WORLD ENVIRONMENT DAY
JUNE 2018

On the Theme of

"BEAT THE PLASTIC POLLUTION"

Celebrated by

PAKISTAN ENGINEERING CONGRESS

Pakistan Engineering Congress
(4th Floor) Pakistan Engineering Congress Building,
97-A/D-1, Liberty Market Gulberg III, Lahore 54660
(Near Liberty Roundabout)
Phone: (042) 35784238, (042) 35784235 Fax: (042) 35784236
Web-site: www.pecongress.org.pk
E-mail: info@pecongress.org.pk

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Compiled and edited
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Engr. Ch. Ghulam Hussain
Immediate Past President / Convener Symposium Committee

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TABLE OF CONTENTS

	Address of Welcome on World Environment Day, June – 2017	***Engr. Tariq Rashid Wattoo,*** *President Pakistan Engineering Congress*	ix
	Keynote Address	*Dr. Abdul Majeed, Water, Energy and Climate Change Expert, IUCN Pakistan*	xi
110	**Plastics: Environmental Issues and Remedial Solutions**	*Dr. S. E. Benjamin*	1
111	**Integrated Plastic Solid Waste Management (ISWM) System Based on 3R Principle and Resource Conservation and GHG Emissions**	*Muhammad Sajid, Iqrash Suhaib, Mahnoor Shah, Asra Tariq, Dr. Asad U Khan, Dr. Nasir M. Ahmad*	9
112	**Impact of Domestic and Industrial Effluent of Lahore City on Groundwater**	*Engr. Dr. Muhammad Saeed, Engr. Rahmat Ullah Sheikh, Engr. Muhammad Shoaib, Engr. Jawad*	19
113	**Need for Intelligent Transportation System for Reducing Traffic Carbon Pollution in Lahore**	*M. Munir, M. Shafiq Qureshi, Dr. A. B. Sufi, S. L. Zaidi*	31
114	**Reducing Plastics Waste Pollution: Challenges and Key Solution Strategies**	*Asif Ali Qaiser, Anum Saeed*	45

115	**Plastic Pollution and its Impact on Water Resources**	*Ghulam Zakir Hassan, Adnan Hassan, Sumayya Noshin*	57
116	**Plastic Pollution: Impacts on Biodiversity**	*Dr. Abdul Aleem Chaudhry*	73
	Listing of papers presented at various World Environment Day(s)		105



Engr. Tariq Rashid Wattoo
President
75th Session

INTRODUCTORY REMARKS
By
ENGR. TARIQ RASHID WATTOO
PRESIDENT
PAKISTAN ENGINEERING CONGRESS
AT
WORLD ENVIRONMENT DAY on Saturday, the 23rd June 2018
ON THE THEME OF "Beat the Plastic Pollution"

Distinguished Guests,

Members of Pakistan Engineering Congress,

Fellow Engineers, Ladies and Gentlemen!

Assalam-o-Alaikum

The Plastic(s) products are made in different sizes and shapes and its use is increasing with the increase in population of the world.

- One-time use, non-biodegradable bags especially Black Plastic Bags
- Bottles
- Jars
- Electric Goods-Switches etc.
- Soft Drink Bottles
- Packaging Materials
- Polyester Fibre- used in cloth
- Re-useable Shopping Bags

The use of plastic products is a result of its numerous characteristics

- Durability
- Corrosion Resistance
- Light Weight- ease in Transportation of Goods etc.
- Conversion in different shapes
- Energy generation through incineration along with other waste materials
- Re-cyclable- it's a good quality which appears the only solution to control its increasing production

Ladies & Gentlemen!

The very characteristics of Durability/ non-biodegradable is causing immense harm to environment and public health. Roughly 8.3 billion metric tons of plastics produced worldwide since the 1950s, about 6.3 billion have been thrown away, according to 2017 study in the Journal "Science Advances".

- Towers of trash engulf Delhi-a Land-Fill storeys high crashes and kills a young man
- A UN report on International Environment Day cautions the world that at present plastic consumption level, the world will be awash with 12 billion tons of plastic trash by the end of the century

- The plastic enjoys a 450 years span of existence gets shredded into pieces and gets ingested by Marine, Birds etc.
- A pilot whale that washed ashore in Southern Thailand in critical condition and with a belly full of black plastic bags, becomes a cause of World Wide concern. And its death a few days later was a reminder of a staggering global problem: plastics in the oceans and seas.

Ladies & Gentlemen!

Plastic bags and products are a source of huge environmental degradation in following ways;

- A great Patch of plastics has appeared (like an island) in the Pacific Ocean
- Drains
- Streets
- Major Water Resources
- Streams
- Clog Sewers
- Habitat of Animals
- Marine Creatures
- Birds Entanglement

The immense harm caused using plastic bags, bottles etc. has forced a number of countries to ban its use some of which are;

- China
- India
- Bangladesh
- Taiwan
- Kenya
- Macedonia
- Rwanda
- Morocco

The only solution to avert the Plastic invasion is;

- Production/use of one-time plastic bags to be totally banned
- Recycling of the Plastic Products especially plastic bottles to check un-controlled production
- Energy generation through incineration of the Plastic Products along with other waste materials

Thank you all for your patient hearing.

PAKISTAN PAINDABAD

Keynote Address

Delivered on World Environment Day 2018

By

Dr Abdul Majeed, Water, Energy and Climate Change Expert,
IUCN Pakistan

The theme for todays' talk is "Beat the Plastic Pollution" and that suddenly reminds me of the good old days' scenario when every household used to have metallic or ceramic utensils, besides a grocery basket in which all the grocery items were brought from the market. Every household used to have a pail especially for fetching milk and every household used to have a special cloth to rap *chapatis* or *naans* from the local "*Tandoor*". In the clinics and hospitals there used to be syringes made of glass were sterilized in the boiling water and used countless number of times or for months or even years. Even the baby feeders were made of glass bottles that were washed by mothers and continuously used as long as the feeder remained useable. I am sure everybody would agree that once this was the standard lifestyle which generated very little garbage. Since then the World has undergone a remarkable change from those old practices to the new lifestyles with its associated vices that go with the modern age.

Plastic use is one of the vices that the modern fast moving age has brought with it with huge environmental consequences. Plastic, as a product, has lots of qualities that gained quick popularity and made it the most used material in everyday life. There is no doubt that it is versatile, lightweight, flexible, moisture resistant and cheaper than other counterpart materials, qualities that, perhaps, have made us turn a blind eye towards its harmful effects on our environment. Our insatiable appetite for it has increased its consumption manifold and so has increased the level of pollution caused by it. It is a classic case of a boon slowly turning into a bane since humans continue to use plastic and products made by it and then littering their surroundings with it. The durable nature of plastic does not let it decompose easily, thus making it a major source of pollution today. Even a small fragment of plastic has the durability to stay on earth for a thousand years.

"Plastic pollution has become an epidemic," a UN Agency concludes. "Every year, we throw away enough plastic to circle the Earth four times. Much of that waste doesn't make it into a landfill, but instead ends up in our oceans, where it's responsible for killing one million seabirds and 100,000 marine mammals every year. For the good of the planet, it's time to rethink how we use plastic."

Causes of plastic pollution

One may wonder "Why is plastic becoming the greatest threat to environment". The answer lies in the properties of plastic that make it attractive. I will briefly dwell upon the same.

- **Long Durability:** The durability of plastic makes it resistant to the natural biodegradation process. Its composition makes it difficult to decompose plastic through natural means.

- **Easy Availability:** Almost all consumer goods are today sold in a plastic bags, wrappers, lining or covering and the plastic packaging is then disposed along with the regular trash.
- **Inexpensive than other counterpart Materials:** A plastic bag is generally cheaper than an eco-friendly bag, for instance. For the lower sections of the society, both lack of awareness and financial constraints make them reach for the plastic bags.

Effects of plastic pollution

Every year the world uses 500 billion plastic bags. Each year 8 million tonnes of plastic is dumped in the oceans. 50% of the plastic that is currently in use is either single-use or disposable. Almost 1 million plastic bottles are sold every minute across the globe. The figures are extremely alarming and leave much to think about what we are doing to the environment where we live. The point is that plastic pollution not only causes drastic harmful effects on its own but also contributes heavily to polluting the air and water bodies of this planet.

- *Contamination of the Ocean Beds*

Pakistan being no exception most of the plastic trash finds its way into the ocean, thus polluting the ocean beds. Some plastics release poisonous substance like BPA (Bisphenol A) during their slow decomposition under the sea. Plastic debris also attracts other contaminants towards them by acting as a sponge thus doubling the harmful effects. A study published in the *Journal of Science* in the year 2015 gave a rough figure of the plastic junk that is littering the sea: between 5.3 million and 14 million tons a year. The shocking figures in a 2006 report, *Plastic Debris in the World's Oceans*, revealed that around 267 different animal species suffer from entanglement and ingestion of plastic debris. National Oceanographic and Atmospheric Administration shared the fact that plastic debris kills more than 100,000 marine mammals annually, along with millions of birds and fishes.

- *Effect on Aquatic Life*

Small fragments of plastics trash become food for marine animals like whales, sea lions, and zooplanktons. Once eaten by them, this plastic blocks their digestive tracts. Unable to eat any other food because of the plastic filling their stomach, they ultimately starve to death. There have been several cases across the world of whales being washed ashore and then dying. Cutting open their stomachs has revealed the horrors of plastic waste filling their insides completely.

The discarded plastic nets used for fishing cause a problem of entanglement and choking for the smaller sea animals. There have been disturbing videos going viral, of dolphins and ducks getting their necks caught in the six-ring plastic can holder disposed of in water by fishermen. This plastic waste affects the coral reefs as well, as they cannot get enough sunlight due to the plastic debris and start breaking.

- *Harming the Food Chain*

Up to 236,000 tonnes of micro-plastics – tiny pieces of broken-down plastic smaller than little fingernail – enter World's oceans each year. These along with the attached toxins are eaten by sea life. These plastics and toxic chemicals accumulate in the food chains, eventually making their way into other animals including humans that eat seafood.

In two recent studies (one in Marine Biology and the other in Animal Behaviour) it was found that micro-plastics can indeed be passed up the food chain to fish. The good news, however, was that the micro-plastics appeared to have no effect on their behaviour. The fishes that consume this plastic debris are further consumed up in the food chain, thus passing the harmful plastic pollution indirectly.

- *Polluting the Water Bodies*

Plastics can have a detrimental impact on groundwater. Studies have shown that during rainy seasons, the plastic rubbish that has fallen on the road gets washed away into the nearby water reservoirs, canals, and drains, leading to their choking up and overflowing. Also, the water quality gets spoiled due to the addition of these synthetic materials.

When dumped in landfills, plastic materials interact with water and form hazardous chemicals. The compounds can seep down towards groundwater aquifers, where they degrade the water quality, leading to groundwater pollution. Plastic trash, when filled in landfills, reacts with water and leaches harmful chemicals into the soil poisoning the underground water.

- *Polluting the Air*

Most plastic is made from fossil fuels like oil and natural gas, which release toxic emissions when extracted from the earth. According to Earthworks, an organization dedicated to protecting communities and the environment from the impacts of irresponsible mineral and energy development, oil and gas drilling releases toxic air contaminants, including benzene, toluene, ethylbenzene, xylene, carbon monoxide, hydrogen sulfide, ozone, sulfur dioxide, particulate matter, and volatile organic compounds. Not to mention the methane gas that can leak and cause greater greenhouse effects than carbon dioxide. Sulfur dioxide, carbon monoxide, and formaldehyde are among the chemicals pumped into the air from natural gas drilling sites. The burning of plastic waste releases harmful gases into the atmosphere causing respiratory problems for both humans and animals.

Fighting Plastic Pollution

Some simple ways to fight plastic pollution are:

1. Banish or reduce use of disposable plates, coffee cups. May be carrying your own cup to the coffee shop or to the office is a habit that will take some time getting used to, but once it becomes a practice, the amount of plastic usage will come down.

2. Carry own cloth bags when going out for their grocery or vegetable shopping, which may seem somewhat cumbersome in the beginning, but it is going to result in one less plastic bag going in the garbage and choking a cow feeding on it.
3. One of the main components of the plastic waste covering the earth is the plastic mineral water bottle that one tends to buy on the go. Carrying a water bottle from home not only ensures that you have easy access to water but also reduces the waste caused by the bottle.
4. Often, when eating out, we tend to order more than we can eat and then get it packed in plastic bags. It is advisable to carry a small paper box from home for such situations and cut down on unnecessary plastic use.
5. In some places in Pakistan sale and use of plastic bags has been banned. We must not only support the ban but facilitate its implementation by carrying our own paper or cloth bags.
6. Recycling plastics is another idea and perhaps the most worthwhile. We must make it a habit to read the resin identification code which imprinted in or on the container and is indicative of whether it can go in the recycle bin or not.

In conclusion I wish to put it the United Nations way:

"If you can't Re-use it, Re-fuse it."

PLASTICS: ENVIRONMENTAL ISSUES AND REMEDIAL SOLUTIONS

Dr. S. E. Benjamin

ABSTRACT

Plastics have revolutionized the world by providing cheap and low weight materials with an added ability of being noncorrosive with a good durable life. Plastic contribution has penetrated into all branches of human activity: everyday utensils to decorations, packing industry, construction and most importantly medical industry. Excessive use of plastics everywhere, on one hand has brought easy comforts while on the other hand its safe disposal has become a major issue that is leading to dangerous levels of environmental pollution. Soil, land, air and marine pollution has worsened due to unlimited use of plastic items. The present paper focuses upon the critical examination and accountability of various contributing factors and challenges of plastic pollution especially regarding human health and wild life today and prediction of future looming perils. Plausible solutions are offered to address this confronting environmental situation for a better world.

INTRODUCTION

Plastics goods are the most widely used commodity after construction materials. The exact history of production cannot be traced back. Its early use was confined to military during world war II. Bakelite dates back to 1905. The large-scale production and use of plastics came in 1950.

Plastics have proliferated into all domains of life. Plastics have gained importance due to ease of handling and molding into various shapes and sizes. The characteristics of plastics can be varied from very soft to very hard retaining high volume to weight ratio. Strength along with lightness has given the polymeric materials a special value. Such properties coupled with long durable life has replaced some iron based materials. Addition of colors to plastics have brought artifical beauty and attractiveness at a cheap cost. Plastics have contributed even in the construction materials as such and also as composite materials. Comprehensive literature is available on use and benefits of plastics [1,2].

The exact expansion of plastics is difficult to calculate as several in-house projects based on plastic precursors are also adding to the worlds total production. Henceforth, a better calculation can be based on the production of nurdles and micro plastics. Almost all type of plastics e.g., Polyethylene (PE): Polyethylene terephthalate (PETE or PET), Polystyrene (PS), Polyvinyl chloride (PVC) etc. etc. are prepared from pellets and beads of polymers. Millions of PET bottles are produced every day for various storage purposes. Water bottles and polythene bags are the most commonly used items. These two items are seen everywhere i.e., on coasts, oceans, rivers and land causing a great deal of harm mainly to the aquatic species, birds, land fertility and flora and consequently to the human beings. Nurdles have caused a huge damage to the environment. These absorb

and concentrate pollutants like as polychlorinated biphenyls (PCBs') and DDT [3]. Thereby increasing the propensity of toxic injury.

8.3 billion metric tons of plastics have been made since 1950 to 2015 and 6.3 billion tons of it is already a waste [4]. This waste has accumulated in the water bodies and landfills. Most of the plastic becomes waste in less than 5 years and resides in the environment as non-biodegradable commodity. Plastics break into smaller plastic particles. These particles disperse in oceans, land and ingested by the living species. Several species suffer due to entanglement in plastic items and these are eradicated in huge numbers [5]. Life of 700 marine species is threatened due to plastic trash [6]. The animals starve to death. Time is not far away when the agricultural lands will show barren areas decreasing the productivity per hectare. In 2014, 150,000 tons of plastic debris was surmised on sea shore of Japan and 300 tons on coasts of India [7].

Process of production of plastics involves chemicals that penetrate through the human skin and adversely affect health. Most common are the phthalates and bis-phenol A (BPA). The former is added to polymers as plasticizers and as solvent while the later is used for making hard polycarbonate plastics and epoxy resins. Both of these are used for making soft and hard plastics, respectively. The widespread use of plastics as bottles and packing food containers has jeopardized firstly, the babies, then the adults and elderly spreading the threat to land, air and water. Not all BPA is locked in chemical bonds and contaminates the stored items. Similarly, Phthalates are not chemically bound to the polymer and hence, leach into water and food. Waste plastics release phthalates and BPA ultimately in air, land and water [8]. BPA interferes with hormonal functions and phthalates metabolites bring abnormalities in human functions [9, 10].

Plastic pollution is now a challenging task and everybody has to participate to minimize the hazards. The present paper critically examines the present status of plastic goods in our life, the alarming hazard associated, offering plausible solutions to combat dangers for a greener world.

HAZARDS OF PLASTIC POLLUTION.

Long durable life of plastics, water resistant properties and leaching of chemicals from plastics are the major contributors to environmental pollution. It is difficult to summarize all the risks associated with plastic pollution. The immense use/applications of plastics have proliferated in all aspects of life i.e., medical [11, 12], construction [13], packaging [14], transport [15], household [16] etc etc. This industry incorporates several chemicals and processes to meet the requirements. Hence, huge diversity has arisen. We have focused upon the most pertinent problems that are commonly encountered outlining a few, but lethal, subsequent implications on the biosphere and as whole.

Plastic Particulate Matter In Air

Burning of different types of plastics produce particles of variable sizes [17]. Such suspended particles produced different ill effects in lungs and may enter the

circulatory system. The VOC's emitted from the recycling units increase nasal congestion and cause mucocutaneous and respiratory problems [18]**.** Birds inhale particles and also eat micro beads and nurdles and fly with plastics in their stomach needing excess energy for the flight [19] when already feeble with digestive problem [19]. Micro plastics have ruined marine species. For an example, the worms have been found to have restrained feeding activity and more stay of food in gut. Inflammation occurs and energy reserves are reduced effecting reproduction and growth [20,21].

Plastic Sprays and additives

Plastic softeners e.g., shower curtains showed 100 VOC's and 7 of these were reported to be

potentially hazardous mainly bringing birth defects. One of these is polyvinyl chloride which is a

potential carcinogen [22].

Bisphenol-A.

Since late 1950s, Bisphenol-A ($C_{15}H_{16}O_2$) is used and commercially boosted in 1957 [23]. **BPA is utilized in polycarbonate plastics and epoxy resins for making food packing materials and water bottles. BPA releases from the degradation of plastics and can penetrate through pores e.g., human skin and paper. Since, it is also a component of thermal receipts it leaches inside wallet and contaminates the currency notes transferring it to hands [24]. Extensive studies have been performed on BPA and considerable amounts of this chemical have been found in urine, blood, skin and other parts of body [25].** BPA is a suspected endocrine disruptor and endangers reproductive processes [26]. It increases blood pressure that leads to other serious lethal diseases. It interferes strongly in estrogen functions due to a similar structure.

Phthalates

Phthalates in plastics are endocrine disruptors [27], [28] and interfere with hormones. Phthalates inhibit androgens and affect males more than females [29].

Entanglement

Entanglement and ingestion of plastic debris is a huge menace for the marine and land habitat. Entanglement can be lethal. Sub-lethal corollaries lower sense of hunger, difficulty in escaping the predators and catching food, movement restriction, and effects on the reproductive system [30, 31].

SOLUTIONS

- Collecting segregated waste at door steps by cleaners and rag pickers.
- Earning from waste. Picking and selling
- Awareness programs at slums
- Banners on road sides and especially in front of schools.

- Media awareness
- Unexpected raid and seizure of plastic items using hazardous chemicals as additives.
- School education
- Seizure of plastic materials at shops
- Penalty for adding plastic pollution
- Excellence awards for plastic controllers
- Collection centers for plastic items outside all supermarkets with some type of incentive.
- Compelling the super markets to limit giving plastic bags to consumers
- Use of green bags
- Critical examination of the end-of-life role of every plastic item
- Sustainable materials management
- More policy discussions
- Replace of all Disposables with Re-usable plastics
- Check Personal Products for Micro beads
- Avoid synthetic wearing
- Limit/reduce waste production
- Recycle plastics.
- Molecular redesign of plastics.
- Green Chemistry i.e., greener routes for the production of plastics.
- More emphasis on biopolymers.
- Avoid plastics whenever you can and replace with glass bottles and containers.
- Controlled Incineration
- Check and re-check the existing strategies and incorporate more incentives.
- Funding relevant academic research and Technological Developments.
- Discuss and advocate the subject.

CONCLUSIONS

The perils of plastic pollution have already started to show the distressing shadows on future. It is a pity that the common people are unaware of menace which is turning into tragedy of commons [32]. What we are accumulating today is left for the generations to come. Every passing day is adding to the huge burden on planet earth. The challenges of this important issue are not easy to deal with. It requires stringent efforts from all sectors to leave a greener biosphere for all to exist and enjoy the blessings of nature.

