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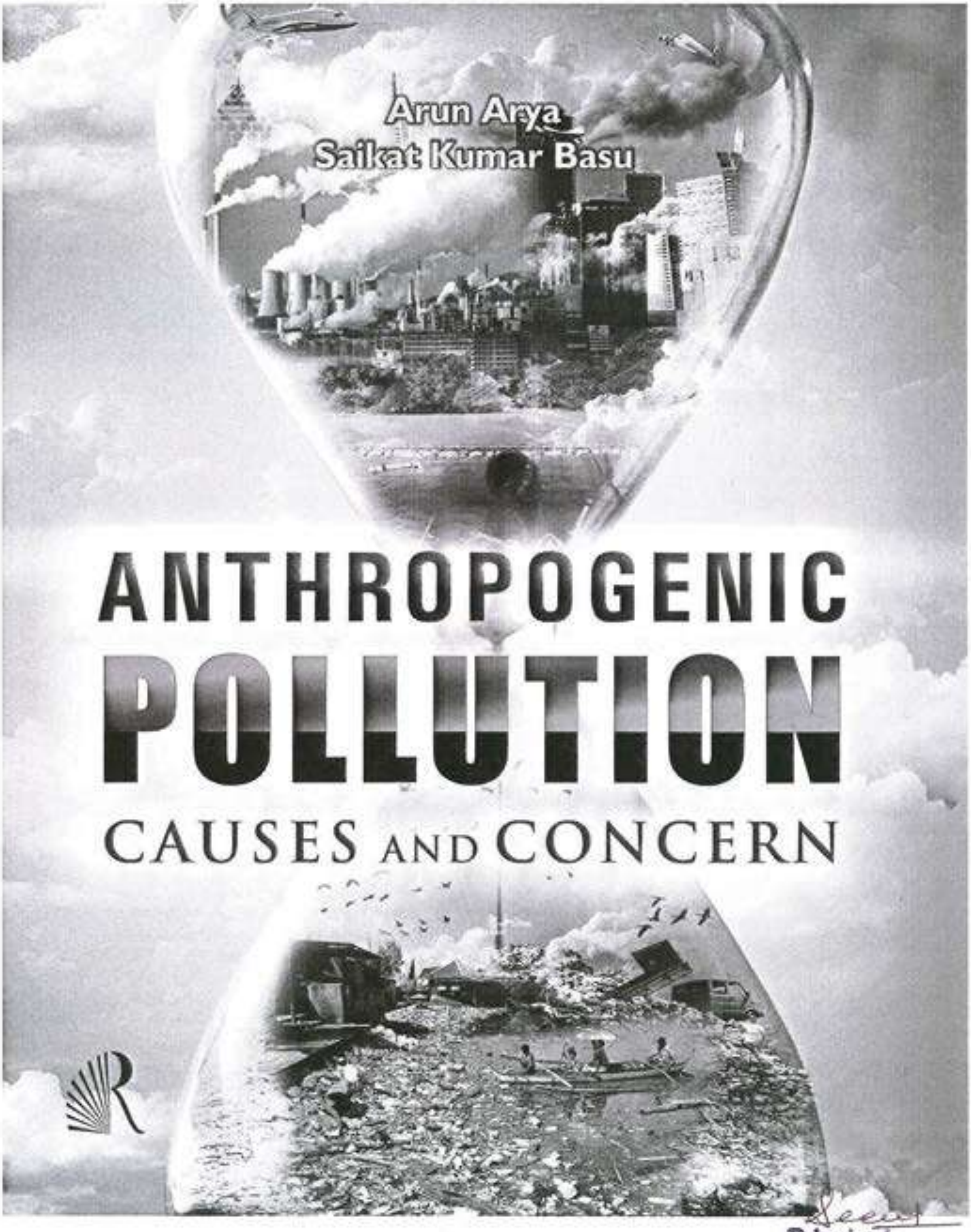

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ANTHROPOGENIC
POLLUTION
CAUSES AND CONCERN

Anthropogenic Pollution:
Causes and Concerns

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Environmental Pollution by Textile Industries: Case Studies and Analysis

