within species and is highly related to soil pH. The pH of the soil system is a very important factor, directly inducing the various reactions and mechanisms such as sorption/desorption, precipitation/dissolution, complex formation, and oxidation-reduction happening in the soil matrix. In general, maximum retention of cationic metals occurs at pH>7 and maximum retention of anionic metals occurs at pH<7[11]. Because of the complicated nature of the soil-waste system, with its myriad of surface types and solution composition, such a generalization may not hold true. For instance, cationic metal mobility has been observed to increase with increasing pH due to the formation of metal complexes with dissolved organic matter. In the soil samples collected from Alwar, the pH of the soil lies in the alkaline phase and due to complicated nature of the samples it is expected that metals undergo dissolution and hence become more bioavailable. Lead is absorbed by root hairs and stored mainly in cell walls. It is reported that 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 **Table 5** and **Figure 5.** The concentration of lead from the soil samples lifted from industrial site AIA is 0.227 ppm and in the residential site ARA is 0.0584 ppm. Thus there is an urgent need of remediation.

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) [12, 13]. After entering the body via the gastrointestinal tract after eating food products grown on contaminated soil may 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. In the samples lifted from the industrial sites it is 0.913 ppm in soil and 3.0435 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[11, 12]. 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. The levels of Cr in soil samples ARA and AIA are 0.572 and 0.868 ppm respectively.

Table 4: Heavy metal ion concentration (ppm) in soil and water samples of Alwar Residential Area (ARA), Alwar Industrial area (AIA) and Alwar Siliserh Lake (ASL)

SAMPLES	Cr	Pb	Cd
WHO_W	0.05	0.01	0.003
ARA_S	0.572	0.0584	0.913
ARA_W	0.016	0.0233	0.15
AIA_S	0.868	0.2277	3.0435
AIA_W	0.014	0.0275	3.3478
ASL_W	0.027	0.0409	0

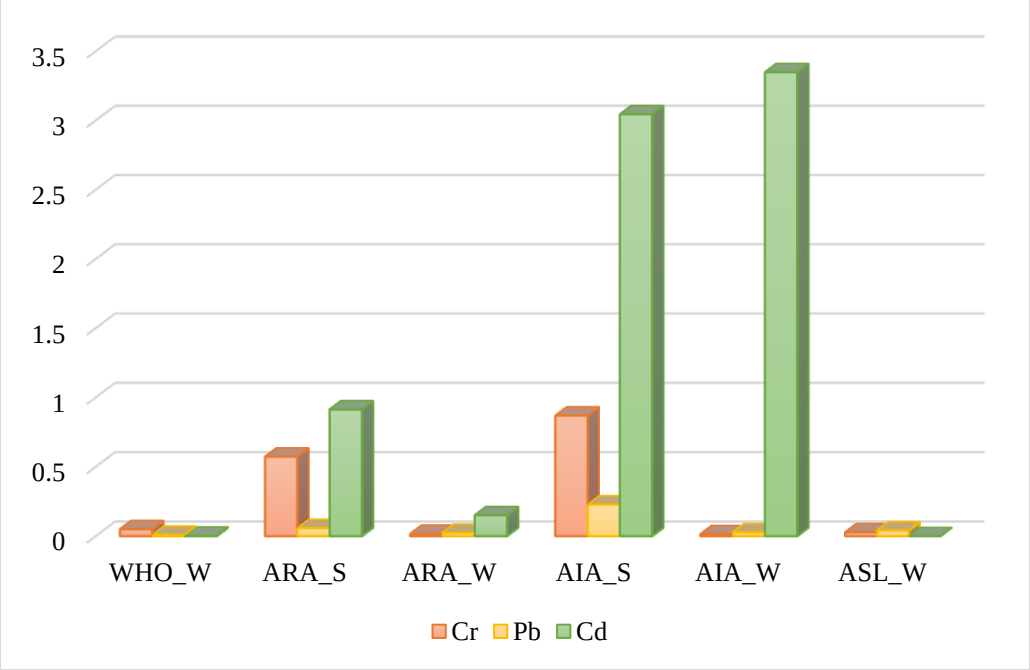

Figure 6: Heavy metal ion concentration (ppm) in soil and water samples of Alwar Residential Area (ARA), Alwar Industrial area (AIA) and Alwar Siliserh Lake (ASL)