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INTEGRATED PLASTIC SOLID WASTE MANAGEMENT (ISWM) SYSTEM BASED ON 3R PRINCIPLE AND RESOURCE CONSERVATION AND GHG EMISSIONS

Muhammad Sajid[1], Iqrash Suhaib[1], Mahnoor Shah[1], Asra Tariq[1], Dr. Asad U. Khan[2], Dr. Nasir M. Ahmad[1]

Abstract

This article highlights the integrated systems for the plastic waste management based on the 3R principals. It also details how the raw material sources can be conserved and optimized. The waste management systems are linked with the greenhouse gases and global warming.

1. Introduction

1.1. Problem

Pollution is a grave issue of this century posing great dangers to the future of the earth. Around 6 million tons of waste is dumped into the ocean each year out of which 80% is plastic. Another study in 2010 reported that between 4.8 to 12.7 million tons of plastic waste is dumped in the ocean; and considering the ever increase in the use of plastics, this number surely has increased substantially today. Plastic pollution is of special importance because of non-biodegradability of polymer products. Tons of discarded, used polymer products are either dumped into the oceans every year or simply contribute to the increasing amount of landfills. Polymers remain in the environment for long periods of time and are often ingested by the marine life or simply absorbed in the soil contaminating it. Not only this but the production of polymers is directly linked to petroleum products like natural gas and crude oil, which as fossil fuels have implications regarding the amount of energy invested which contributes greatly to the energy crisis of the world; also the adverse effects it has on the environment as a major contributor of climate change through greenhouse gas emissions.

[1] *Polymer and Surface Engineering Lab, Department of Materials Engineering, School of Chemical and Materials Engineering (SCME), National University of Sciences and Technology (NUST), NUST H-12 Campus, Islamabad-44000, Pakistan.*

[2] *Department of Chemcial Engineering, COMSAT Institute of Information Technology, Lahore-54000, Pakistan,* Corresponding author: asadkhan@ciitlahore.edu.pk



Figure 1

The Pacific Ocean has long known to have country sized garbage patches in it. According to a recent study the Arctic Ocean, which is considered a pristine paradise for wildlife, has not been spared either. Two massive garbage patches have been found in the Arctic which have around 300 billion pieces of used, discarded plastic concentrated in two different zones north of Norway and Russia. What is upsetting is that these patches are constantly growing in size and close to match the humongous garbage patches of the Pacific.

We know that polymers do not biodegrade; it takes about 450 years for some plastics to completely degrade. But they do break down into small fragments and this increases the dangers associated with plastic waste disposal into the oceans as they become prone to be ingested by living organism in the ocean. About 267 species including marine turtles, seabirds and marine mammals are directly affected by plastic pollution through direct ingestion which has been proved fatal for these species. And this rate of ingestion has doubled over the last 25 years specifically for marine turtles. This plastic ingestion if not causing direct death, can stay in the system of these animals even if present in low non-lethal amounts causing physiological and biological changes. This 'harmless' ingestion does worse by becoming part of the food chain and indirectly affecting humans triggering diseases in the long term whose main cause and cure is difficult to identify.

What is worse is that the use of plastic is not being reduced. With the ever increasing population and the idea of ease and leisure in all aspects of our life, polymers seem to be a viable material to fulfill our needs through a wide range of polymer products. Their properties like durability, corrosion resistance, lightweight,

mold-ability and electrical/heat resistance makes them suitable for all kinds of products which makes it ever more difficult to completely discard the use of polymers.

1.2. Purpose and Aim

The only possible solution that seems practical for this plastic waste problem is recycling. There is a 3R principle of Reduce, Reuse and Recycle which aims at reducing the use of plastic by replacing plastics with degradable and easily recyclable materials, reusing plastic products to elongate their period of use before they go into waste and recycling used, waste plastic into new usable products. Though plastic recycling is a worldwide issue and third world countries like Pakistan are a major contributor in uninhibited waste production. Due to large usage of PET, one must aim recycling of PET.

1.3. Life Cycle Assessment of PET

PET is a product obtained from crude oil, so discarding PET bottles will be a great burden on the environment. PET from discarded and used bottles is collected and transported to Material Recovery Facility (MRF) where it is separated from other plastic waste and compacted together onto large blocks or bales. These bales are then transported to the recycling plants where they undergo physical and chemical processing and made into PET granules. These granules are then further transported to PET bottles manufacturing plants. This is closed-loop recycling lifecycle of PET. PET can also be recycled into polyester fiber to make clothing and carpets and it is a viable process but as polyester clothing after being used is discarded into landfills and cannot be recycled further this process is not the focus of any study.

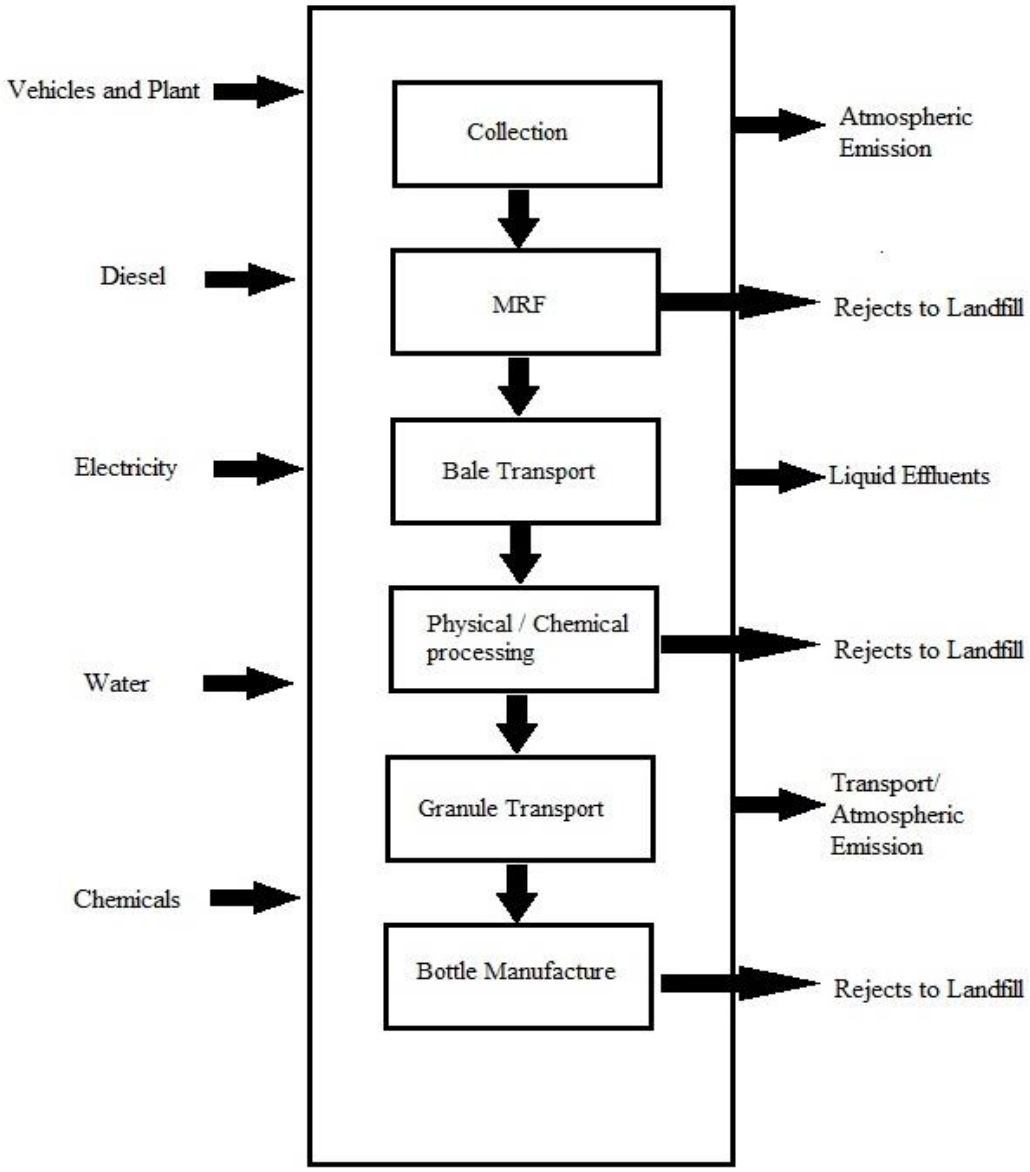


Figure 2: LSA of PET

2. Literature Review

This chapter presents an overview of the previous research based on recycling of waste plastic and their use in producing high grade polymer blends for various applications. The purpose of this review is to analyze the most commonly produced plastics in municipal solid waste (MSW), understand the different types of plastic recycling processes and to examine how post-consumer plastic can be used to produce blends with enhanced properties. Furthermore, the impact of plastic recycling on greenhouse gas emissions (GHG) was also studied.

2.1. Introduction

Plastic is a synthetic (man-made) material that is formed by joining together low molecular weight monomers in a chain through the process of polymerization. The plastics, also called polymers, generally contain carbon and hydrogen with, sometimes, other elements such as oxygen, nitrogen, chlorine or fluorine (UNEP, 2009). Therefore, they are made from both organic and inorganic elements.

Plastics have a significant role in our everyday lives. The exponential increase in the consumption of plastics is due to its exceptional properties and wide range of applications. They have a high molecular weight, low density, long life, low cost, light weight and they can be molded into different shapes. This makes them suitable for a number of applications such as bottles, jars, packaging, artificial implants, communication materials, healthcare, household items, etc. The world's annual consumption of plastic materials has increased from around 5 million tons in the 1950s to nearly 100 million tons in 2001 (Siddique R., 2008). Moreover, in order to meet the demands of particular applications and to improve their performance, the properties of plastics are often modified by adding compatabilizers, additives or colors.

In the recent years, the amount of waste plastic production is rapidly rising, but a proper plastic waste management system for recycling does not exist due to which natural resources are being wasted, the GHG emissions are increasing and the landfill sites are growing.

2.2. Plastics Types and Their Uses

There are two main types of plastics: thermoplastics and thermosetting polymers.

1) Thermoplastics have the ability to continually soften and melt when enough heat is supplied. They also harden on cooling, which makes them suitable for making plastics products and also facilitates recycling. For example, polyethylene (low and high density), polystyrene, polyethylene terephthalate and polyvinyl chloride. Their properties and applications are listed in table 2.1.
2) Thermosets or thermosetting cannot be remolded or remelted and take shape only once. This is because when they are treated, they tend to form a three-dimensional network. For example, phenol formaldehyde and urea formaldehyde.

Table 1: Types and uses of plastics and recycled plastics (Siddique R., 2008) (UNEP, 2009)

Sr.no	Types of Plastic	Description	Some uses of virgin plastic	Some uses of recycled plastic
1	Polyethylene terephthalate (PET)	Can be used as a fiber, Clear tough plastic	Soft drinks and water bottles, packaging, jars etc.	Clear film for packaging, carpet fibers, fleecy jackets
2	Polypropylene (PP)	It is hard, but flexible plastic	Labelling textiles, Ice-cream containers, potato crisp bags, Tables and chairs, stationary	Compost bins, kerb side recycling crates, and worm factories
3	Polystyrene (PS)	Rigid and brittle plastic. It can also be clear, glassy	Cheap, transparent kitchen ware, bottles, toys, and food containers	Clothes pegs, coat hangers, and video/CD boxes
4	High Density polyethylene (HDPE)	Very common plastic, usually white or colored	Crinkly shopping bags, freezer bags, and milk	Compost bins, detergent bottles, crates, and mobile rubbish bins
5	Low density polyethylene (LDPE)	Soft, flexible plastic, milky white, unless a pigment is added	Lids of ice-cream containers, garbage bags, and garbage bins	Film for builders, industry, packaging and plant nurseries
6	Polyvinyl chloride (PVC)	Most widely produced plastic, maybe flexible or rigid depending on the addition of plasticizers	Pipes, floor tiles, medical devices, cards	New flooring, doors, windows, fittings

2.3. Polyethylene Terephthalate (PET)

Polyethylene Terephthalate is a well-known thermoplastic polymer and a member of the polyester family. Virgin PET is formed when Ethylene glycol and Terephthalic acid are polymerized. This polymer is strong, rigid, very light weight, impact resistant and has an excellent clarity, color ability and process ability. Due to its physical properties, it is used in many applications. Many companies produce virgin PET globally giving it different trade names such as Arnite, Diolen and Mylar [3] [4]. The Polyethylene Terephthalate repeating unit is shown in Fig 1. Commercial PET has a wide range of intrinsic viscosity [g] that varies from 0.45 to 1.2. [5].

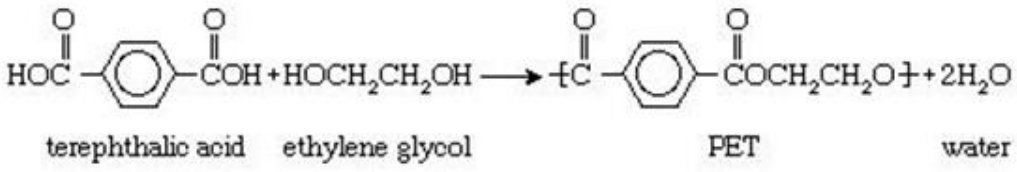


Figure 3: PET Repeating Unit

Table 2:

Property	Testing	Values (unit)	Reference
Weight-average MW	-	30,000-80,000(g/mol)	[9]
Molecular Weight (Monomer)	-	192 (g/mol)	-
Density	-	1.41 ($g/cm^{3)}$	[9]
Glass Transition temperature	DSC	69-115 (°C)	[3] [9] [10] [11]
Heat of Fusion	DSC	166 (J/g)	[3]
Melting Temperature	DSC	265(°C)	[11] [12]
Breaking Strength	Tensile	50 (MPa)	[13]
Tensile Strength	-	1700 (MPa)	[13]
Yield Strain	Tensile	4(%)	[13]
Impact Strength	ASTM D256-86	90(J/m)	[13]

2.4. Recycling of PET

Recycling processes are the best way to economically reduce PET waste [14–16]. Recycling of PET is starting to become a valuable business nowadays but as mentioned earlier R-PET loses a lot of chemical and physical properties during recycling like molecular weight (MW) and intrinsic viscosity. The primary reason is that plastic carbonated soft drink bottles and water bottles are almost exclusively PET, which makes them easier to identify in a recycle stream [7]. A lot of research has been done into how PET should be recycled and what can be done to help R-PET retain its properties.

First the method of recycling is of importance. (Reference) PET can be recycled through various methods like

1) Mechanical Recycling
2) Closed-loop recycling
3) Blending
4) Energy Recovery through Incineration
5) Feedstock recycling

2.4.1. Mechanical Recycling

(Reference) Mechanical recycling mainly constitutes the closed loop recycling process in which PET bottles are recycled into new PET bottles (reference). Post-consumer PET is collected, sorted, cleaned and then shredded before being melted and processed into new bottles. The processing involves addition of stabilizers or chain extenders (reference) in order to help regain the lost properties of PET due to contamination or thermal degradation. The benefit of this process is that, that an equal amount of virgin PET is saved and the emissions and fuel consumption during processing is less compared to other processes making it environment friendly, though extensive cleaning is required which becomes a strenuous and expensive process especially if the market is not suitable for R-PET products.

Blending is a technique where the processing part includes addition of other polymers like PP, PS or HDPE along with compatablizer in order to make R-PET regain some of its properties or acquire different properties for newer and different uses in novel applications.



Figure 4: Mechanical Recycling Process

2.4.2. Energy Recovery Through Incineration

Energy in the form of power/heat is generated by incinerating waste PET. Here the PET is not collected separately; it is collected with other non-recyclable waste and burned to generate power. The process is beneficial as sorting and cleaning is not required but the emissions from burning waste and running the incinerators make the process less environment friendly than mechanical recycling (reference). Also the efficiency of the thermal process if below 15% will make the process not suitable and expensive.

2.4.3. Feedstock Recycling

Feedstock recycling is a process used to break down polymer through gasification and pyrolysis into valuable chemical building blocks – liquid, semi-liquid products, monomers which then undergo the whole polymer addition or condensation processes to make large chains or are used in various other applications like producing reducing agents replacing coke or coal in blast furnaces, used as raw materials or as fuel. Plastic contaminated with metal, food, soil or low quality mixed plastics are suitable streams for feedstock recycling. But the problem is that this process is not only long and strenuous but also expensive (reference) and requires more development.

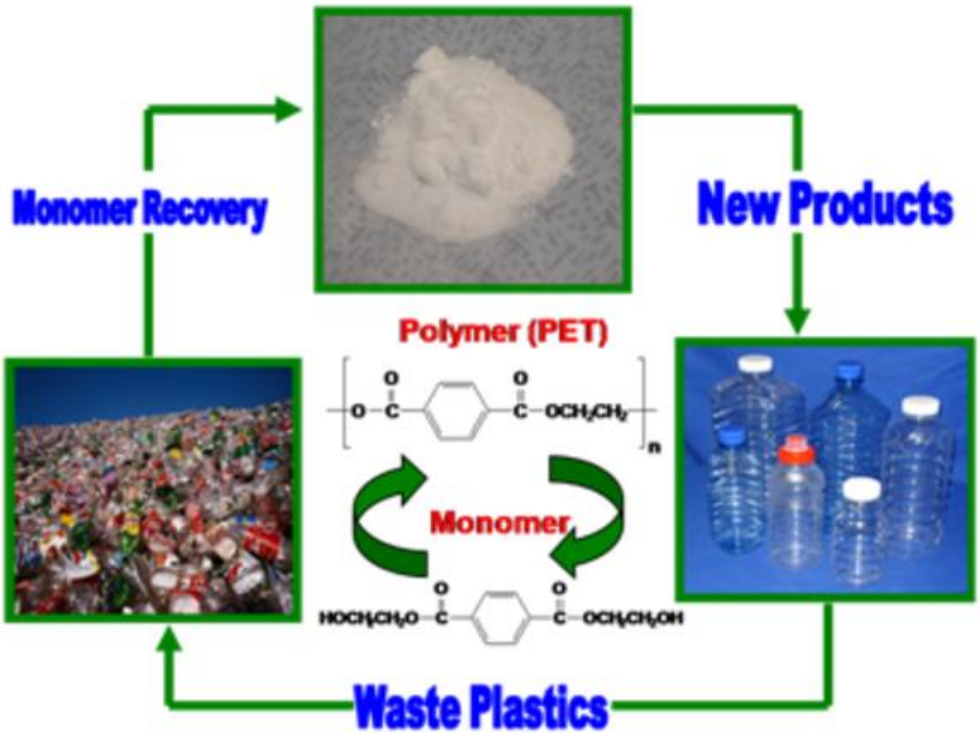


Figure 5: Feedstock Recycling
http://procal.kaist.ac.kr/research.html

After a comparative analysis of the recycling techniques (2 references), we reached the conclusion of using mechanical recycling incorporating proper separation and sorting for PET bottles but not confining it to closed-loop recycling allowing to use blending with PP and then find the properties for varied applications.

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IMPACT OF DOMESTIC AND INDUSTRIAL EFFLUENT OF LAHORE CITY ON GROUNDWATER

Engr. Dr. Muhammad Saeed[1], Engr. Rahmat Ullah Sheikh[2], Engr. Muhammad Shoaib[3], Muhammad Jawad[4]

Abstract

Lahore is a main city of Pakistan which is recognized internationally and it should have the basic facilities of road infrastructure, sanitation, clean drinking water and sewerage. This crowded city generates a huge amount of wastewater i.e. 8 MCM a day which is disposed off into the Ravi River without any treatment. Now it is the need of the day that this wastewater should be properly disposed off. As the drainage channels around the Lahore city are disposing their effluent in the Ravi River and these channels are unlined and wastewater is seeping down and mixing with groundwater and as a result groundwater of the Lahore city is also being polluted. In this context, International Waterlogging and Salinity Research Institute (IWASRI) is conducting a research study to assess the impact of wastewater seepage through drainage channels and Ravi River on groundwater.

In this regard water samples were collected from different locations and depths along the Ravi River in Lahore city i.e. Mehmood Booti, Shadara and Sabazazar Scheme. The groundwater samples were collected from hand pumps or motors installed at 100, 200 and 350 ft depth. The collected water samples were analyzed from PCSIR Laboratory, Lahore and the different parameters like COD, BOD, Toxic material like pesticides, arsenic and heavy metals were tested in the Laboratory. The results show that the groundwater samples collected from shallow depths i.e. 100 and 200 ft have the worst quality as compared with the samples of deeper depths. In most of the cases total dissolved solids and some other parameters were exceeding the National Environmental Quality Standards (NEQS), limits. Like at Mehmood Booti the TDS is in access than NEQS by 117%, Total Hardness by 140% Nitrate by 91%, Reactive Silica by 140% and Sulphate by 32%. All of which then decreases with increase in depth except Reactive Silica. The parameters which are exceeding the NEQS are harmful for aquatic life as well as for human health.

Therefore, it is recommended that before disposing the wastewater in the drainage channel, each industry should have its own treatment plant keeping in view the polluting ingredients in their wastewater. The domestic effluent may be treated through stabilization ponds before throwing in the disposal channel.