2.1 Introduction

Thousands of hazardous waste sites have been generated worldwide resulting from the accumulation of xenobiotics in soil and water over the years (Jain *et al.*, 2005). Specifically, drugs such as antibiotics are xenobiotics in humans because the human body neither produces them itself; nor would they be expected to be present as part of a normal diet. Organs transplanted in foreign bodies of different species are termed as xenotransplantation. However, the term is also used in the context of pollutants such as dyes, dioxins and polychlorinated biphenyls and their effect on the biota. Natural compounds can also become xenobiotics if they are taken up by another organism (*e.g.*, uptake of natural human hormones by fish found downstream of sewage treatment plant outfalls). There are two types of xenobiotic compounds. They may be biodegradable or nondegradable /recalcitrant. Biodegradable xenobiotic compounds are those that get degraded by the action of microbes or other reactions while recalcitrant compounds are resistant to degradation by any reactions. The recalcitrant xenobiotic compounds can be grouped into various groups like halocarbons, polychlorinated biphenyls, oil mixtures, synthetic polymers, alkyl benzyl sulphonates, etc. The potential health hazard of a xenobiotic compound is a function of its persistence in the environment as well as the toxicity of the chemical class. They tend to accumulate in the environment and lead to bioaccumulation and biomagnifications (Aelion *et al.*, 1987).

2.2 Biodegradation

Biodegradation is considered as a phenomenon of biological transformation of organic compounds by living organisms particularly microbes. Biodegradation can be divided into three categories i.e. Mineralization, Biotransformation and Cometabolism. Mineralization is a process where the organic chemical is broken down into inorganic compounds. It is also known as "ultimate biodegradation". Typical products of aerobic mineralization are carbon dioxide, water and ammonia. In biotransformation, the organic chemical only undergoes small structural changes.Co metabolism is the transformation of a nongrowth substrate in the obligate presence of a growth substrate or another transformable compound. Bioremediation is one of the efficient methods of remediation of organic pollutants/xenobiotics, as it is less expensive and can selectively achieve complete destruction of organic pollutants (Alexander, 1994; Cookson, 1995). Bioremediation can be defined as the action of microbes or other biological systems to degrade environmental

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pollutants. Microorganism has the capability of degrading all naturally occurring compounds; this is known as the principle of microbial infallibility proposed by Alexander in 1965. Mix cultures of microbes can together be used to degrade xenobiotic compounds completely because they produce different enzymes that act on recalcitrant compounds and degrade them to simpler form. Smaller compounds are again taken up by other series of microbes and degraded wholly. Since xenobiotics consist of a wide variety of compounds, their degradation occurs via a large number of metabolic pathways. Degradation of alkanes and aromatic hydrocarbons generally occurs as follows: an oxygenase first introduces a hydroxyl group to make the compound reactive, the hydroxyl group is then oxidized to a carboxyl group, the ring structure is opened up (in case of cyclic compounds), the linear molecule is degraded by âoxidation to yield acetyl CoA, which is metabolized in the usual manner.

2.3 Dyes and Phenol

Dyes and phenol are such xenobiotic compounds which accumulate in environment after being produced from various industrial operations. Textile dyes are one of the most prevalent type chemicals used today. Textile industry is the single largest organized sector in the country, employing almost 25% of the country's labour force. India textile industry largely depends upon the textile manufacturing and export. It also plays a major role in the economy of the country. It account for almost 1/3 rd of the total export earnings in the country (Juwarkar*et al.*, 1997; Paul, 1997).Further, the textile industry of India also contributes nearly 14% of the total industrial production and 3% to the Gross Domestic product (GDP) of the country (Annual Report 200910, Ministry of Textiles).The industry is expected to grow from the present US$ 70 billion to US$ 220 billion by 2020. The total cloth production has increased by 2.9% during December 2010 as compared to December 2009.

2.4 Indian Textile Industry

Indian textile industry can be divided into several segments i.e. Cotton, Silk, Woolen and Jute. The cotton industry constitutes a major portion of textile industry in India. These are located in Ahmedabad, Kanpur, Indore, Surat, Nagpur, Kolkata, Chennai, Coimbatore and Madurai. The annual production of cotton yarn in India is about 102.1 crore Kg. India is world's second highest cotton producer. The Jute industries are located in cities like Kanpur, Guwahati and Kolkata. The Silk industries have flourished in Southern India. These are present in cities like Bangalore, Benaras, Chennai, Coimbatore and Madurai. Srinagar, Kanpur and Bengaluru are the major cities with wellflourished Wool industries (Mathur and Kumar, 2012a and 2012b, Mathur *et al.*, 2008).