Table 5: Physiological parameters in soil and water samples of Alwar Residential Area (ARA), Alwar Industrial area (AIA) and Alwar Siliserh Lake (ASL)

SAMPLES	pH	Conductivity $\times 10^{-2}$ (S cm^{-1})
ARA_S	9.47	7.19
ARA_W	7.15	2.74
AIA_S	7.39	4.26
AIA_W	6.60	16.58
ASL_W	7.74	8.84

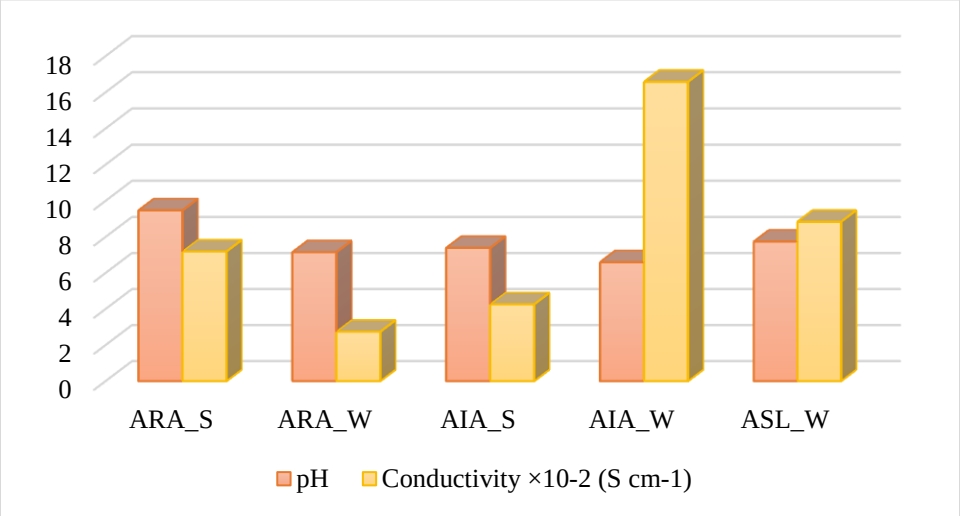

Figure 7: Physiological parameters in soil and water samples of Alwar Residential Area (ARA), Alwar Industrial area (AIA) and Alwar Siliserh Lake (ASL)

Point of view of resident/worker

After reaching the Nagli Circle of Alwar, team visited the industrial area of Alwar, Amit Kumar, a worker working in an industry here informed that prior to inclusion in the NCR region, and the population of this area was very less. Eventually the industries have come up on the land which was used for agricultural purposes earlier. As Ground water is being used by industries and its level is continuously depleting. According to Bharat Singh a local resident of the village near Siliserh Lake, though the city has developed and has a better infrastructure, the natural resources have been over exploited and are constantly dwindling day after day. On reaching the large "Siliserh Lake", the team investigated and found that its water is not good for consumption. Its pH level was around 7.74. Even boating has been banned here. This has caused major unemployment in the area. This earlier a beautiful lake spreads in 7 sq Kms area, was built by Maharaja Vinay Singh in year 1845. This lake and reservoir of Siliserh was created for the people of Alwar.

V. CONCLUSIONS AND RECOMMENDATIONS

The inference generally drawn on the impact of climate change are not typically exhibited according to the socio-technical paradigm (that is, as physical and social elements that interact in various ways), but on the basis of aggregate structure level parameters. For instance, an education model might show that rote learning among the students is increasing, but an analysis of how their learning behavior may also change is lacking. In a similar way explicit replication of adaptation procedures is a missing step. Thus there is an urgent need of simulating the interconnectedness of environmental management, climate change and land utilization, as exploration of strategies for adapting our society's backbones to climate change is paramount[14]. In this direction there is an urgent need for chemical/bioremediation of this environmental menace and compliance of environmental norms to avoid diffusion of heavy metal ions to man through the food chain[15-17].

VI. ACKNOWLEDGMENTS

The authors are extremely thankful to University of Delhi for providing financial assistance in completing this project under the Innovation project scheme KMC-204.

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