[1] *Additional Chief Engineer, IWASRI,WAPDA, Lahore; E. Mail: engrsaeed_47@yahoo.com, Cell: +92 333 4431183*

[2] *Director General, IWASRI, WAPDA, Lahore.*

[3] *Junior Engineer, S&E Section, IWASRI, WAPDA Lahore*

[4] *Junior Engineer, Drainage Section, IWASRI, WAPDA Lahore*

INTRODUCTION

In the history of mankind, natural water resources have almost always been the mainspring of civilization. Being an indispensible resource, human civilizations engineered methods to harvest, store and utilize water. In addition, water bodies have served as reservoirs to dump waste material, mainly owing to the concept that flowing water will replenish itself downstream by dilution. Accordingly, there has been ruthless and unchecked discharge of waste material into natural water bodies. Exponential booming of human population has further exacerbated the stress on water resources, causing a reduction in their capability to dispose waste material merely by dilution. But there is no more downstream. Consequently, water pollution has emerged as one of the toughest challenges for the survival of mankind.

The growing ecosystem degradation around the world is particularly more damaging to vast population of poor developing countries like Pakistan. Pakistan economy holds a double edged sword of economic growth and ecosystem collapse. Process complexities, high energy consumption, lack of highly skilled operators, and high capital and operational costs have made the conventional treatment methods difficult to adopt in these countries.

The River Ravi is one of the three Western rivers of the Indus Basin whose waters were allocated to India under the Indus Waters treaty, 1960. Since the early 21st Century, the development of irrigation and water infrastructure in India has meant that little or no water flows across the Indo-Pak border in the River Ravi.

Unfortunately, the banks of the River Ravi along Lahore are used for the discharge of untreated domestic and industrial wastewater and effluent. There are over a dozen disposal stations and two surface water drains that discharge untreated wastewater into the river. The levels of impurities in the water are in excess of National Environmental Quality Standards set by the Pakistan Environment Protection Council and enforced by the Environment Protection Agency, Punjab (the EPA, Punjab). The scale of this discharge is enormous. It is calculated that nearly 48% of the overall pollution discharged into the River Indus comes from the River Ravi. At this point in time, the River Ravi is no more a river but a sludge carrier.

OBJECTIVES OF THE STUDY

The main aim of this research is to study the impact of industrial and domestic effluents on groundwater of Lahore city especially along Ravi River as it carries all the effluents of Lahore city.

LITERATURE REVIEW

The Ravi River is the most polluted river in Pakistan. It receives untreated domestic and industrial wastewaters through five outfalls and two natural surface drains located between a stretch of 98 km between Ravi Siphon and Balloki Headworks (Haider & Ali 2010).

The Ravi River presently receives 47% of the total municipal and industrial pollution load discharged into all rivers of Pakistan. In Lahore, six major wastewater drains that are Chota Ravi Drain, Sagian Drain, Gulshan-e-Ravi Drain, Mian Mir Drain, Babu Sabu Drain and Kharak Drain outfall into the river at downstream of Ravi Bridge (Sami, 2001)

The wastewater from eastern and southern Lahore is carried by Hudiara Drain that also disposes its effluent into the Ravi River. The impact of this pollution and degradation of water quality greatly effects flora, fauna and also to human being through the food chain as the water of Ravi River has been used for irrigation since many years (Ali, 2003).

The main sources of pollution in the river Ravi stretching from Lahore Siphon to Baloki headworks are urban, agricultural and industrial wastewaters discharged from various industries like electroplating workshops, steel factories, paper and pulp industries, medicine and scientific laboratories, as well as surface runoff and municipal sewage. The present study revealed that Mehmood Booti, Shad Bagh, Farrukhabad, Munshi Hospital, Taj Company, Bakkar Mendi and Hudiar nullas, added substantially towards deterioration of river water and bed sediments. However, maximum metal contaminated water was discharged by upstream tributaries like Farrukhabad, Munshi Hospital, Taj Company, Bakkar Mandi and Hudiara nullas and Degh Fall. (Rauf.a et. Al., 2009)

The Ravi River which has the smallest catchment of Pakistan's Rivers is 894 km long with a catchment area of 39,680 km2 . The municipal and industrial effluents are discharged in the River through 6 major drains at Lahore and its surroundings. In addition, untreated municipal effluents of Lahore city and Shahadra are disposed off into the River. The discharge of untreated municipal and industrial effluents has converted the River into a sludge carrier (Ayesha, 2001)

The entire municipal waste from Lahore city is collected through a network of 14 main drains and discharged into the River Ravi without any treatment. The industrial waste is directly discharged into the canal system by 271 industrial units. These industries include textile, chemical, food processing, pulp and paper, poultry, dairy, plastic, paint, pesticides, leather, tanneries and pharmaceuticals. (Asad Q. & Ali H.S., 2014)

A large scale of uncontrolled pollution of water in Pakistan is due to the increasing quantity of the pesticides and fertilizers in runoff to meet the demands of increasing population and urban sprawl. Non functional and poorly working factories and industries drain their effluents in the river Ravi in the vicinity of Lahore and its surrounding areas (Briscoe and Qamar, 2008).

Many researchers (Akinbile and Yusoff, 2011; Longe and Balogon, 2010; Vasanthi et al., 2008; AbuRukah and Al-Kofahi, 2001) have been examined municipal landfills possible impacts on groundwater resources by using microbiological examination and physicochemical analysis of landfill leachate and ground water.

They explored that landfill sites are major threats for the groundwater, local environment and communities as well.

METHODOLOGY

1.1 Site Selection:

To study the impact of effluents on the quality of ground water three sections are selected at Ravi River that are;

1. At Near Mehmood Booti
2. At Shahdara
3. At Sabza-Zar, Near Babu-Sabu Interchange.

1.2 Collection of Groundwater samples

Form the each selected site the groundwater samples were collected at 3 different depths to study the vertical profile of impact on groundwater. The samples were collected at 100, 150-200 and 350-400 ft depths from hand pumps or electric pumps of verified bore depth.

1.3 Analysis of Groundwater Samples

2. The collected samples were then submitted to PCSIR laboratories for complete analysis. The following different parameters of water quality are to be tested from PCSIR Laboratory for complete analysis of the pollutant and its impact.

Sr.No.	Parameters	Sr.No.	Parameters
1	pH value	17	Nickel
2	COD	18	Arsenic
3	BOD2	19	Barium
4	Oil & Greases	20	Iron
5	Pesticides/Herbicides	21	Manganese
6	Phenolic Compounds	22	Zinc
7	Cyanide	23	Boren
8	Chlorides	24	Total Toxic Metals
9	Sulphates	25	Ammonia
10	Cadmium	26	Anionic Detergents
11	Chromium	27	Fluorides
12	Copper	28	Sulphides
13	Mercury	29	Total Dissolved Solids

Sr.No.	Parameters	Sr.No.	Parameters
14	Lead	30	Total Suspended Solids
15	Silver	31	Chlorine
16	Selenium		

RESULTS AND DISCUSSIONS

2.1 DATA PROCESSING

The water sample analysis results, received from PCSIR are then studied and screened for non-detected values and compared with NEQS Limits.

2.2 RESULTS

Vertical profile for groundwater at different locations is drawn and different detected parameters are then compared with each other and NEQS Limits. Detail of parameters at different locations is shown in Table-1, 2 and 3.

Table-1: Details of Different Parameters at Sabza-Zar (Near Babu-Sabu Interchange)

	Parameters	NEQS Limits	at 100ft Depth	at 150ft Depth	at 400ft Depth
1	Total Dissolved Solids	500	704	392	156
2	Methyl orange alkalinity	-	600	140	120
3	Total Hardness	250	320	150	130
4	Calcium Hardness	-	200	70	70
5	Magnesium Hardness	-	120	80	60
6	Chlorides	250	86.2	16.4	12.3
7	Sulphates	200	37	38.44	15
8	Sodium	30	20	21	12
9	Nitrate	10	2.05	3.46	1.92
10	Iron	-	4.5	0.01	0.01
11	Arsenic	0.05	0.008	0.045	0.025
12	Reactive Silica	-	0.18	0.16	0.15
13	Potassium	-	3	1.3	1.2
14	Total plate count	20	3200	16000	780
15	Total Coliform	1	540	1600	350

Table-2: Details of Different Parameters at Shahdara

	Parameters	NEQS Limits	at 60 ft Depth	at 150 ft Depth
1	Total Dissolved Solids	500	88	72
2	Methyl orange alkalinity	-	90	120
3	Total Hardness	250	120	130
4	Calcium Hardness	-	80	80
5	Magnesium Hardness	-	40	50
6	Chlorides	250	13.4	15.2
7	Sulphates	400	7.8	8.2
8	Sodium	30	6	7
9	Nitrate	10	2.05	1.92
10	Iron	-	0.02	0.01
11	Arsenic	1.05	0.11	0.026
12	Reactive Silica	-	0.99	1.55
13	Potassium	-	1	2
14	Total plate count	20	24000	9900
15	Total Coliform	1	280	220

Table-3: Details of Different Parameters at Mehmood Booti (Near Bodi Sha Darbar)

	Parameters	NEQS Limits	at 100 ft Depth	at 200 ft Depth	at 350 ft Depth
1	Total Dissolved Solids	500	1088	690	118
2	Methyl orange alkalinity	-	600	310	110
3	Total Hardness	250	600	440	150
4	Calcium Hardness	-	350	230	70
5	Magnesium Hardness	-	250	210	80
6	Chlorides	250	103.7	29.7	9.8
7	Sulphates	200	264	172.68	12.4
8	Sodium	30	34	40	6.4
9	Nitrate	10	19.12	1.79	4.1
10	Iron	-	0.02	0.16	0.02
11	Arsenic	1.05	0.015	0	0.03
12	Reactive Silica	-	0.12	0.75	0.72
13	Potassium	-	4	4	2
14	Total plate count	20	8600	8100	280
15	Total Coliform	1	1600	920	N.D

Vertical profile of different parameters at Sabza-Zar in graphical representation is shown in Figures.1 to 3. Total Dissolved Solids (TDS) and Total Hardness (TH) are exceeding the NEQS limit at 100ft depth and decreases and remains under the NEQS limit at 150 and 400ft depths. Similarly the value of Methyl Orange Alkalinity, Calcium Hardness, Magnesium Hardness, Chlorides, Sulphate and Sodium are higher at 100ft depth decreasing with increase in depth.

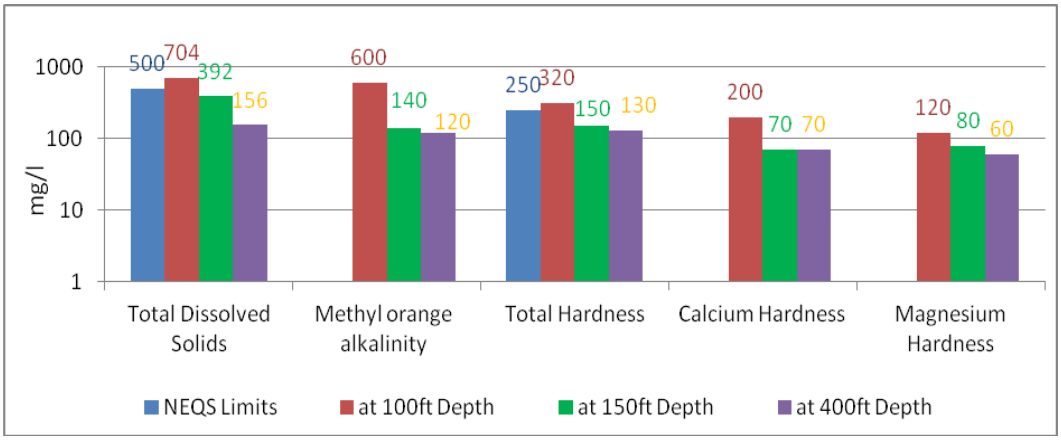


Figure.1: Profile of parameters at Sabza-Zar (Near Babu-Sabu Interchange)

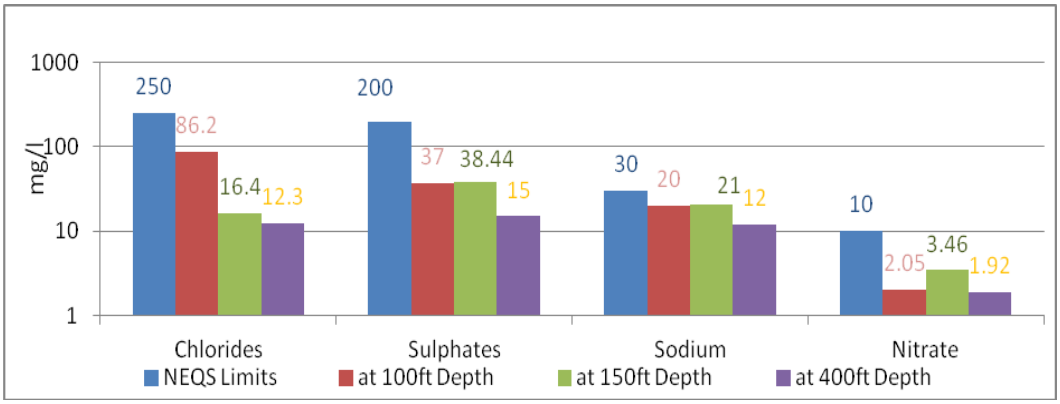


Figure.2: Profile of parameters at Sabza-Zar (Near Babu-Sabu Interchange)

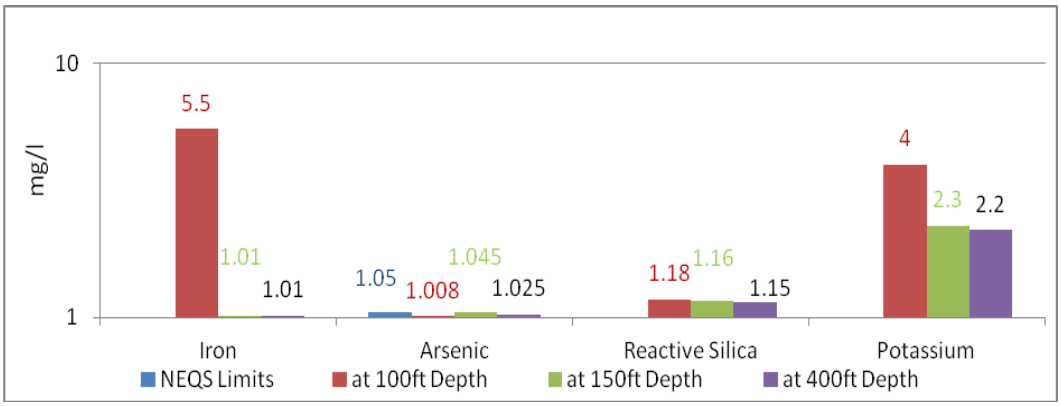


Figure.3: Profile of parameters at Sabza-Zar (Actual values = Graph value-1)

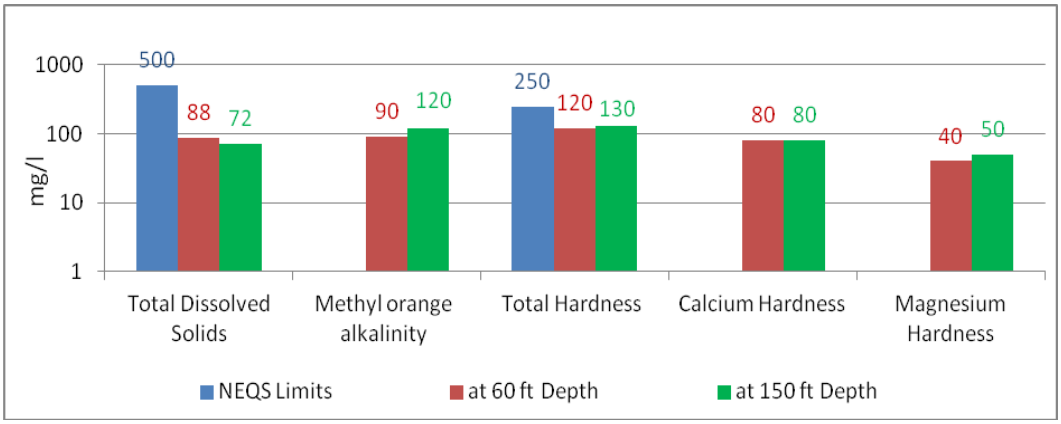


Figure.4: Profile of parameters at Shahdara

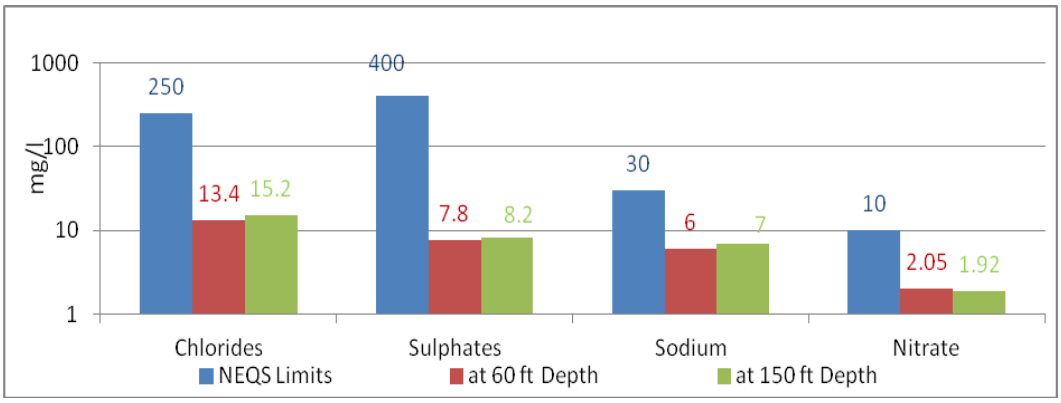


Figure.5: Profile of parameters at Shahdara

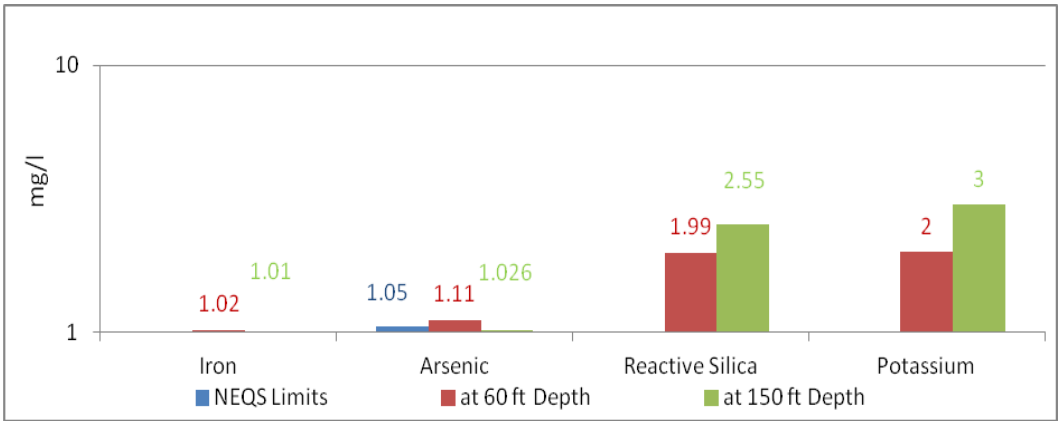


Figure.6: Profile of parameters at Shahdara (Actual values = Graph value-1)

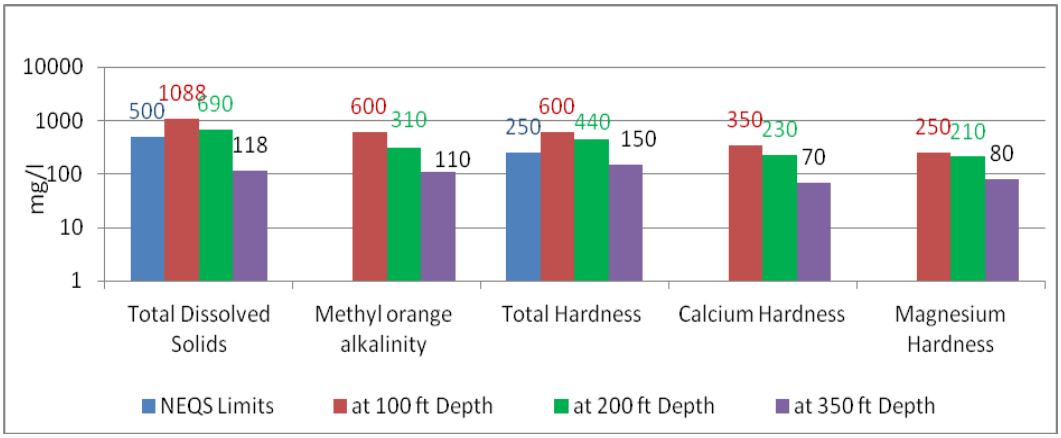


Figure.7: Profile of parameters at Mehmood Booti (Near Bodi Sha Darbar)