This sector has wide spectrum of industries ranging from smallscale units that use traditional manufacturing process, to large integrated mills using modern machineries and equipment. There are 2324 textile industries in the country including composite and process houses. Textile industries transform fibres into yarn; convert the yarn into fabrics or related products, and dye and finish these materials at various stages of production. At present 9000 different types of dyes, belonging to various application and chemical classes are in use in the textile production and other industrial processes such as pulp and paper, tannery, paints etc. About 56% of the total dye production is consumed in the textile sector. Various dyes used in textile printing are listed in Table 1.

Table 1. Types of dyes used for printing purposes

Fibres	Application classes
Natural fibres:	
(I) Animal:	
Wool	Acid, basic, mordant, reactive, solubilized vat
Wool blends (woolcotton, woolviscose etc.)	Acid, direct mordant, reactive
Silk	Acid, basic, direct, mordant, reactive, solubilized vat
(II) Vegetable fibres:	
a. Unmodified	
Cotton	Azoic, basic, direct, mordant, oxidation, reactive, sulphur, vat
Bast (linen, flax, hemp, jute, ramie)	Acid, direct,(disperse), reactive, vat, solubilized vat
b. Modified cellulose fibres	
Viscose	Direct, mordant, pigment, reactive, sulphur, vat, solubilized vat
Secondary acetate	Disperse
Triacetate	Disperse
Synthetic fibres:	
Polyamide (nylon, perlon, rilsan)	Acid, disperse, mordant, pigment, reactive
Polyester (Dacron, terylene)	Basic, disperse, pigment
Polyacrylonitrile (acrilan, courtelle, orion)	Basic, disperse, pigment
Polyvinyl chloride (envilon, thennovyl)	Basic, disperse
Polyolefinens (meraklon, prolene)	Disperse
Elastomers (glospan, lycra)	Acid, disperse, reactive, (wool), vat

2.5 Industries of Rajasthan

Rajasthan state which is situated between 23º3' and 30º12' N latitude and 69º30' and 78º17' E longitude,textile industry has established itself in a big way, accounting for nearly 20 percent of the investment made in the State (Joshi and Kumar, 2011). Rajasthan contributes over 7.5 percent of India's production of cotton and blended yarn (235,000 tonnes in 200203) and over 5 percent of fabrics (60 million sq meters). However, dyeing and printing of textile being a traditional industry of Rajasthan and due to the heavy demand in the country and outside of cloth printed in Rajasthan and liberal policies of Rajasthan Government to encourage industrial growth with a view to provide employment to the people of this part of the State, a good number of textile industries have come up in the area. Another key factor responsible for development of textile industry in Rajasthan is availability of cotton and wool in the state. As textile processing requires good amount of water, these industries are invariably situated near river banks where transportation facilities also exist. As a result, in Pali, Jodhpur and Balotra towns, clusters of manual processing, dyeing and printing industries have come up. The other important areas are Bhilwada, Bagru and Sanganer.

2.6 Waste water released fromTextile Units

Rajasthan has leading position in spinning of polyester viscose yarn & synthetic suiting (at Bhilwara) and processing, printing & dyeing of low cost, low weight fabric (at Pali, Balotra, Sanganer and Bagru). Besides, Jaipur is also a wellknown center for manufacturing garments primarily for exports. Some knitting units are in process of setting up their ventures at Neemrana.

Bhilwara emerged as India's largest manufacturer of suiting, fabrics and yarn. Its share in the polyester/viscose fabrics (suiting) sector is around 50 per cent in India.In processing of textiles, the industry uses a number of dyes, chemicals, auxiliary chemicals and sizing materials. Waste water discharge from these textile units has caused degradation of water quality in the area. Local people are facing problem in obtaining water for drinking and irrigation since ground water is also significantly polluted in the area. The problem has attracted the attention of media and also of the Central and State Governments.