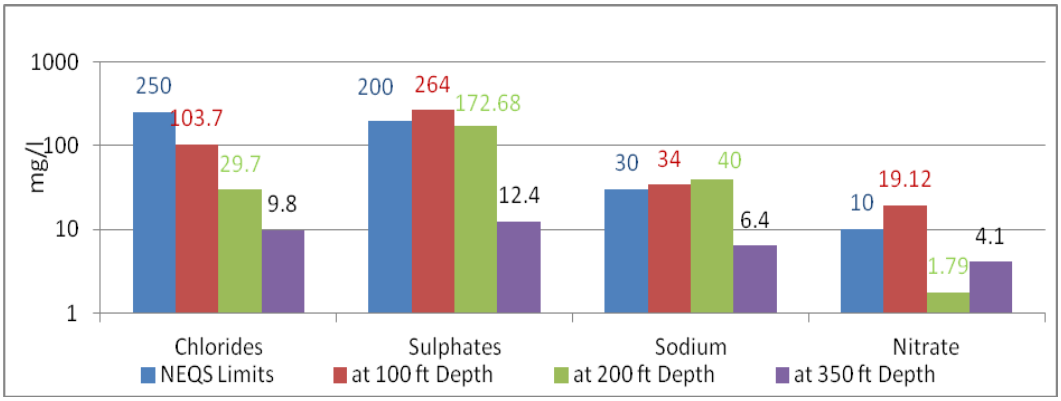


Figure.8: Profile of parameters at Mehmood Booti (Near Bodi Sha Darbar)

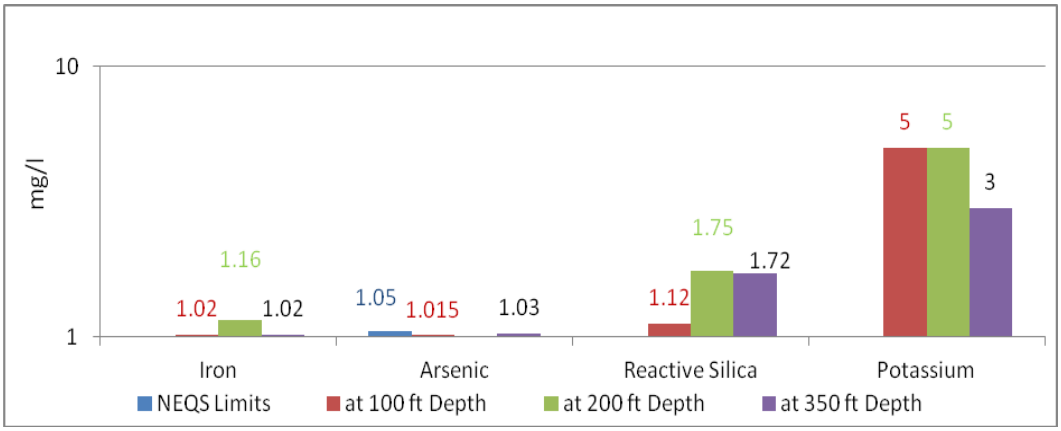


Figure.9: Profile of parameters at Mehmood Booti Actual values = Graph value-1)

CONCLUSIONS AND RECOMMENDATIONS

2.3 CONCLUSIONS

Based on groundwater analysis reports following conclusions are made for each selected area

2.3.1 Sabza-Zar (Near Babu-Sabu Interchange):

Total Dissolve Solids: TDS is exceeding by 40% at 100ft depth as compared to NEQS Limits, which then decreases by 44% and 78% at 150 and 400 ft depths.

Methyl Orange Alkalinity: The value at 100ft Depth is 600 mg/l, which then decreases by 76% and 80% at 150 and 400ft depth.

Total Hardness: TH is exceeding by 28%% at 100ft depth as compared to NEQS Limits, which then decreases by 53% and 59% at 150 and 400 ft depths.

Calcium & Magnesium Hardness: The calcium hardness at 100ft depth is 200 mg/l, which then decreases by 65% at 150 and 400ft depth. Whereas magnesium hardness at 100ft depth is 120 mg/l, which then decreases by 33% and 50% at 150 and 400ft depths.

Reactive Silica: The RS is quite high as compared to NEQS limits, which is decreasing a little at greater depths.

Chlorides, Sulphates, Sodium, Nitrate, Iron, Arsenic and potassium are well in range of NEQS limits, which are the more decreasing with increase in depth.

Whereas other heavy metals like Cadmium, Lead, Manganese, Zinc, Nitrite, Cyanide, Fluoride, Ammonia and non-Reactive silica were not detected in those groundwater samples.

2.3.2 Shahdara Area:

Total Dissolve Solids: TDS is well in range by 82% at 60ft depth as compared to NEQS Limits, which then again decreases by 18% at 150ft depth.

Methyl Orange Alkalinity: The value of MOA at 60ft Depth is 90mg/l, which then increases by 33%at 1500ft depth and still in limit.

Total Hardness: TH is 120mg/l which is 52% less then NEQS limit with is again decreasing by 8%at 150ft depth.

Calcium & Magnesium Hardness: The values of calcium and Magnesium hardness at 100ft depth are 80 and 40mg/l, which are within the safe limits.

Reactive Silica: The RS is quite high as compared to NEQS limits, which decreases a little at greater depths.

Chlorides, Sulphates, Sodium, Nitrate, Iron, Arsenic and potassium are well in range of NEQS limits, which are the more decreasing with increase in depth.

Whereas other heavy metals like Cadmium, Lead, Manganese, Zinc, Nitrite, Cyanide, Fluoride, Ammonia and non-Reactive silica were not detected in those groundwater samples.

2.3.3 Mehmood Booti Area:

Total Dissolve Solids: TDS is exceeding by 117% at 100ft depth as compared to NEQS Limits, which then decreases by 36% and 89% at 200 and 350ft depths.

Methyl Orange Alkalinity: The value of MOA at 100ft Depth is 600mg/l, which then decreases by 48% and 81% at 200 and 350ft depths.

Total Hardness: TH is 600mg/l which is increasing by 140% then NEQS limit with is then decreasing by 26% and 80% at 200 and 350ft depths.

Calcium & Magnesium Hardness: The values of calcium and Magnesium hardness at 100ft depth are 350 and 250mg/l, which then decrease at 200 and 350ft depths to safe values of 70 and 80mg/l at 350ft depth.

Reactive Silica: The RS is quite high as compared to NEQS limits, which again increases to excess of 525% and 500% at 200 and 350ft depths.

Sulphates are exceeding the NEQS limit by 32%, Sodium by 13% and Nitrate 91% at 100ft depth and with increase in depth the value of the parameters are decreasing.

Chlorides, Iron, Arsenic and potassium are well in range of NEQS limits, which are the more decreasing with increase in depth.

Whereas other heavy metals like Cadmium, Lead, Manganese, Zinc, Nitrite, Cyanide, Fluoride, Ammonia and non-Reactive silica were not detected in those groundwater samples.

2.3.4 Overall Effect of Ravi River on Groundwater

1. Municipal and industrial effluent is being discharged indiscriminately without any treatment which is contributing pollution in the River.
2. Ravi River is contributing towards recharging the aquifer as groundwater levels fluctuate with the River Gauge.
3. Groundwater quality is deteriorated along Ravi River.
4. Pollution entering the Ravi River is ultimately affecting adversely the quality of underlying groundwater.
5. Groundwater quality improves with the depth below natural surface.

Effects on Human Health

The parameters exceeding than NEQS limits can cause severe health problems like, mortality from all categories of ischemic heart disease (restriction in blood

supply to tissues, causing a shortage of oxygen) and acute myocardial infarction with high levels of soluble solids, calcium, magnesium, sulfate, chloride, fluoride, alkalinity, total hardness, and pH values of drinking water.

2.4 RECOMMENDATIONS

1. Detailed monitoring of the groundwater levels and quality is required to quantify the different contaminating parameters more precisely.
2. Industrial and municipal effluents must be treated before throwing into the Ravi River.
3. Fresh surface water may be arranged to minimize the hazardous effects by dilution of pollutants.
4. Construction of a lake/ponds at upstream of Lahore to recharge the aquifer. This can be accomplished after detailed investigation.
5. To reduce the pressure on groundwater, rainwater harvesting technique may be adopted to counter balance the groundwater abstraction.

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NEED FOR INTELLIGENT TRANSPORTATION SYSTEM FOR REDUCING TRAFFIC CARBON POLLUTION IN LAHORE

M. Munir[1], M. Shafiq Qureshi[2], Dr. A. B. Sufi[3] and S. L. Zaidi[4]

SUMMARY

Over the past decades, Intelligent Transportation Systems (ITS) have been developed and deployed in order to improve transportation safety and mobility. It is aimed to reduce environmental pollution to promote sustainable transportation development and Time/Fuel saving. ITS employs high technology and improvements in information systems, communication, sensors, controllers and advanced mathematical models with the routine world's transportation infrastructure. Whilst, the economic benefit of ITS is well established, the goal of this research is to demonstrate the simultaneous propensity for low carbon emission through the deployment of ITS. Therefore, the basic aim of this paper is that the deployment of these technology measures contribute positive to both economic and environmental sustainability.

The research shows that vehicle density and high technology are significant variables in determining the propensity for I T S to feature as a high priority in future transport strategies. ITS holds a value to deliver both economic and sustainability gains. It holds relevance for both policy analysts and transport environmental strategies at international, national and regional tiers for better management of our crowded traffic system in big cities.

1. INTRODUCTION

In 150 years information technology progressed from transmission of a few bytes per second to the transmission of billions of bytes per second. Much of this progress has occurred in the last 20 years as shown in the Table-1. It was however hoped that the progress in telecommunications would lessen the need for transportation, particularly for business travel. This suggests the presence of hidden demands for human interaction in the form combined communication and transportation rather than mere exchange of communications for transportation. The phenomenon was also true earlier in the 19th century when

Tele-phone was first introduced in transportation.

The dramatic increase in the performance and reduction in real costs of both the computing and communication technologies have enabled engineers to address, among other things, traffic congestion problems and to make transportation

[1] Managing director, DMC Lahore (Pvt.) Ltd., 177-M, Gulberg-III, Lahore.
[2] Head Hydropower and Business Development, DMC Lahore (Pvt.) Ltd.
[3] Water Resources Management Expert, DMC Lahore (Pvt.) Ltd.
[4] Junior Engineer, DMC Lahore (Pvt.) Ltd.

operation more efficient. Traditional objectives have not changed, but information technologies (IT) offer new ways for achieving them. For example, cities like Austin Texas improved emergency vehicle location in the early 1980's. Technology now permits this to be done in real time and with full consideration of existing traffic conditions. The inventions with respect to different periods are shown in Table-1.

Table-1: Inventions with Respect to Different Periods

Year	Development
1847	Telegraph
1877	Telephone
1920	Sound
1930	Telex ,fax ,television
1960	Hi-fi stereo , color TV , mobile phone
1975	Medium speed data transmission, paging
1984	High-speed data transmission, telemetry, computer networks, video-conferencing
2000	Wide-band data transmission, advanced television

Transport has become fundamental to the everyday functioning of society and the economy. Yet the reliance on motorized transport as an everyday function is a substantive contributor to global climate change. Without significant policy or technological advances, the likelihood of decoupling transport growth from emissions growth would appear slim given that 95 per cent of transport energy is derived from fossil fuels As there are a number of possible pathways for reducing the carbon intensity of transport, it is understandable that there has been lack of agreement on a definitive approach. Principal carbon reduction pathways include supporting low carbon technological innovation and deployment; encouraging modal shift from private car use to less polluting options such as walking, cycling and public transport; advocating more efficient forms of traffic management and driving behavior and employing strategies that seek to reduce the need to travel altogether (e.g. spatial planning). The main areas for debate appear to be between behavioral and technological innovation, and between reforms and radical changes.

2. INTELLIGENT TRANSPORTATION SYSTEM (ITS)

Intelligent transportation systems are advanced applications which, without expressing intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of

transport networks. Intelligent transport system covers a broad range of information technology and telecommunications for roads, road users and vehicles. It gives a fundamental solution to traffic related problems like traffic accidents, congestion, delays and pollution to improve transport efficiency, safety and sustainability. The objectives of ITS:

- To improve traffic safety
- To relieve traffic congestion
- To improve transportation efficiency
- To reduce air pollution
- To increase the energy efficiency
- Efficient transportation of grains, vegetables and fruits from farm to market
- Different timings for farm and traffic
- To promote the development of related industries to for local markets

In order to arrange ITS, a framework is developed highlighting various services. The ITS can offer to the users. A list of 30 user services has been provided in the National ITS Program Plan. The number of user services, keep changing over time when a new service is added. All the services are divided in eight groups. The division of these services is based on the perspective of the organization and sharing of common technical functions. Some of the users services of by ITS, are shown in Figure-1 and the benefits of ITS are given in Table -2.

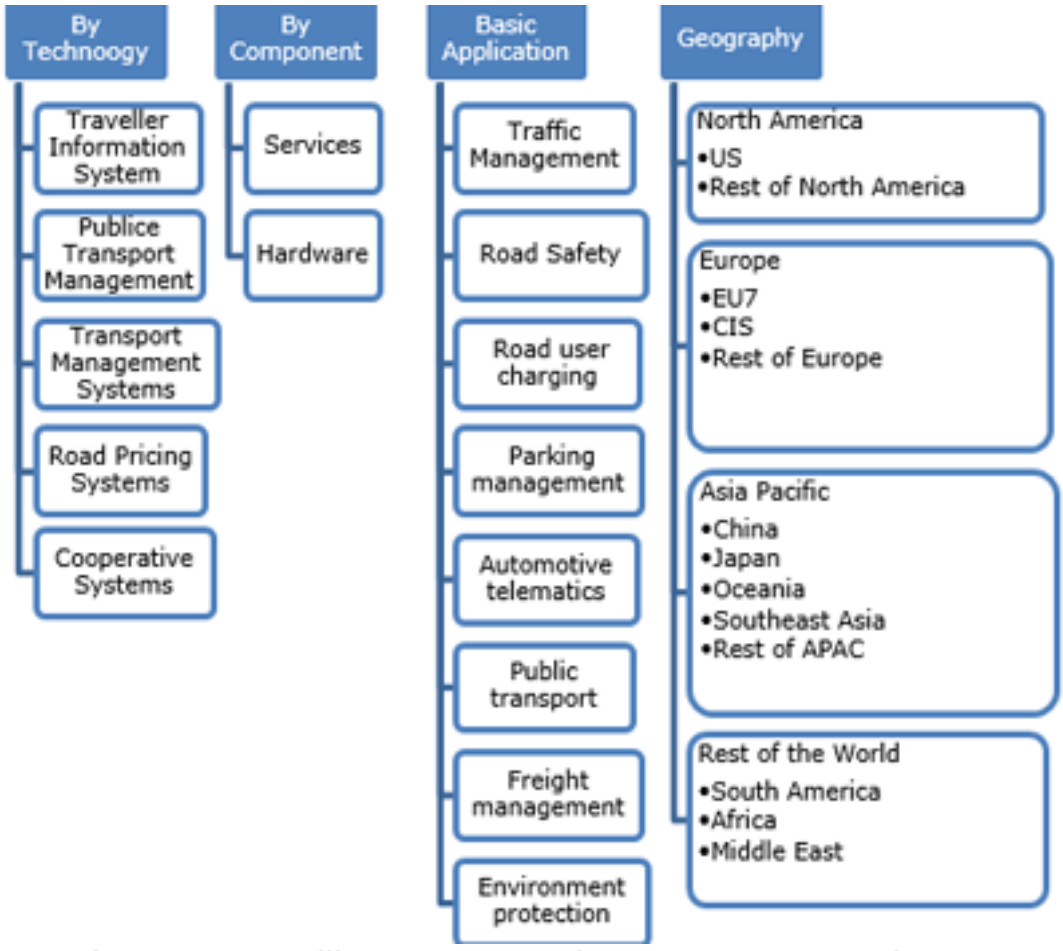


Figure-1; Intelligent Transportation System Users Services

Table- 2: Examples of Intelligent Transportation System Users Benefits

ITS Scheme	Data Collection Method	Study Location/Context	Reported Benefits
Teleworking	review of studies and modeling	UK	2.4 % of carbon emissions from cars in UK may be reduced due to teleworking by 2050
Teleworking	Expert review	UK	Inconclusive and recommendation that more detailed research is needed

ITS Scheme	Data Collection Method	Study Location/Context	Reported Benefits
Personalized travel planning	Field trial	Japan	A personalized travel planning system helps commuters choose environmentally friendly routes and modes; reduces carbon dioxide emissions by 20 percent
Transport management system: Electronic charging	observed	London Congestion Charge	a) Between 2003 and 2006, a reduction in carbon emissions in the central congestion area of 16 % b) western extension zone introduced in 2007 led to a reduction of 6.5% by 2008
Transport management system: Hard shoulder running and variable speed limits (VSL))	simulation and observation	UK Motorways (M42 and M25)	M42: Most vehicle emissions reduced by between 4% and 10%. Fuel consumption Reduction by 4%. Similar findings obtained from two other studies of VSL on M25
Eco-driving: In-vehicle control and performance systems	on-board monitoring	USA, Denver, normal driving Conditions	5% fuel saving with no feedback/coaching, 10% fuel saving with Feed-back / coaching. Assumes carbon saving equivalent to fuel saving
Eco-driving	review of studies	Field trials	average 10% reduction in carbon emissions

ITS Scheme	Data Collection Method	Study Location/Context	Reported Benefits
In vehicle speed control	Field trial using instrumented vehicles and emissions models	UK (Leeds and Leicestershire), different road types	Motorway average 6% benefit on CO2 Other road types little benefit or small dis-benefit on low speed urban roads. 20% Difference in CO2 emissions between lowest and highest emitting drivers
Eco-driving: dynamic systems that utilize RTTI	Simulation	simulated environment	Reduction in carbon emissions and fuel consumption by 10%-20% per cent Without a significant increase in journey time. Real world experiments showed similar but slightly lower findings
Eco-driving	field trial	Netherlands, 1999-2004	fuel consumption reduced 0.3%-0.8%
In vehicle technology and other measures	review of studies	Europe	5% to 25% carbon saving with 10% generally agreed
Platooning and road-trains	Laboratory testing of vehicles	Motorways	Fuel consumption and carbon emissions. Approx. 20 %

3. ROLE OF INTELLIGENT TRANSPORTATION SYSTEM IN REDUCING ENVIRONMENTAL POLLUTION

ITS strategies that can address the problem of air pollution on roads depend upon the specific area, **Intelligent Transportation System** technology and local conditions. Various **Intelligent Transportation System** technologies adopted are targeted to mitigate specific traffic related problems such as congestion, road calming, parking, speed control, vehicle stopping, smoother movement of traffic flow, shortest route and reduction of number of vehicles on roads that result in control of emissions on roads (Bell, 2006). In speed control traffic signals, signal control systems are optimized to minimize the traffic congestion and avoid unnecessary display of red signals on priority lanes, thus the intersection will

operate at optimal efficiency, reducing congestion and emissions of roads (Bell, 2006).

ITS technologies can be adopted to divert single occupancy vehicles (SOV) drivers to ride sharing, biking, use of public transportation and other alternatives to decrease the number of vehicles on roads so that emissions can be reduced to some extent (Burbank, 1995). ITS can also be employed to make transit "smarter" and more efficient; expanding and improving ride sharing programs; beefing up speed limit enforcement, especially for high-emitting trucks and buses; adopting traffic flow improvements that give preference to buses and other high-occupancy vehicles; and providing better information on transit, rides haring, and bicycle/ pedestrian access to potential users (Burbank, 1995).Remote sensing, ITS devices include roadside devices which can detect vehicles with higher emissions on roads. These vehicles may be penalized and referred to routine maintenance. It has been suggested by various studies that about 10 % of vehicles are responsible for 50 % of road emissions. So it is wise to detect such vehicles on roads for corrective measures with available ITS technologies (Burbank, 1995).

The use of Variable Message Signs (VMS) to display real time air pollution on roads has not been previously studied before; however some previous work of similar nature that encompasses forecasting of air pollution for the control of traffic has been done. The Environmental Fore-casting for the Effective Control of Traffic (EFFECT) project was demonstrated in the cities of Leicester and Maid stone in the U.K, Gothenburg in Sweden and Volos in Greece. The environmental performance was evaluated by direct measurement and by modeling. The predicted emissions and measured concentrations were compared between sites. The results showed that there was a greater measured decrease of carbon monoxide, of up to 5 grams/sec, at the closed site compared with the increase, of up to 1 gram/sec, at the open site, demonstrating the significant value of tactical control of queue location.

4. USE OF INTELLIGENT TRANSPORTATION SYSTEM IN TRAFFIC MANAGEMENT

Intelligent Transportation System enhances transportation for wellbeing and versatility and upgrades worldwide availability by methods for efficiency changes accomplished through the incorporation of cutting edge correspondences advances into the transportation foundation and in vehicles. A wise transportation framework incorporate a wide scope of remote and wire line correspondence based on data and gadgets advances to better oversee activity and augment the usage of the current transportation foundation. It enhances driving background, wellbeing and limit of street frameworks, lessens hazards in transportation, soothes activity blockage, and enhances proficiency.

From a policy development perspective, the business case for greater roll out of ITS schemes as a means of achieving climate goals requires further quantified evidence. ITS is likely to be compared with other options before investment is made and may well be taken into an economic appraisal process. Quantified

evidence for ITS climate benefits is not widely published and largely based on a relatively smaller number of studies than is the case with traditional infrastructure schemes. Evidence on impacts may be gathered from either field studies of real life implementation or through simulation and modeling studies. A summary of some recent evidence involving field trials, simulation and laboratory testing is provided in Table-2. It illustrates the degree of variation in the definitions of the schemes, the technologies involved and difficulty in therefore producing synthesized and scheme-relevant evidence that could act as inputs to a proposed scheme appraisal process. The outcomes generally suggest impacts of between 5% and 20% reduction on carbon emissions and fuel savings are indicated from 5% to 20% and other emission types are evidenced alongside in reducing pollution as indicated in table-2.

5. ENFORCEMENT OF ITS

The problem is in populous metropolitan areas where traffic flow is heavy, keeping traffic under control and maintaining road safety has become a tricky problem because of sparse traffic law enforcement. Traffic violations such as speeding, median crossing and running a red light are often neglected, giving rise to more serious offences and worse traffic congestion as drivers ignore the possibility of getting caught.

Automatic road enforcement, one of the most critical ITS applications, requires embedded appliances that integrate the best and the latest technologies, including those for image capturing, information filtering and network computing, for retrieving real-time images and license plate numbers, in order to deliver instantaneous traffic reports back to the data centers for automatic ticketing. Automatic road enforcement can further assist crime investigation by cross-referencing vehicle registrations and criminal records for locating stolen vehicles and for identifying suspects on the run, via face recognition software.

5.1 ITS Laws Enforcement and Personnel Safety

First step for enforcing intelligent transportation system is policy making which includes as follow:

- Round the Clock Patrolling
- Monitoring and control of suspicious vehicles
- Hazardous Material Screening
- Infrastructure Safety & Security

Second step for enforcing intelligent transportation system is Traffic Regulations Enforcement which includes as follows:

- Speed Enforcement
- Ramp Metering Enforcement
- Axle Load Regime Control
- Other Traffic Regulations Enforcement
- Safety Enhancement for Vulnerable Road Users

6. LAHORE'S TRAFFIC AGENCY DESIGN, PAKISTAN'S FIRST ITS

The Pakistan city of Lahore's Traffic Engineering and Planning Agency (TEPA) has designed an Intelligent Transportation System (ITS) with an estimated cost of US$29 million to solve problems facing the provincial capital. According to TEPA officials, the plan is in its final stage of approval and implementation.

A feasibility study of the project has already been completed. Under the project, TEPA in its implementation stage will upgrade all the city's traffic signals with modern facilities, such as countdown displays and CCTV cameras. A central control room will also be established to monitor all the traffic signals, as well as roads and crossings. CCTV will provide real-time information of the entire city to the control room.

The ITS system will be the first of its kind in Pakistan and is due to cover all three parts of the city – central, southern and northern Lahore. The agency had planned to install ITS in the city as a result of the rising traffic congestion and problems, which has arisen due to increased motorization, urbanization, population growth and changes in population density. TEPA has assessed that congestion reduced the efficiency of the current transportation infrastructure and increased the travel time, air pollution, and fuel consumption. According to Israr Saeed, Director of traffic engineering at TEPA, traffic flow measurement and automatic incident detection using video cameras was another advantage of the new ITS. He said the system would also ensure variable speed limits and would be able to control traffic signals to regulate VVIP and VIP movement across the city, without disturbing the normal traffic flow. Direct monitoring of roads and important crossings would also ensure immediate response of law enforcement agencies to crime, as well as to incidents and accidents. Mr. Saeed further revealed that, at the moment, about 60 signals are digital, while the remainder would be upgraded to meet the technological criteria of the ITS. The speed detectors flash lights and cameras near Punjab College Campus-9 on canal bank are shown in Figure-2.

7. DISORGANIZED TRAFFIC IN LAHORE

The city has experienced an extraordinary rise in vehicular traffic. Despite having a network of well-constructed roads, overpasses and underpasses, the traffic flow is unruly, often resulting in hectic logjams. The increasing traffic mismanagement is beginning to tarnish the otherwise adorable image of this beautiful metropolis. It is strongly felt that, considering the rapidly multiplying number of vehicles, if remedial measures are not taken urgently, the problem has the potential to assume unmanageable proportions. A few years ago, a Colombian transportation expert was invited by the Govt. of Punjab government for consultations regarding traffic congestion. He opined that the solution lay in designing and implementing a modern traffic management system and not in further widening the already adequate roads and enhancing the number of traffic wardens. Similar views were expressed by the mayor of Istanbul, Dr. Qadir, during his recent visit to the city. He believe, strongly that Lahore, which can boast of having better roads than London, needs only an efficient traffic management system to get rid of its vehicular woes.

The Punjab government should prioritize this issue before it gets worse. A competent foreign consultant firm may be engaged to automate traffic management. The city authorities should ensure a smooth, hassle-free and an uninterrupted traffic flow for residents who do not want to be stuck on the roads, sometimes for hours as shown the traffic rash in Figure-3.



Figure-2: Speed Detectors Flash Lights and Cameras near Punjab College Campus-9 on Canal Bank



Figure-3: Need of ITS Devices in Congested Areas of Lahore

8. SUGGESTIONS TO CONTROL CARBON EMISSION FROM TRAFIC RUSH IN LAHORE

The following are a few suggestions to manage carbon emission in Lahore:

- We should use Floating car data to determine the traffic speed, direction of travel and real time information on the road. Based on this data traffic congestion can be identified, travel times can be calculated, and traffic reports can be rapidly generated.
- Automatic traffic signals should be used in order to control the traffic.
- Due to overcrowded traffic as shown in the figure-3 bollards should be used to prevent the access of vehicles to the particular area for parking purposes.
- In order to reduce the accidents, Adaptive Cruise Control is necessary for road vehicles that, automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead.
- In Lahore road side encroachment is a major reason of road congestions should be removed. Parking of vehicles on main roads or at places not specified for parking be banned. Venders should be strictly kept off the roads and unauthorized stops on road sides should be restricted.
- Universities, stadiums, recreational parks should be planned and built outside of the Lahore congested areas because these type of places hold a large number of people and thus require huge parking spaces in addition to that, all public places and buildings should have a sufficient parking space so that people might avoid to park their cars on road and create further traffic related issues.
- To ease traffic congestion in Lahore, we need to reduce number of vehicles entering roads. This can be achieved by providing efficient public transport facilities in the form of metro-buses, metro-trains and subways. Many people avoid public transport because the routes of these buses do not cover all parts of our cities. In addition to that, there are people who find the condition of public buses too pathetic for their use. Lahore needs public transport systems that would cover all parts of the city. We also need to acquire modern buses to ensure comfortable experience for the travellers.
- By separating the mixed traffic like cars, buses, LTV etc. should be separated from rickshaws, carts, and others.
- Awareness of traffic signals and more traffic studies and training to be given to the drivers, special campaign should be carried out for this purpose.

- Placement of proper traffic signs and signals on the streets.
- Slow speed of traffic inside the intercity routes and region with high percentage of pedestrians should be stream lined.
- Widening of roads for the free flow of traffic.
- Proper modern system for collection of fine against traffic violation.
- Training drivers and pedestrians strictly to follow the driving lane rule.
- Proper maintenance and drainage works to be done on regular basis to avoid difficulty for the drivers and pedestrians by sewerage/rain water on roads.

9. CONCLUSIONS AND RECOMMENDATIONS

Based on the preceding discussions the following conclusions and recommendations are framed:

9.1 CONCLUSIONS

The rapid growth of population demands a compatible transportation system which can be provided using latest technologies. The vehicular position is an important aspect for the road users, and the intelligent transportation system can timely alert the position of the vehicle to avoid the traffic peak hours.

- The Intelligent Transportation System is one of the latest techniques which can handle the traffic congestion problem and can also provide the environmental, safety and socio economic benefits.
- The application of this transport system can provide an affordable, convenient and safe transportation to the users and travellers.
- An anticipatory traffic forecast is necessary for road users which can be done on the basis of implementation of this sort of transport system.
- Pre-trip investigation for day to day travelling of the route choice can be given by intelligent transportation system.
- In all the transportation modes, a proper intelligent transportation system is vital for the safe, efficient and economical movement of the goods and passengers.

9.2 RECOMMENDATIONS

- Intelligent Transportation System should be continued to develop a rapid pace and full technology assessment for the road users.
- Affordable and sustainable models should be prepared for all kind of road users.

- Vehicle manufacturers should consider the training options of the drivers about ITS.
- The relevant authorities should provide the proper infrastructures to enable the intelligent transportation system.
- There is no single traffic measure that can solve the problem of traffic management. Therefore, comprehensive transport plans are necessary. Advanced transport technologies can mitigate congestion, provide safety to the users and also reduce the amount of accidents.
- A study of ITS devices should be done in congested areas of Lahore to deal with the present condition of the city.
- An, Intelligent Transportation System devices should be affordable to the users.
- An investigation should be done at congested areas to observe that at which type of routes what kind of intelligent transportation devices should be used to improve the service level.
- Full political support and commitment in the application/implementation of advanced technologies is very essential especially in Lahore.

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REDUCING PLASTICS WASTE POLLUTION: CHALLENGES AND KEY SOLUTION STRATEGIES

Asif Ali Qaiser[1] and Anum Saeed[1]

Abstract

Emerging use of plastic in every field is one of the many innovations of last century. Plastic material owing to its light weight, good impact and thermal resistance, found to be the part of almost every daily used products. Use of these materials also facilitated in enhancing the economy of industries which substituted plastic materials with the metallic materials in certain procedures. But with these eye catching features, there is also a darker side of plastics. Plastic materials are the substantial source of adding pollution to the environment. The world's annual usage of plastics is increased enormously so is the plastic waste. There is intense need to adopt procedures to tackle with this situation. Plastic recycling is the best way to handle this problem. There are also other useful ways that can altogether help to deal with this challenge.

Introduction

In the last century, mankind has witnessed many novelties. One of the most prominent innovations is in plastics we know and use today in our daily life. These plastics are the part of every household, every country either developed or underdeveloped and are independent of our economic condition. But there is also a darker side to these commodities (A.Khan*, K.Nawaz, 2015). The most substantial is; they are adding to the pollution in this clean world as was once known. The world's annual consumption of plastic materials has increased from around 5 million tons; in the 1950s to nearly 100 million tons; thus, 20 times more plastic is produced today than 50 years ago. This indicates that on the one hand, more resources are being used to fulfill the augmented demand of plastic, and on the other hand, more plastic waste is being produced (Jalilinasrabady et al., 2015). Even the cities with low economic growth have initiated producing more plastic waste due to plastic packaging, plastic shopping bags, polyethylene terephthalate (PET bottles) and other goods using plastic as the major constituent (Logan, 2005).

The plastics processing industry is noticeable in every aspect of modern life, e.g. transportation (aerospace, automotive, marine, aircraft), building and construction (buildings related material), Furniture (bedding, other house furniture) and consumer goods (cutlery, luggage and lawn). A major issue confronted by the plastics industry is that of waste dumping. Recycling material would seem to propose a solution which is satisfactory in terms of avoiding environmental pollution (Elamri et al., 2015). Growing interest has recently, been fixated on the recycling of plastic wastes, particularly PET (Y.KODERA, 2010). The PET

[1] *Department of Polymer & Process Engineering, University of Engineering & Technology Lahore, Pakistan, Email: asifaliqaiser@uet.edu.pk*

recycling technology has been developed better and better across the world. There are mainly two methods: chemical recovery and physical recovery. Compared with the method of chemical recovery, the physical recovery has made less secondary pollution on the environment. It is easier to implement the process and realize large-scale industrial production. Thus the method of physical recovery has been widely applied (Yuan et al., 2013). The earlier is already being recycled and a number of uses have been found for it, containing: fibrefill, fabric, automotive parts, industrial strapping, sheet and film, new containers for both food and non-food products, containers for baked goods. From this extensive variety of redeveloped materials, plentiful applications for recycled polyesters can be discovered depending on the properties of the resin.

The removal of municipal waste plastics has become a foremost environmental problem all over the world. USA, Europe and Japan produce about 50 million tons of post-consumer plastic waste material (Saket, 2008). Saudi Arabia is one of the major creators of plastic in the world with total production capacity of around six million metric tons per year. The amount of plastic wastes in Saudi Arabia is about 15-wt% in the configuration of domestic municipality waste (Saket et al., 2007).

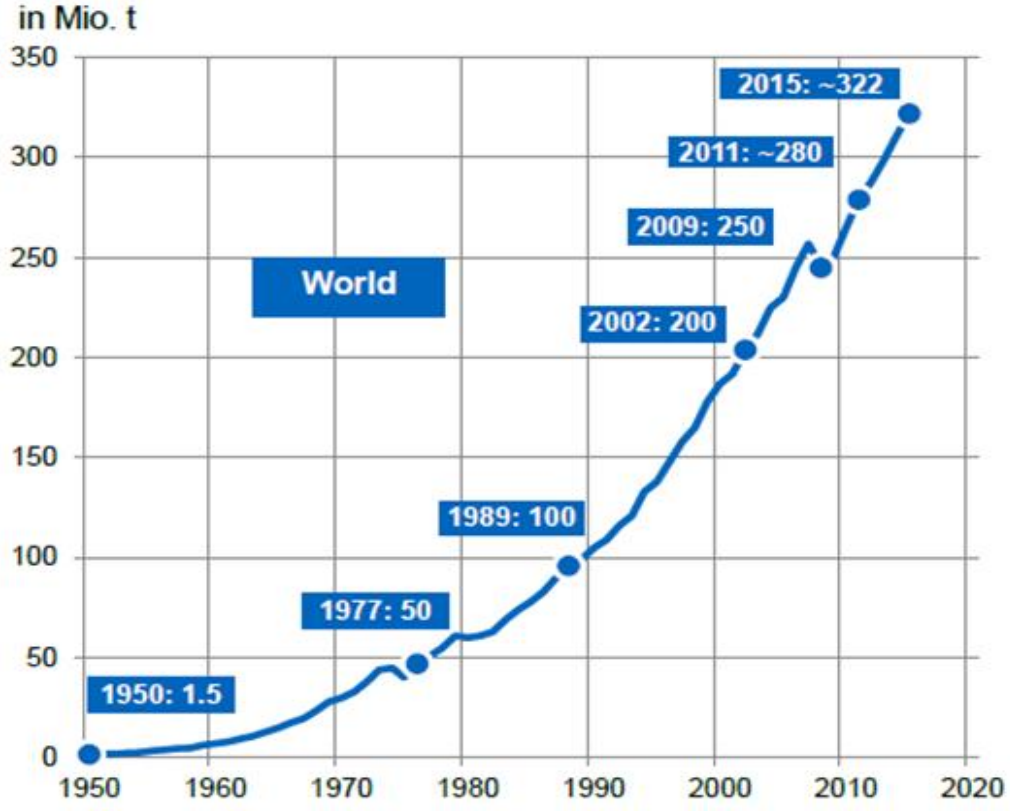


Fig. 1 Global Plastic Production

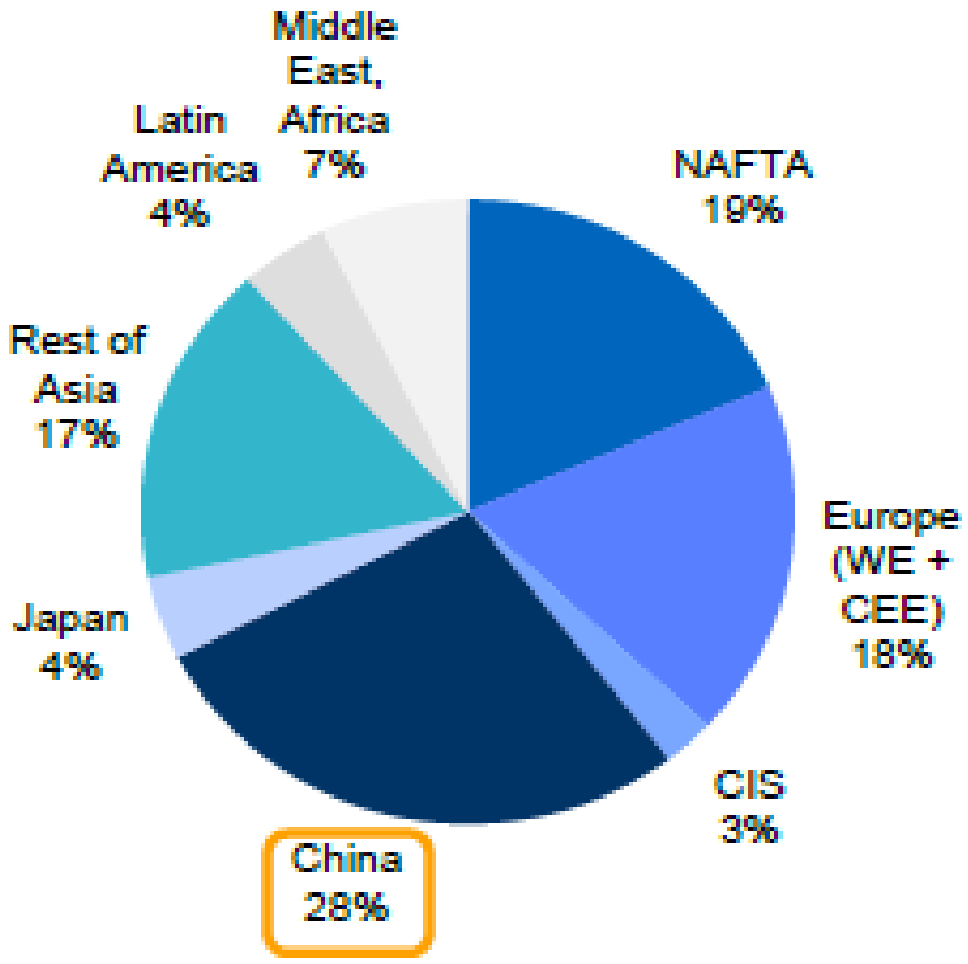


Fig.2 World Production of Plastic Material

The lifecycle of plastics includes three stages: manufacturing in the first stage, usage in the second stage, and recycling and/or removal in the third stage. The use of plastics covers a lot of ranges from toys to aircrafts, from hosepipes to dolls, from soft drink bottles to refrigerators, from gramophone records to television sets. Packaging signifies the largest single sector of plastics utilization. The sector accounts for 35% of plastic intake and plastic is the material of choice in nearly half of all packaged goods.

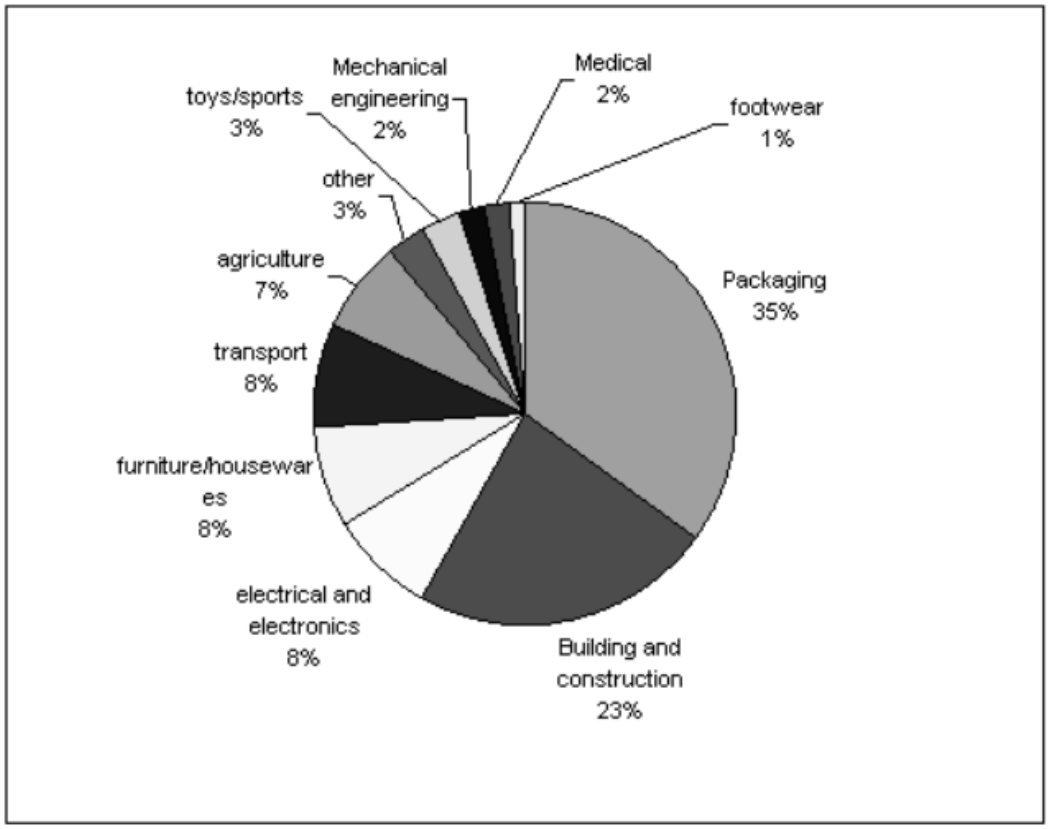


Fig.3 Utilization of Plastics in various fields

Approximately 10–20 million tons of plastic finish off in the oceans each year. Counting financial losses by fisheries and tourism as well as time spent cleaning beaches, $13 billion a year is lost in environmental harm by plastics to marine ecosystems. Marine wildlife is predominantly susceptible to plastic pollution. Animals such as seabirds, whales, and dolphins can become intertwined in plastic matter.