Textile wastewater is a major source of pollutants. Textile industries consume large amount of water and chemicals for wet processing of textiles. After processing, these industries discharge generally untreated effluents into the AmanishahNalla or adjoining drains from where they finally reach the AmanishahNalla. During the course of movement of the effluents, there is considerable amount of infiltration and percolation of the toxic chemicals into the soils thus polluting soil, underground water, pools and vegetation. The chemical reagents used are very diverse in chemical composition, ranging from inorganic compounds to polymers and organic products (Banat *et al.*, 1996). In general, textile effluents are mostly discharged into the environment after minimal pretreatment with a high amount of pollutants (Oxspring*et al.*, 1993). It is typically grey or coloured, alkaline and high in temperature, BOD(700 to 2,000 milligrams per liter (mg/L)) (Park and Shore, 1984)and chemical oxygen demand (COD) (approximately 2 to 5 times the biochemical oxygen demand (BOD) level), solids, oil and possibly toxic organics, including phenols (from dyeing and finishing) and halogenated organics (from processes such as bleaching) (Table 2). Dye wastewaters are frequently highly colored and may contain heavy metals such as Cu, Cr, Cd, Co, Hg, Ni, Mg, Fe and Mn (Wagner, 1993). Wool processing may release bacteria and other pathogens. Pesticides are sometimes used for the preservation of natural fibers and these are transferred to wastewaters during washing and scouring operations. Pesticides are also used for moth proofing, brominated flame retardants for synthetic fabrics, and isocyanates for lamination.The toxic effluents from dyeing and printing units are scattered all over the Sanganer and have polluted soil, water and vegetation. The different processes involved in dyeing and printing of clothes are shown in Fig. 1 (AC).

Table 2: Properties of waste water from textile chemical processing.

Property	Standard	Cotton	Synthetic	Wool
pH	5.59.0	812	79	310
BOD(mg/l)	30350	150750	150200	5000 8000
COD (mg/l)	250	2002400	400650	10,00020,000
TDS (mg/l)	2100	21007700	10601080	10,00013,000

2.7 Industrial Affluent Containing Dyes

Industrial effluents containing dyes, aniline, caustic soda, acids, bleaching powder, metal ions etc. are discharged into AmanishahNalla (Canal) which flows through Sanganer. Water from the canal is used by farmers to irrigate their fields (Fig. 1 D & E). Vegetables grown in these fields are sent to the market in the urban centre for consumption which causes many disorders and diseases. Workers engaged in this type of industry also suffer from various health hazards like eczema, contact dermatitis, asthma etc.