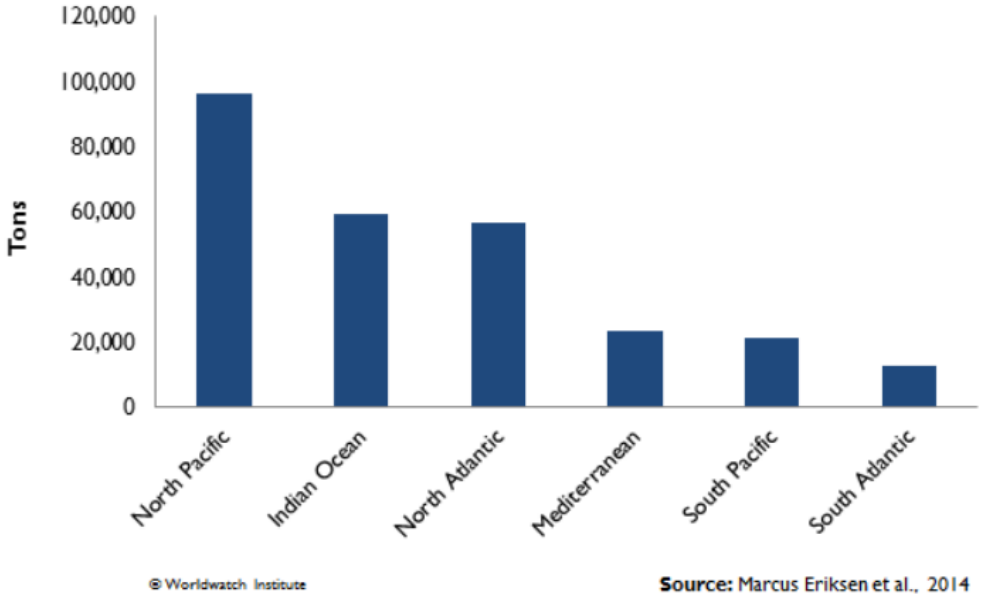


Fig. 4 Plastic Pollution in the World's Oceans

Plastic waste recycling can offer a prospect to gather and dispose of plastic waste in the most environmental friendly way and it can be transformed into a resource. In most of the circumstances, plastic waste recycling could also be economically feasible, as it produces resources, which are in great demand (Coelho, 2014). Plastic waste recycling also has a great prospective for resource conservation and greenhouse gas emissions reduction, such as generating diesel fuel from plastic waste (Rahimnejad and Adhami, 2015). This resource conservation objective is very imperative for most of the national and local governments, where prompt industrialization and economic expansion is putting a lot of pressure on natural resources.

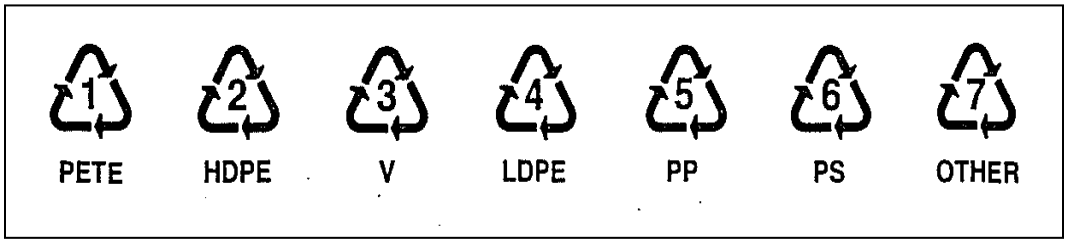
Plastics wastes include ***Post-processing or industrial waste-i.e****.,* regrind or machine startup scrap, out-of-spec products, edges or trim from some processes, or all scrap generated within the polymer industry, ***Commercial scrap-i.e****.,* used packaging, stretch wrap, returnable items, such as computer housings, clean construction materials and ***Postconsumer waste (PCR)****-i.e.,* all products that have been subjected to consumer use, such as grocery bags, blister packs, plastic cups, milk and beverage containers, and rubber tires. Such waste is generally contaminated to some degree with other materials.

There are many methods to dispose of the waste polymer, which contains:

1. Recycling into identical or similar new products.
2. Recycling into less-demanding new products-preferably one with a long service life.

3. Depolymerizing by pyrolysis into basic monomers or fuels.
4. Incineration, with or without recovery of energy of combustion, and with or without presorting to cull out recyclable materials.
5. Greater use of biodegradable plastics where appropriate.
6. Greatly reduced use of plastics intended for disposable uses, such as diapers, no-deposit bottles, and other packaging.
7. Substitution of materials, such as paper or glass, for plastics in packaging.
8. Using fewer polymers in the product by better design and better materials.

Still there are some limitations in disposal of plastic material. One of the constraints is **Contamination**-Containers for food or drinks must be cleaned and sterilized if returned as is for reuse, **Collection costs-**Collection of light-weight fluffy products, in all colors and conditions, and subsequent sorting into separate categories for further processing is costly, **Compatibility-**Sources such as discarded automobiles have large quantities of polymer products, but they are of many different types of polymer, **Low prices-** for virgin plastics, **Sales resistance-** to recycled plastics and **Public relations-**Public perceptions greatly affect acceptance of incineration plants.



Product marking-In the U.S., the Society of the Plastics Industry (SPI) has developed a voluntary labeling code for plastics commonly used in containers. ISO published a six-digit code for recyclable polymers

Waste materials can be recycled into identical or similar products. Most food or drink containers can be recycled provided that they can find their way back to a fabricator in usable 'condition. Deposit bottle that can be washed and cleaned at sufficiently high temperature to be sterilized and refilled. Properly designed HDPE containers for milk can be recycled at least 25 times. LDPE grocery sacks can be recycled at least once into the same product- collection stations at the local supermarkets. The virgin LDPE sack is generally clear blue or white with water-based inks used for printing. After recycling once, the clear blue will be dyed a light tan, but the bag will otherwise be about the same in properties and performance.

Engineering plastics are generally part of longer-lived products e.g., appliance, automobile, or machine, can be recycled into reasonably high-valued new products. E.g., under-hood acetal parts may be remolded into kitchen utensils or luggage hinges.

Table 1: Engineering Plastics

Property	Unfilled virgin Celcon GC-25A	Unfilled reclaim mixed acetal	25% Glass virgin GC-25A	25% Glass mixed acetal
Tensile (MPa)	61	54	110	83
% Elongation	60	57	2.8	3.3
Flexural strength (MPa)	90	79	134	127
Flexural modulus (GPa)	2.6	2.3	7.2	6.3
Notched Izod (ft/lb-in)	1.3	1.3	1.1	0.7
HDTUL (°C @1.82 MPa)	110	110	161	161
Specific gravity	1.41	1.41	1.59	1.59

Incineration is a substitute to landfill discarding of plastic wastes, but this practice could result in the development of intolerable emissions of gases such as nitrous oxide, sulfur oxides, dusts, dioxins and other toxins. The choice of secondary recycling or mechanical recycling, which is the reusing of plastic waste into new plastic products with a inferior quality level, is not showing any signs of growth in the recycling industry (Sakumoto and Miyata, 1994). Tertiary recycling, this returns plastics to their essential monomers or to their higher value hydrocarbon feed stock and fuel oil, is gaining momentums as another method. Tertiary recycling comprises of all those processing which attempt to transform the plastic wastes to elementary chemicals by the use of chemical reactions such as hydrolysis, methanolysis and ammonoloysis for condensation polymers and to fuels with conventional refinery procedures such as pyrolysis, gasification, hydrocracking, catalytic cracking, coking and via breaking for addition polymers excluding PVC (Urd et al., 2012).

Incineration of mixed waste can use the heating value of polymers to deliver net usable energy from the plant and to promote complete combustion of nonpolymeric wastes.

Incinerability index I:

$$I = C + \frac{100}{HV}$$

$I = 10 + (100/1.67) = 69.9$

$I = 1 + 100/11.1 = 10.0$

Table 2: Heating Values

Material	Heat of combustion	
	kcal/gm	Btu/lb
Food wastes	1.67	3000
Yard wastes	2.22	4000
Average MSW	2.78	5000
Newspaper	4.44	8000
Pine sawdust	5.33	9600
Rubber	5.55	10000
PMMA	6.55	11800
Foamed PUR	7.22	13000
Ethyl alcohol	7.40	13325
Carbon	7.83	14093
PS	10.0	18000
#2 heating oil	10.8	19430
PE, PP	11.1	20000

Polymers can be depolymerized into useful chemicals or fuels. Thermal depolymarization is the way to transfer polyesters, nylons and other plastics back into useful monomers. Thermal depolymerization in absence of oxygen yields component monomers from PMMA, PS, and some POM homopolymers. Through alcoholysis Industrial PET scrap has been converted to monomer and heat to dimethlyterephthlate (DMT) and ethylene glycol. DMT can be remade into PET. Pyrolytic liquefaction and pyrolytic gasification is a method to depolymerize addition polymers. Thermal reaction in absence of oxygen produces naphtha and hydrogen-rich aliphatics. Petroleum hydrocracker plants have been successfully fed mixtures of shredded polyolefin wastes, up to 2.5%, along with the heavy oil. It has been demonstrated that PE film can be pyrolyzed to yield 80% heavy oil and 15% gas. Pyrolysis and catalytic alteration of plastic is a superior method of recycling the waste. The distillate product is a brilliant fuel and makes pyrolysis one of the finest, economically feasible and environmentally sensitive recycling systems in the world today. Catalytic pyrolysis diesels can be utilized in any standard diesel engine, trucks, buses, trains, boats, heavy equipment and generators (C.LIN, 2013).

Nine countries in Europe reached a recovery ration of more than 95% of the post-consumer plastic waste. These countries have landfill ban. Also six of these countries are amongst the eleven countries with the highest recycling rates (>30%).

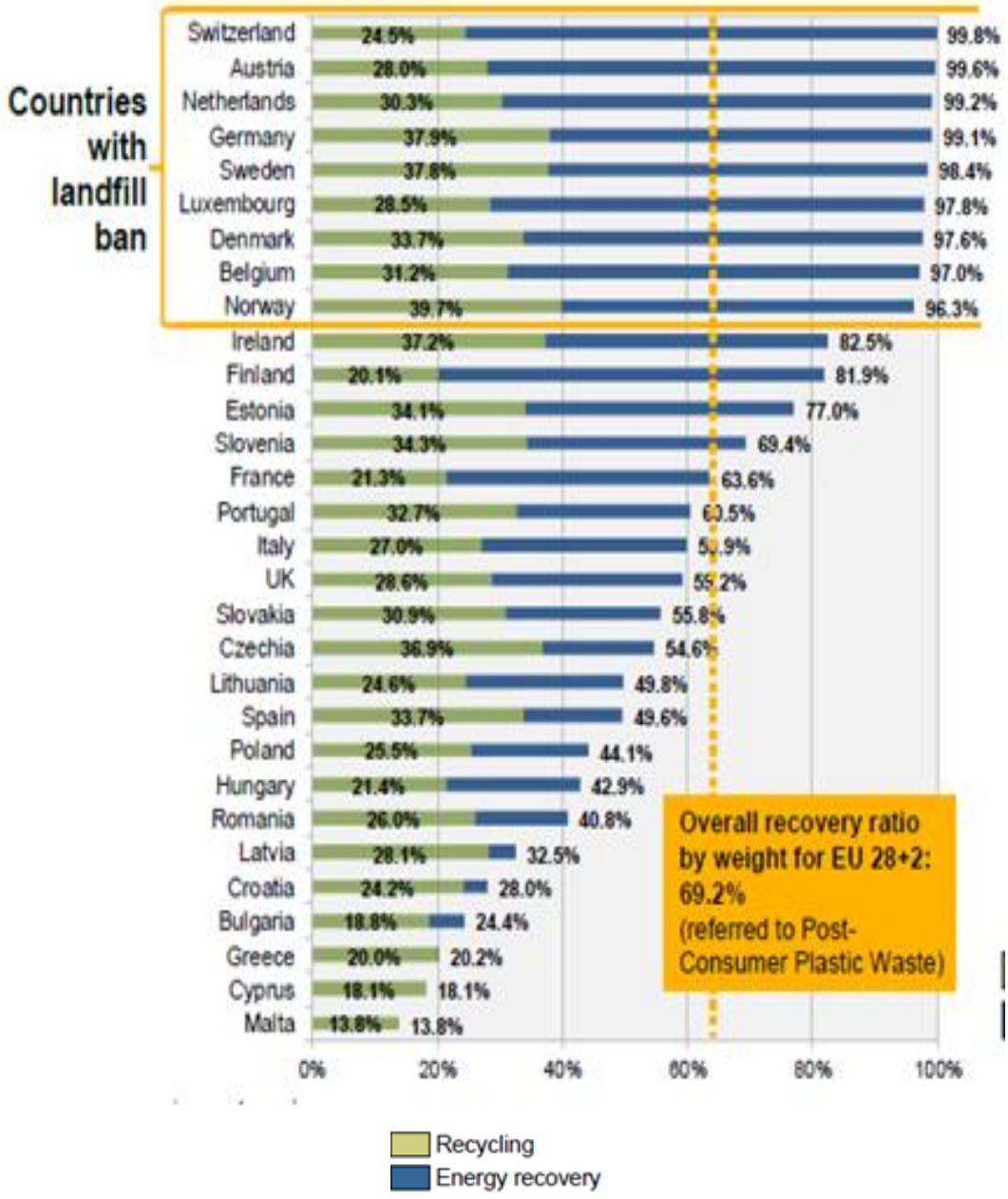


Fig.5 EU Energy Recovery

The plastic bags made of totally biodegradeable polymeric materia are less competitive than the partially biodegradable or non-biodegradable ones for their green and high-tech, high production cost and small scale. Regardless of this fact, more qualified alternatives must be designed and promoted as soon as possible, as to plastic bags which don't fulfill particular standards, especially the single-use plastic bags, supervisions and even punishment must be strengthened until the product is standardized (Karlaitė, 2016).

Types of Biodegradable Polymers according to ASTM D620.96,

1. Not water soluble, but hydrolyzable and biodegradable: polylactic acid and its relatives, regenerated cellulose (Cellophane), starch-based polymer with or without minor amounts of LDPE, polycaprolactone (an aliphatic polyester), and a copolyester (PHBV).

2. Photodegradable: ethylene/carbon monoxide copolymer, divinyl ketone copoymers of ethylene, propylene, or styrene.

3. Soluble in water solutions and potentially degradable: PVAL and its alloys, cellulose ether and polyethylene oxide blends.

Instruments used in the management of plastics:

Category of Instrument	Type	Policy Instrument	Remarks
Regulatory (Command and Control)	Regulation of Standard	Minimum Thickness Standard	Introduction of a phased minimum thickness standard starting with 20 microns and moving to 30 microns. As the experience of many countries has shown, such a standard is the most effective way to deal with very thin bags considering their high vulnerability to littering, single-use character, low price, and poor recycling feasibility.
Economic Instruments - The main essence of the application of economic instruments is to facilitate private sector involvement	Price-Based	Subsidy	Targeted subsidies to support development of environmentally friendly alternative bags. The development of more durable, reusable, recyclable bags should be supported.
	Price-Based	Subsidy	Support for development of an effective plastic bags recycling system. The support should be directed at strengthening and expanding this sub—sector, especially in segregation, collection and supply mechanisms. Innovative financing products for promoting investment in the sector should be established preferably by the micro finance institutions. Investment tax allowances, differential power and water tariffs and zero-rating of recycled products should be encouraged.
	Price-Based	Subsidy	Support for development of a managed disposal system to cater for the plastic bags that will eventually enter the waste stream. Since some plastic bags will eventually reach the disposal stage despite the measures taken, it is prudent to have proper guidelines on disposal of plastic bags since they take very long period (20 to 1000 years) to degrade. Financial incentives such as tax holidays, public land provision, and reduced corporate taxes to promote private-public partnerships in the development and management of sanitary landfills should be encouraged.
	Price-Based	Levy	A plastic bag levy collected from the suppliers and shifted to the shoppers. A levy on plastic bags rationalizes the consumption and production of plastic bags, as has been shown from the experience of several countries.
Voluntary /Information – Based Instruments	Information based	Consumer awareness and anti-littering campaign.	Active support to be extended to the existing consumer awareness and anti-littering campaigns, with special emphasis on management of plastic bags.
	Voluntary Agreement	A National Code of Practice	Promotion of voluntary schemes such as a national code of practice for retailers and manufacturers. Such a code will commit retailers to reduce use of bags by voluntarily declaring the number of plastic bags issued within a specified period, increase the usage of plastic bags made from recycled material, and provision of convenient and accessible recycling stations to customers among others.

Conclusion:

Plastic waste is a real threat to environment and ultimately to civic life. Waste management is extremely imperative in addressing the concerns of plastic waste. It requires community awareness and participation in systematic collection. The systems vary from country to country and region to region. Although international and European legislation exists, it necessitates better monitoring to guarantee complete implementation. There is also a need for better education and awareness around plastic waste. Plastics waste has large potential to be converted into profitable products. Plastic footprints and labelling on products are likely but need

the appropriate education to make them meaningful. Better knowledge is needed on the actual influence of chemicals associated with plastic waste on the environment and human health.

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PLASTIC POLLUTION AND ITS IMPACT ON WATER RESOURCES

by

Ghulam Zakir Hassan[1], Adnan Hassan[2] and Sumayya Noshin[3]

ABSTRACT

The word plastic has been derived from the Greek word 'PLASTIKOS' which means 'FIT FOR MOULDING'. Plastics are typically synthetic polymers of high molecular weight that consists of many organic and inorganic compounds and is mostly derived from petrochemicals. Polyethylene, polyvinyl chloride, polystyrene is largely used in the manufacture of plastics. As per an estimate of 8.3-billion-ton plastic has been produced to-date. If current position and waste management trends continue, roughly 12 billion tons of plastic waste will be in landfills or the natural environment by 2050. In 1907 first modern plastic, Bakelite, was invented. It pointed the way to a whole family of products based on synthetic polymers. Like other countries in the world, Pakistan is also facing health and other hazards being created due to extensive and widespread use of plastics in the country. Irrigations system of Pakistan is one of the largest gravity flow irrigations systems in the world comprising of dams, barrages, head-works, secondary and tertiary canals and water courses, bridges, syphons and other hydraulic structures. Plastic pollution starts from the catchment areas in the mountain ranges due to tourism, local population, agricultural, industrial and other activities which cause transportation of disposed plastic bags/bottles etc. into streams/rivers due to wind or water flow actions. In this paper a review of issues/problems caused by plastic pollution to our irrigation system has been outlined with some remedial steps.

1. INTRODUCTION

Plastic waste is a major environmental and public health problem in Pakistan, particularly in the urban areas. Plastic shopping or carrier bags of all colors and sizes are one of the main sources of plastic waste worldwide and in Pakistan as well. The word plastic has been derived from the Greek word 'PLASTIKOS' which means "FIT FOR MOULDING" Plastics are typically synthetic polymers of high molecular weight that consists of many organic and inorganic compounds and is mostly derived from petrochemicals. Polyethylene, polyvinyl chloride, polystyrene is largely used in the manufacture of plastics. In 1907 first modern plastic, Bakelite, was invented. It pointed the way to a whole family of products based on synthetic polymers. In the late 1950s and early 1960s, improvements in manufacturing

[1] *Director, Irrigation Research Institute (IRI), Government of the Punjab, Irrigation Department, Library Road, Lahore 54000, Pakistan: Correspondence author:* zakirjg@gmail.com

[2] *Deputy Director, Irrigation Research Institute (IRI), Government of the Punjab, Irrigation Department, Library Road, Lahore 54000, Pakistan*

[3] *Assistant Director, Irrigation Research Institute (IRI), Government of the Punjab, Irrigation Department, Library Road, Lahore 54000, Pakistan*

processes brought the cost of making plastics down dramatically. Plastics in the last 60-70 years, has transformed everything from clothing, cooking and catering, to product design, engineering and retailing. Plastic pollution is defined as the accumulation of the different types of plastic material on land, as well as in water bodies like rivers, oceans, canals, lakes, etc. Basically, it is a synthetic polymer that consists of many organic and inorganic compounds and is mostly derived from petrochemicals like olefins. **P. Phebe et al (2014)** has investigated that plastic bag wastes contribute to blockage of drains and gutters and are a threat to aquatic life when they find their way to water bodies. Such plastics can cause livestock deaths when the livestock consume them as a food material by mistake. Besides, when filled with rainwater, plastic bags become breeding grounds for mosquitoes, which cause the spreading of malaria and other diseases. Likewise, plastics take many years (20-1000) to degrade and hence pose a disposal challenge for controlling the plastic wastage**. Proshad et al (2018)** has summarized that different human health problems like irritation in the eye, vision failure, breathing difficulties, respiratory problems, liver dysfunction, cancers, skin diseases, lungs problems, headache, dizziness, birth effect, reproductive, cardiovascular, genotoxic, and gastrointestinal are caused by using toxic plastics. Plastics cause serious environment pollution such as soil pollution, water pollution, and air pollution. Application of proper rules and regulations for the production and use of plastics can reduce toxic effects of plastics on human health and environment. **Delilah Lithner (2011)** has concluded that plastics are extremely diverse in terms of chemical composition, properties and possible applications, and are widely distributed in the society and the environment. Several of the chemicals used to produce plastics are hazardous for human health and the environment. These, and their degradation products, may be released during the life cycle of a plastic product. The plastic polymers are not considered as toxic, but in plastic products there may be non-bound residual monomers, polymerization chemicals, degradation products, and additives which have toxic properties. Plastic accumulation is also harmful for aquatic/marine life. (Laist 1997; Wabnitz and Nichols 2010) inferred that ingestion or entanglement in plastic debris, over 270 species, including turtles, fish, seabirds, and mammals, have experienced impaired movement, starvation, or death.

Plastic has found place in our daily life like plastic bags, furniture, toys, stationary, fittings, sanitary-ware and flexible plastic packaging etc. The properties of plastics including heat resistant, light weight, insulator, moisture resistant, flexible, versatile, durable and relatively inexpensive has assigned the plastics an imperative role in our life, industry and anywhere. In 1907 first modern plastic, Bakelite, was invented. It pointed the way to a whole family of products based on synthetic polymers. In the late 1950s and early 1960s, improvements in manufacturing processes brought the cost of making plastics down dramatically. Plastics in the last 60-70 years, has transformed everything from clothing, cooking and catering, to product design, engineering and retailing. One of the great feature of many types of plastic is its long-lasting ability- for a very long time. And nearly all the plastic ever created still exists in some form today. Generally, stryroform

cups, Aluminum cans, nappies, and plastic bottles have life more than 50 years, 200 years, 450 years respectively. Long life cycles of some plastics are given in **Figure 1.**

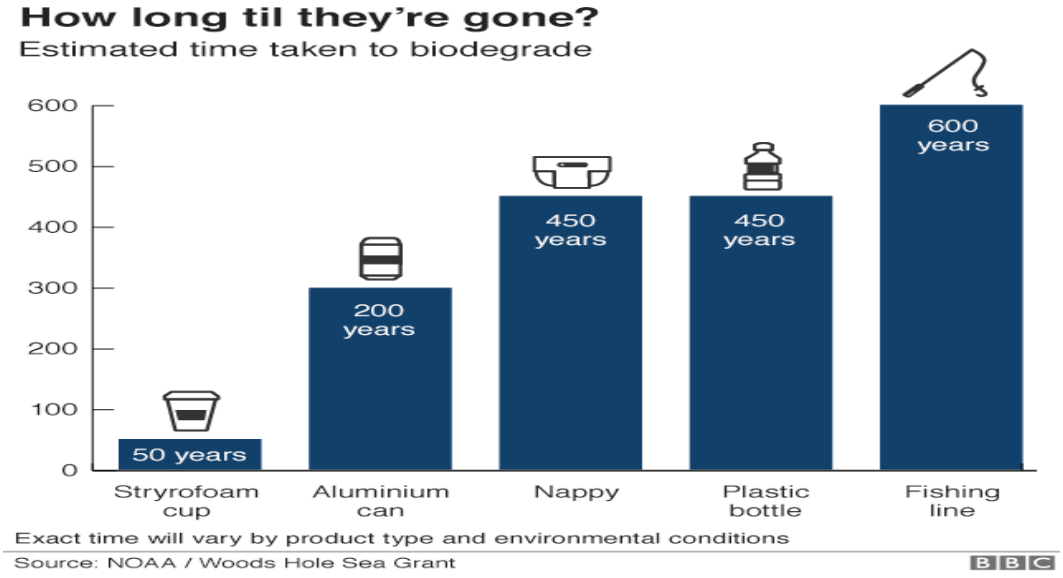


Figure. 1: Life spans of different plastics

As per an estimate of 8.3-billion-ton plastic has been produced to-date. If current position and waste management trends continue, roughly 12 billion tons of plastic waste will be in landfills or the natural environment by 2050. Due to its properties Plastic is found everywhere either in the form of food containers, financial transactions (Debit/Credit cards, plastic money), storage, baggage, stationary items, electronic and electrical products and every foreseeable item that a human being can think of. Plastic waste is a growing day by day and the drivers behind it look set to continue. Plastic is a highly useful material and its applications are expected to increase as more new products as plastics are developed to meet demands. Almost 322(Million tons) plastic produced in 2015 while this production increased to 335(Million tons) in next year. The increased use and production of plastic in developing and emerging countries is a particular concern, as the sophistication of their waste management infrastructure may not be developing at an appropriate rate to deal with their increasing levels of plastic waste. Over the last ten years we have produced more plastics than during whole of the last century. The major land-based sources are Illegal dumping (mismanaged plastic waste- Figure 2) and inadequate waste management. Global production of plastics is now up to around 300 million tones and non degradable plastic accounts for 73% of litter in any aquatic habitat with roughly 50% disposed of after a single-use **Kibria, G. (2017).**

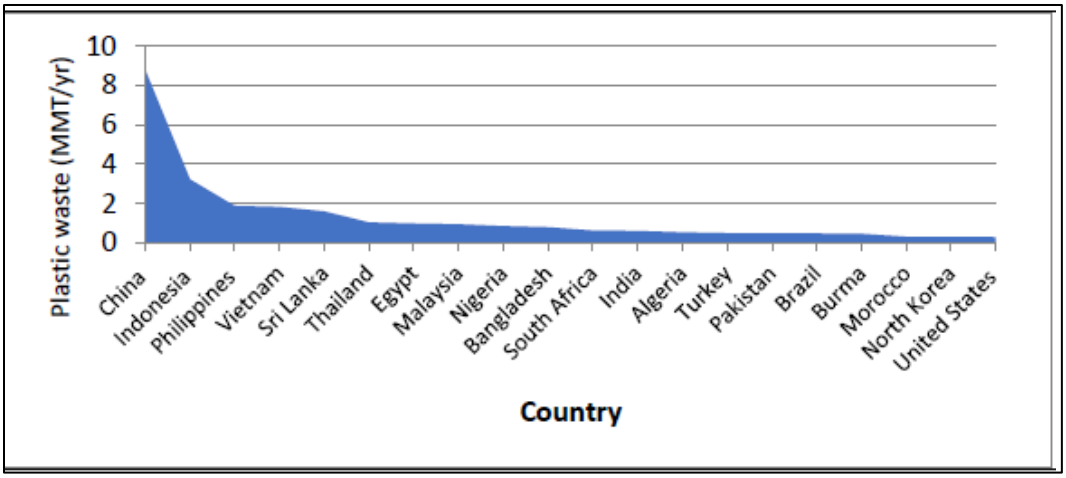


Figure. 2: Mismanaged Plastic waste in top 20 countries in the world.

The present consumption of Plastics in Pakistan is around 5.5 kg per capita. This consumption is very likely to increase due to certain encouraging factors like Urbanization, Modern life styles, spreading of vast shopping malls on modern lines, increased use of bottled water, Introduction of new drinks and Lack of awareness **(Figure 3)**

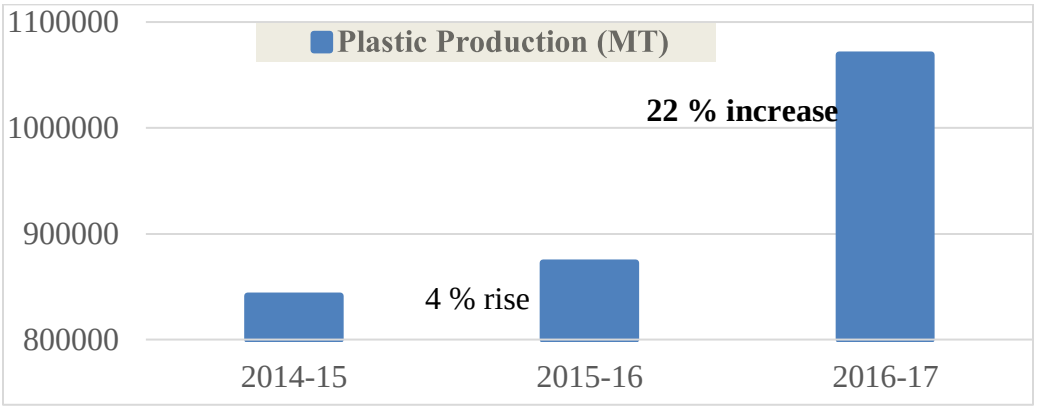


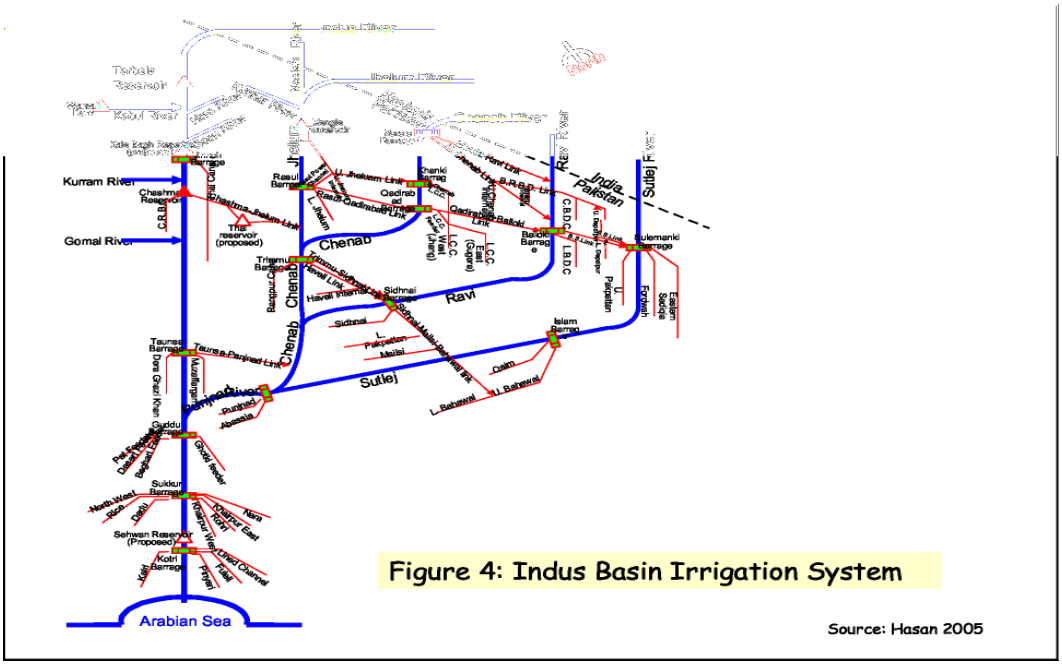
Figure. 3: Plastic production in Pakistan

We need a different kind of economy, where we prevent and recycle waste much more, so that valuable resources aren't lost. Past experience has shown that remedial actions to clean up polluted sites and water bodies are generally much more expensive than applying measures to prevent pollution from occurring.

2. PLASTIC POLLUTION IN WATER RESOURCES

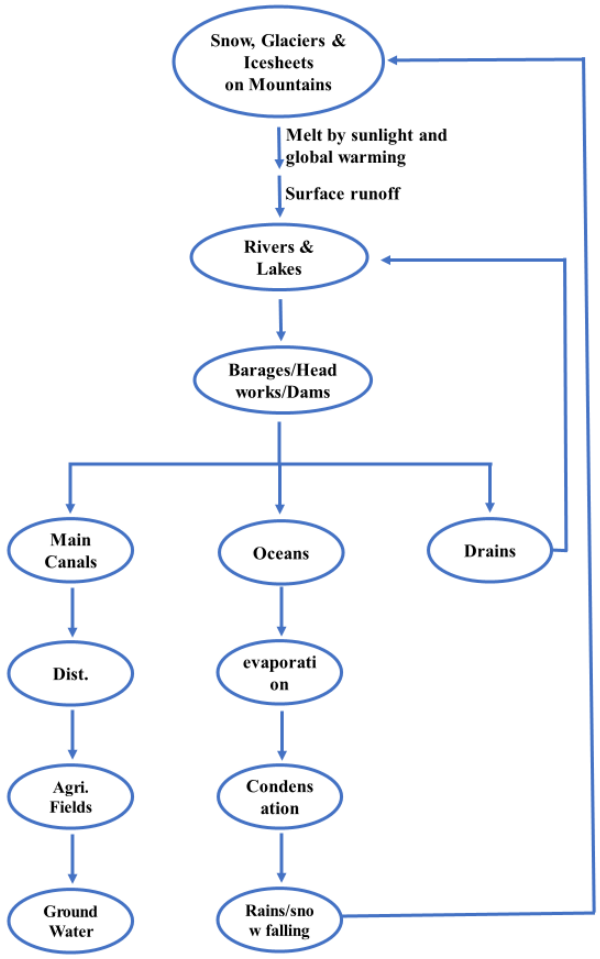
Water bodies like canals, drains, dams, barrages, lakes, rivers are the ultimate destination of most of the plastics irrespective of the fact we dispose them anywhere. Through natural carriers like wind and rainfall transport these waste materials from one place to other and some travelling a distances of many hundred

kilometers. These plastics materials travel in water channels and finally reach either the irrigation fields or the ocean if not trapped/removed on the way. If we have a look at the water resources of Pakistan we have rainfall, glaciers, rivers and groundwater reservoir, which all are under sever threat due to this menace of plastics wastes spreading widely around us. The Indus Basin Irrigation System (IBIS) of Pakistan is one of the largest gravity flow irrigation networks in the world. Agriculture is the mainstay of impact on food, power and domestic water requirements. Ninety percent of the agriculture produce is benefited from irrigation water supplies. The irrigated agriculture of Pakistan mainly depends on Indus River System and its tributaries. The annual flow of Indus River is 143 MAF out of which 103 MAF is diverted into different canal commands. Being semi arid to arid climate of the country, having an average annual rain fall of 240 mm, the 90% of the irrigated agriculture is being carried out in Indus plains. The 80% flow of the Indus River is generated during monsoon period i.e. from June - August, which necessitates the effective water management for sustainability of irrigated agriculture. The Indus Basin irrigation system comprises of three major reservoirs i.e. Tarbela, Mangla, and Chashma reservoirs, which accommodate 10% of the flow of Indus River. The Indus Basin Irrigation System (IBIS) is shown in **Figure. 4**



There are three main components of water resources in Pakistan comprising of Rainfall, Ground water and Surface runoff.

In Pakistan irrigation water flows in a system which is shown in flow chart below,



3 PLASTIC POLLUTION IN PUNJAB IRRIGATION NETWORK

Different control structures have been constructed over the rivers, canals and drains where these plastic are entangle and cause many physical, environmental and financial challenges for successful operation and maintenance of the system. A map of IBIS with location of Punjab Irrigation network with major control/diversion structures is shown in (Figure 4). The Punjab irrigation system consists of a major part of Indus Basin Irrigation system. It is a contiguous system and occupies a pivotal role in Pakistan's economy and accounts for 80% of the country's agricultural production. The Punjab irrigation system serves about 26.78 million acres of cultureable lands and existing average cropping intensity is 130%. The river supplies are distributed to agricultural fields through a network of main canals, branch canals, distributaries, minors and outlets / watercourse. Punjab province

the food basket for the country comprises of the major part of IBIS and is irrigating fertile lands throughout the province with the salient features shown in the box.

Punjab irrigation network is badly affected due to plastic accumulations at different points which are creating multidimensional challenges/threats for the system. A field survey has been carried out to visualize the impacts of plastic wastes on various structures of the water flow system.

SALIENT FEATURES OF PUNJAB IRRIGATION NETWORK

i. 13 barrages;
ii. 24 main canals;
iii. 9 inter-river link canals;
iv. 6,429 km of main canals;
v. 31,214 km of distributary and minor canals;
vi. more than 58,000 field outlets;
vii. 3,228 km of flood protection embankments
viii. 56 small dams.

3.1 DAMS/RESERVOIR

There are several sources of plastic accumulation at such places. These include tourist visits and plastic flowing with water from catchment area. Dams/Barrages have tourist places where people visit very frequently for their picnic/party purposes. They carry along with them, a lot of plastic bottles/plastic packing etc. which they don't properly dispose off and throw it in water and areas around which ultimately accumulate in canals. Similarly, the water flowing from catchment area also contains such materials due to plastic gathering at upstream. The pictures below show hindrance to flow of water at Rawal Dam. Besides this plastic pollution is making uglier our natural resources.



Figure. 5: Plastic accumulation in Rawal Dam Islamabad

3.2 CANALS

Plastic accumulation causes reduction in channel capacity with more roughness due to which flow velocity is reduced, owing to silting up and breaches occurred resulting in more O&M Cost. It also causes to growth of aquatic plants/weeds with

the degradation of Water Quality. During the rainy season, the plastic rubbish that has fallen on the road gets washed away into the nearby water reservoirs, canals, and drains, leading to their choking up and overflowing. Also, the water quality gets spoiled due to the addition of these synthetic materials. Blockage of flow in canals due to plastic accumulation may form shelters for the breeding of mosquitoes and other harmful vectors insects, which might cause numerous diseases in humans and animals.For example, the pics below are of Lower Bari Doab Canal showing accumulation of Plastic. This canal is flowing through urban area and people carelessly throwing the trash in the water and on the banks of canal from where it comes into water.



Figure. 6: Plastic accumulation in lower Bari Doaab canal.

3.3 DRAINS

Debris, plastic accumulation resulted in clogging, blockage and hindrance in flow of the drain. Increased Retention time for waste water/Deep percolation resulted in degradation of lands, deterioration of ground water quality and Increased O&M Cost. Overtopping during rainy season and breaches also occurred due to plastic accumulation.



Figure. 7: Plastic accumulation in Drains of Sargodha Zone.

3.4 HYDROPOWER UNITS

Plastic accumulation is a big challenge being faced in hydropower units resulting the choking and chances of damages to machinery/system. This accumulation of plastics resulted in Extra labour and machinery for the normal performance of hydraulic structures. This leads to remarkable increase in annual maintenance cost. A similar situation was observed in the precious asset of nation which is Renala Hydro Power Station, a unique hydropower station in the world.

Sir Ganga Ram (1851–1927), a civil engineer and leading philanthropist of his time, established Renala Hydral Power Station in 1925, Pakistan's (Indian subcontinent's) first hydropower station. Renala Khurd Hydropower Plant (RKHPP) is a small, low-head, run-of-the-river hydroelectric generation station with a 1.1 megawatts (1,500 hp) capacity, located at Renala Khurd, Okara District, North-East of Punjab province of Pakistan, on the flows of Lower Bari Doab Canal. It is located about 116 kilometres (72 mi) away from Lahore and 18 kilometres (11 mi) away from the district capital Okara city towards south-west of Lahore on national highway (GT Road) and on Lahore-Karachi main railway line. Having five turbine units, each rated for 22 kW (30 hp) production capacity, this plant was set up to meet the electricity needs of the Mitchells Fruit Farms and Food Processing unit etc.



Figure. 8: plastic accumulation in Sir Ganga Ram Hydropower station.

3.5 OTHER HYDRAULIC STRUCTURES

Other hydraulic structure of irrigation network like bridges, culverts, syphons, cross drainage works, headworks etc. are being affected badly by plastics floating in water channels. This causes blockage when stuck in outlets some time cause damage to the structure, overtopping and surely reduction in water share to the stakeholder on turn.



Figure. 9: Plastic accumulation at Ravi syphon.

3.6 AGRICULTURAL FIELDS

Some plastics floating along the water and crossing all hurdles/structures ultimately reach the agricultural field with irrigation water and remain there for rest of their life. When plastics are dumped in lands, it interacts with water and forms hazardous chemicals which cause land and water degradation besides creating physical hindrance in on-farm agronomic practices like ploughing, levelling, growing, irrigation, harvesting etc. and cause a significant reduction in crop yields as well. When these chemicals seep underground, they degrade the ground water quality. Wind carries and deposits plastic from one place to another, increasing the land litter. It can also get stuck on poles, traffic lights, trees, fences, tower etc. and animals that may come in the vicinity and might suffocate them to death.