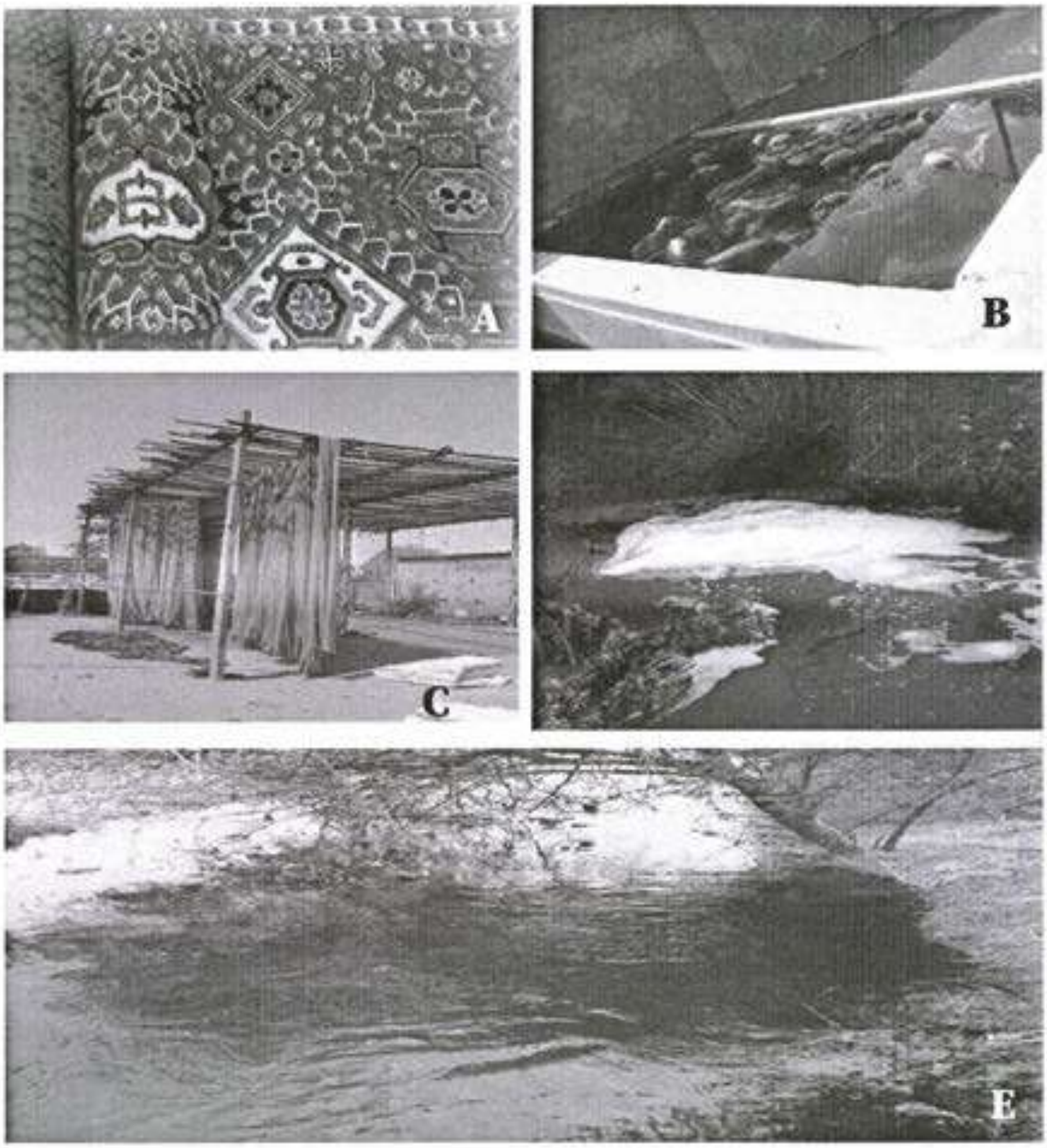

Fig. 1. Processing and washing of clothes in the textile industry and subsequent pollution. A. Hand block printing; B: Washing of finished cloth to remove excess color; C: Sun-drying of colored cloth; D: Drain carrying effluents from different textile industries; and E: Dyes polluting soil and water

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2.8 Environmental Pollution

Several studies reported highly colored, foul smelling soil samples with alkaline (pH 8.8), containing trace metal ions. The presence of color in the effluents might be due to high exhaustion rate of unused dyes, which reduces the light penetration, thereby limiting the biological activity in it which ultimately reduces the self purification ability of the ecosystem (Sarnaik and Kanekar, 1995; Banat *et al.*, 1996). Alkaline pH reported to be due to excessive usage of NaOH, H_2O_2, detergents and anionic stabilizers during bleaching processes (Wood and Kellogg, 1988). High pH in the wastewater limits the microbial growth in it which is an important source of bioremediation in water ecology (Banat *et al.*, 1996). The values of electrical conductivity of somewere found to be quite high as compared to others. The high value of electrical conductivity might be due to the presence of high concentration of ions and dyes contributed by numerous printing houses located near the drain. Similar reports on high pH and high electrical conductivity values of the soil samples were also reported by Gupta *et al.* (1994) and Joshi & Kumar (2011).

Presence of heavy metal ions arises from material used in the dyeing process, or in a considerable amount, from metal complex dyes. Metal complex dyes incorporate metals such as Zn, Cu and Ni after their degradation into water supplies (Heinfling*et al.*, 1997). Similarly, Sabour*et al.*, (2001) studied the area of Mostorod, Cairo (Egypt), and reported the effluent samples from fabric industry had the greatest amount of total Zn, Cu, Cd, Co and Pb. Longterm irrigation with such effluents can increases electrical conductivity, organic carbon content and heavy metals accumulation in soils. Accordingly, high concentration of heavy metal ions like Zn, Fe, Cu and Mn and higher values of organic carbon were reported in Sanganer.

2.9 Conclusion

It is therefore important to note that textile affluent could be serious and significant source of environmental pollution due to lack of proper monitoring and surveillance and lack of strict regulations of the offenders. The use of industrial affluent is not recommended for secondary use as irrigation water since it can lead to significant level of soil pollution under long term application.

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