4 PLASTIC POLLUTION IN OCEANS

A significant portion of plastics floating in water channels like rivers, drains, nullahs etc which is not diverted to canals, ultimately finds its destination in the oceans

after travelling thousands of kilometers and even travel long journeys there as well. Marine wildlife faces a growing number of threats across the globe, and the survival of many species and populations will be dependent on conservation action. Garbage has been discarded into the oceans for as long as humans have sailed the seven seas or lived on seashores or near waterways flowing into the sea. Since the 1940s, plastic use has increased dramatically, resulting in a huge quantity of nearly indestructible, lightweight material floating in the oceans and eventually deposited on beaches. Plastic pollution in marine water bodies leads to innumerable deaths of aquatic animals, and this also affects the aquatic plants to a considerable degree. Plastics absorb ultraviolet (UV) radiation and undergo photolytic, photo-oxidative, and thermo-oxidative reactions that result in degradation of their constituent polymers **Gugumus (1993)** and **Andrady et al. (1998).**



Plastic waste is finding its way into the rivers, oceans and seas of the world due to which the rich marine life is facing serious health hazards. Marine animals like fish, sea birds, otters and other marine species are swallowing these plastic wastes as food items that are leading to a premature death of these precious marine species. Further these plastics and their toxic materials reach to human body through food chain.



Figure. 10: Plastic accumulation in Oceans/Sea.

5 IMPACT OF PLASTIC POLLUTION ON GROUNDWATER

Blockage of drainage network increases the retention time of polluted water which contain domestic, agricultural and industrial effluents. Hazardous water will stay in the drainage network for a longer period and will enhance the deep percolation of polluted water which resultantly degrade the land and groundwater resources and the subsurface ecosystem as well. Similarly, plastics dumped in landfills when degrade due to weathering effects, toxic chemicals produced leach down when there is rainfall and pollute the groundwater.



Figure. 11: Plastic accumulation in drains polluting ground water-Sargodha Zone

6. CONCLUSIONS

The study revealed that plastic is causing a big problem on this planet. As a result of plastic waste, waterways, earth's ocean, freshwater biodiversity groundwater are being negatively affected. Since plastics are lightweight and durable, are capable of traveling long distances in waterways. As plastics float in the oceans, they are affecting marine wildlife. Plastics are acting as a medium for invasive species. The hard surfaces of plastics are now an alternate material for invasive species.Community awareness and participation in systematic collection is the

major issue. Plastics waste has large potential to be converted into profitable products. Non-traditional technical and business approaches may help. A clear and comprehensive policy is required involving technical aspects of plastics recycling etc. Technology can help in fighting with this technical menace. Plastic pollution is posing severe impacts/hurdles in smooth operation of canal and drainage network and putting extra financial burden. Changes in the condition of natural assets due to plastic pollution can influence social and economic systems by altering environmental quality for future generations. Plastic pollution decreases the value of ecosystem services, and potentially causing negative health implications **(Vegter et al 2009)**. Specifically, the impact of Plastic Pollution is as follows:

SOIL FERTILITY: is affected due to plastic material as it forms part of manure remaining in the soil for years without natural degradation

DEATH OF ANIMALS: due to suffocation, stomach and intestine related diseases due to improper disposal of plastic.

MARINE LIFE: Plastic waste is finding its way into the rivers, oceans and seas of the world due to which the rich marine life is facing serious health hazards.

HUMAN HEALTH: by drinking polluted water and eating the seafood which may be contaminated by plastics

Ecosystems, lakes, wetlands, barrages, reservoirs are also badly polluted and efficiency is much reduced.

Solutions to ensure that plastic materials are recycled or disposed of properly need to be developed. Even with research, recycling, and new technologies, alternate packaging material should be utilized to reduce the dependence on plastic goods. Plastics do not disappear and will remain in our environments indefinitely affecting wildlife, until the pollution is reduced. “Water is something every living organism on this planet cannot live without. If this resource is so precious that life cannot exist without it, we shouldn’t be contaminating it” (Sherri Mason as cited in Blackwell 2012 para. 19).

7 RECOMMENDATIONS

- All the stake holders starting from producers to end users must be well coordinated for the reduction of plastic use.
- There should be a vast awareness campaign to stop using plastic bags. People should be very well educated about plastic pollution and its effect on our environment at local, national and regional level. People should be well aware polluting our environment including water sources, land sources etc.
- Research, Recycling and Re-use of Plastic products need to be introduced and focused.
- Research and development propositions at the material design level

- There should be remedial measures to capture plastic items at source
- There should be some Rules & Regulation including bans on certain products.
- There should be economic incentives for different actors in the supply, use and disposal chain
- There should be End-of-life waste management practices and setting of achievable policy targets relevant to marine plastic pollution.
- There should be well coordination between the countries for transfer of technology-technical cooperation regarding the issue.
- Resource should be mobilized for all plastic free/management interventions.
- There should be development of national and regional capacities for the management of solid waste, marine litter.
- There should be g management of plastics and good environmental practices a constituent of the education system by incorporation in a suitable subject matter and/or curricula at all levels
- There should be Public Private Partnership for the management of plastics.

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PLASTIC POLLUTION: IMPACTS ON BIODIVERSITY

by

Dr. Abdul Aleem Chaudhry

The Theme of "World Environment Day, June 5, 2018" **BEAT PLASTIC POLLUTION: and *If you cannot reuse it, refuse it.***

The Day is celebrated to raise awareness and urge governments, industry, communities, and individuals to come together and explore sustainable alternatives and urgently reduce the production and use of single-use plastic that pollutes oceans, damages marine life and threatens human health.

Plastic has become the most common material since the beginning of the 20th century and modern life is unthinkable without it. Unfortunately, what makes it so useful, such as its durability, light weight and low cost, also makes it problematic when it comes to its end of life phase due to its non-biodegradable nature.

Plastic bags and climate change are linked in a variety of ways. From air quality to ocean toxicity, plastic bags contribute to eco-system disruption. Even worse, plastic is poisonous. Some of its ingredients such as biosphenol-A and Phthalates have been proved to cause cancer, birth defects, impaired immunity, endocrine disruption and other ailments. Additionally, plastic threatens wildlife and is a pollutant of groundwater. Cases of groundwater pollution due to landfills have been reported worldwide, and toxic leachates from landfills are among the major groundwater quality risks, according to the International Association of Hydrological Sciences.

"The plastic bags are so flimsy that millions of them only get used once before being thrown away, you see them in the trees, in the hedges and on the ground. And when they settle on the ground, they collect small pools of stagnant water, in which mosquitos breed."

Plastic pollution is the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat, or humans. Plastics that act as pollutants are categorized into micro-, meso, or macro debris, based on size. Plastics are inexpensive and durable, and as a result levels of plastic production by humans are high. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors have led to a high prominence of plastic pollution in the environment.

Plastic pollution can afflict land, waterways and oceans. Living organisms, particularly marine animals, can be harmed either by mechanical effects, such as entanglement in plastic objects or problems related to ingestion of plastic waste, or through exposure to chemicals within plastics that interfere with their physiology. Humans are also affected by plastic pollution, such as through disruption of various hormonal mechanisms.

Plastics themselves contribute to approximately 10% of discarded waste. Many kinds of plastics exist depending on their precursors and the method for their polymerization. Depending on their chemical composition, plastics and resins have varying properties related to contaminant absorption and adsorption. Polymer degradation takes much longer as a result of haline environments and the cooling effect of the sea. These factors contribute to the persistence of plastic debris in certain environments. Recent studies have shown that plastics in the ocean decompose faster than was once thought, due to exposure to sun, rain, and other environmental conditions, resulting in the release of toxic chemicals such as bisphenol A (BPA). However, due to the increased volume of plastics in the ocean, decomposition has slowed down. The Marine Conservancy has predicted the decomposition rates of several plastic products. It is estimated that a foam plastic cup will take 50 years, a plastic beverage holder will take 400 years, a disposable nappy will take 450 years, and fishing line will take 600 years to degrade.

It has been estimated that global production of plastics is approximately 250 m tons/yr. Their abundance has been found to transport persistent organic pollutants, also known as POPs. These pollutants have been linked to an increased distribution of algae associated with red tides.

China is the biggest offender, discarding nearly 30 percent of the world's ocean-bound plastic. According to an analysis of plastic trash in the sea, 8 billions of trash or grocery bags, filled with plastic trash, are dumped into the world's water. Plastic waste is generated by people from 192 countries, living within 30 miles of the coast. The researchers have found that if nothing changes, as many as 155 million tonnes (10 bags) of trash for every mile on a coastline would be tossed out and find its way into the oceans in 2025. According to the report most polluting countries are Indonesia, Philippines, Vietnam, Sri Lanka, Thailand, China and USA.

Some researchers suggest that by 2050 there could be more plastic than fish in the oceans by weight.



Effects on Environment

The distribution of plastic debris is highly variable as a result of certain factors such as wind and ocean currents, coastline geography, urban areas, and trade routes. Human population in certain areas also plays a large role in this. Plastics are more likely to be found in enclosed regions. It serves as a means of distribution of organisms to remote coasts that are not their native environments. This could potentially increase the variability and dispersal of organisms in specific areas that are less biologically diverse. Plastics can also be used as vectors for chemical contaminants such as persistent organic pollutants and heavy metals.

On Land

plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem. This can cause serious harm to the species that drink the water.

Landfill areas contain many different types of plastics. In these landfills, there are many microorganisms which speed up the biodegradation of plastics. The microorganisms include bacteria such as *Pseudomonas*, nylon-eating bacteria, and Flavobacteria. These bacteria break down nylon through the activity of the nylonase enzyme. Breakdown of biodegradable plastics releases methane, a very powerful greenhouse gas that contributes significantly to global warming.

In Oceans

In 2012, it was estimated that there was approximately 165 million tons of plastic pollution in the world's oceans. One type of plastic that is of concern in terms of ocean plastic pollution is nurdles. Nurdles are manufactured plastic pellets (a type of microplastic) used in the creation of plastic products and are often shipped via cargo ship. Many billions of nurdles are spilled into oceans each year, and it has been estimated that globally, around 10% of beach litter consists of nurdles. Plastics in oceans typically degrade within a year, but not entirely. In the process, toxic chemicals such as bisphenol A and polystyrene can leach into waters from some plastics. Polystyrene pieces and nurdles are the most common types of plastic pollution in oceans and combined with plastic bags and food containers make up the majority of oceanic debris.

One study estimated that there are more than 5 trillion plastic pieces (defined into the four classes of small microplastics, large microplastics, meso and macroplastics) afloat at sea.

The litter that is being delivered into the oceans is toxic to marine life, and humans. The toxins that are components of plastic include diethylhexyl phthalate, which is a toxic *carcinogen*, as well as lead, cadmium, and mercury.

Plankton, fish, and ultimately the human race, through the food chain, ingest these highly toxic carcinogens and chemicals. Consuming the fish that contain these toxins can cause an increase in cancer, immune disorders, and birth defects.

The majority of the litter near and in the ocean is made up of plastics and is a persistent pervasive source of marine pollution. There are 5.25 trillion particles of plastic pollution that weigh as much as 270,000 tons (2016). This plastic is taken by the ocean currents and accumulates in large vortexes known as ocean gyres. The majority of the gyres become pollution dumps filled with plastic.

Almost 90% of plastic debris that pollutes ocean water, which translates to 5.6 million tons, comes from ocean-based sources. Merchant ships expel cargo, sewage, used medical equipment, and other types of waste that contain plastic into the ocean. Naval and research vessels eject waste and military equipment that are deemed unnecessary. Pleasure crafts release fishing gear and other types of waste, either accidentally or through negligent handling. The largest ocean-based source of plastic pollution is discarded fishing gear (including traps and nets), estimated to be up to 90% of plastic debris in some areas.

Continental plastic litter enters the ocean largely through storm-water runoff, flowing into watercourses or directly discharged into coastal waters. Plastic in the ocean has been shown to follow ocean currents which eventually form into what is known as Great Garbage Patches. Knowledge of the routes that plastic follows in ocean currents comes from accidental container drops from ship carriers. For example, in May 1990 The Hansa Carrier, sailing from Korea to USA, broke apart due to a storm, ultimately resulting in thousands of dumped shoes; these eventually started showing up on the U.S western coast, and Hawaii.









Land-based sources of ocean plastic pollution

Estimates for the contribution of land-based plastic vary widely. One study estimated that, in 2015, Jambeck *et al*. (2015) calculated that 275 million tonnes of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million tonnes entering the ocean - a percentage of only up to 5%.

A source that has caused concern is landfills. Most waste in the form of plastic in landfills is single-use items such as packaging. Discarding plastics this way leads to accumulation. Although disposing of plastic waste in landfills has less of a gas emission risk than disposal through incineration, the former has space limitations. Another concern is that the liners acting as protective layers between the landfill and environment can break, thus leaking toxins and contaminating the nearby soil and water. Landfills located near oceans often contribute to ocean debris because content is easily swept up and transported to the sea by wind or small waterways like rivers and streams. Marine debris can also result from sewage water that has not been efficiently treated, which is eventually transported to the ocean through rivers. Plastic items that have been improperly discarded can also be carried to oceans through storm waters.







Effects on Animals

Plastic pollution has the potential to poison animals, which can then adversely affect human food supplies. Plastic pollution has been described as being highly detrimental to large marine mammals, described in the book Introduction to Marine Biology as posing the "single greatest threat" to them. Some marine species, such as sea turtles, have been found to contain large proportions of plastics in their stomach. When this occurs, the animal typically starves, because the plastic blocks the animal's digestive tract.

Marine mammals sometimes become entangled in plastic products such as nets, which can harm or kill them.

Entanglement

Entanglement in plastic debris has been responsible for the deaths of many marine organisms, such as fish, seals, turtles, and birds. These animals get caught in the debris and end up suffocating or drowning. Because they are unable to untangle themselves, they also die from starvation or from their inability to escape predators. Being entangled also often results in severe lacerations and ulcers. In a 2006 report known as Plastic Debris in the World's Oceans, it was estimated that at least 267 different animal species have suffered from entanglement and ingestion of plastic debris. It has been estimated that over 400,000 marine mammals perish annually due to plastic pollution in oceans. Marine organisms get caught in discarded fishing equipment, such as ghost nets. Ropes and nets used to fish are

often made of synthetic materials such as nylon, making fishing equipment more durable and buoyant. These organisms can also get caught in circular plastic packaging materials, and if the animal continues to grow in size, the plastic can cut into their flesh. Equipment such as nets can also drag along the seabed, causing damage to coral reefs.

Ingestion

Marine animals

Sea turtles are affected by plastic pollution. Some species are consumers of jelly fish, but often mistake plastic bags for their natural prey. This plastic debris can kill the sea turtle by obstructing the oesophagus. So too are whales; large amounts of plastics have been found in the stomachs of beached whales.

Some of the tiniest bits of plastic are being consumed by small fish, in a part of the pelagic zone in the ocean called the Mesopelagic zone, which is 200 to 1000 meters below the ocean surface, and completely dark. Not much is known about these fish, other than that there are many of them. They hide in the darkness of the ocean, avoiding predators and then swimming to the ocean's surface at night to feed. Plastics found in the stomachs of these fish were collected during Malaspina's circumnavigation, a research project that studies the impact of global change on the oceans. A study conducted by Scripps Institution of Oceanography showed that the average plastic content in the stomachs of 141 mesopelagic fish over 27 different species was 9.2%. Their estimate for the ingestion rate of plastic debris by these fish in the North Pacific was between 12,000 and 24,000 tons per year. The most popular mesopelagic fish is the lantern fish. It resides in the central ocean gyres, a large system of rotating ocean currents. Since lantern fish serve as a primary food source for the fish that consumers purchase, including tuna and swordfish, the plastics they ingest become part of the food chain. The lantern fish is one of the main bait fish in the ocean, and it eats large amounts of plastic fragments, which in turn will not make them nutritious enough for other fish to consume.

Deep sea animals as well have been found with plastics in their stomachs.



















Birds

The amount of plastic in the seas has increased dramatically since the first record in the 1960s, coming from waste discarded by ships, offshore dumping, litter on beaches and waste washed to sea by rivers. It is impossible to digest and takes up space in the stomach or gizzard that should be used for food, or can cause an obstruction that starves the bird directly. Studies of birds in the North Pacific have shown that ingestion of plastics results in declining body weight and body condition. This plastic is sometimes regurgitated and fed to chicks; a study of Laysan albatross chicks on Midway Atoll showed large amounts of ingested plastic in naturally dead chicks compared to healthy chicks killed in accidents. While not the direct cause of death, this plastic causes physiological stress and causes the chick to feel full during feedings, reducing its food intake and the chances of survival.

Plastic pollution does not only affect animals that live solely in oceans. Seabirds are also greatly affected. In 2004, it was estimated that gulls in the North Sea had an average of thirty pieces of plastic in their stomachs. Seabirds often mistake trash floating on the ocean's surface as prey. Their food sources often have already ingested plastic debris, thus transferring the plastic from prey to predator. Ingested trash can obstruct and physically damage a bird's digestive system, reducing its digestive ability and can lead to malnutrition, starvation, and death. Toxic chemicals called polychlorinated biphenyls (PCBs) also become concentrated on the surface of plastics at sea and are released after seabirds eat

them. These chemicals can accumulate in body tissues and have serious lethal effects on a bird's reproductive ability, immune system, and hormone balance. Floating plastic debris can produce ulcers, infections and lead to death. Marine plastic pollution can even reach birds that have never been at the sea. Parents may accidentally feed their nestlings plastic, mistaking it for food. Seabird chicks are the most vulnerable to plastic ingestion since they can't regurgitate like the adult seabirds.



Short-tailed albatross (*Phoebastria albatrus*)



The remains of this Laysan albatross chick show the plastic ingested before death, including a bottle cap and lighter.

This black-browed albatross has been hooked on a longline.

After the initial observation that many of the beaches in New Zealand had high concentrations of plastic pellets, further studies found that different species of prion ingest the plastic debris. Hungry prions mistook these pellets for food, and these particles were found intact within the birds' gizzards and proventriculi. Pecking marks similar to those made by northern fulmars in cuttlebones have been found in plastic debris, such as styrofoam, on the beaches on the Dutch coast, showing that this species of bird also mistakes plastic debris for food.



An estimate of 1.5 million Laysan albatrosses, which inhabit Midway Atoll, all have plastics in their digestive system. Midway Atoll is halfway between Asia and North America, and north of the Hawaiian archipelago. In this remote location, the plastic blockage has proven deadly to these birds. These seabirds choose red, pink, brown, and blue plastic pieces because of similarities to their natural food sources. As a result of plastic ingestion, the digestive tract can be blocked resulting in starvation. The windpipe can also be blocked, which results in suffocation. The debris can also accumulate in the animal's gut, and give them a false sense of fullness which would also result in starvation. On the shore, thousands of bird corpses can be seen with plastic remaining where the stomach once was. The durability of the plastics is visible among the remains. In some instances, the plastic piles are still present while the bird's corpse has decayed.

Similar to humans, animals exposed to plasticizers can experience developmental defects. Specifically, sheep have been found to have lower birth weights when prenatally exposed to bisphenol A (BPA). Exposure to BPA can shorten the distance between the eyes of a tadpole. It can also stall development in frogs and can result in a decrease in body length. In different species of fish, exposure can stall egg hatching and result in a decrease in body weight, tail length, and body length.

Effects on Humans

Due to the use of chemical additives during plastic production, plastics have potentially harmful effects that could prove to be carcinogenic or promote

endocrine disruption. Some of the additives are used as phthalate plasticizers and brominated flame retardants. Through bio-monitoring, chemicals in plastics, such as BPA and phthalates, have been identified in the human population. Humans can be exposed to these chemicals through the nose, mouth, or skin. Although the level of exposure varies depending on age and geography, most humans experience simultaneous exposure to many of these chemicals. Average levels of daily exposure are below the levels deemed to be unsafe, but more research needs to be done on the effects of low dose exposure on humans. A lot is unknown on how severely humans are physically affected by these chemicals. Some of the chemicals used in plastic production can cause dermatitis upon contact with human skin. In many plastics, these toxic chemicals are only used in trace amounts, but significant testing is often required to ensure that the toxic elements are contained within the plastic by inert material or polymer.



It can also affect humans in which it may create an eyesore that interferes with enjoyment of the natural environment.



















Clinical significance

Due to the pervasiveness of plastic products, most of the human population is constantly exposed to the chemical components of plastics. 95% of adults in the United States have had detectable levels of BPA in their urine. Exposure to chemicals such as BPA has been correlated with disruptions in fertility, reproduction, sexual maturation, and other health effects. Specific phthalates have also resulted in similar biological effects.



Thyroid hormone axis

Bisphenol A affects gene expression related to the thyroid hormone axis, which affects biological functions such as metabolism and development. BPA can decrease thyroid hormone receptor (TR) activity by increasing TR transcriptional corepressor activity. This then decreases the level of thyroid hormone binding proteins that bind to triiodothyronine. By affecting the thyroid hormone axis, BPA exposure can lead to hypothyroidism.

Biodegradable and degradable plastics

The use of biodegradable plastics has many advantages and disadvantages. Biodegradables are biopolymers that degrade in industrial composters. Biodegradables do not degrade as efficiently in domestic composters, and during this slower process, methane gas may be emitted.

There are also other types of degradable materials that are not considered to be biopolymers, because they are oil-based, similar to other conventional plastics. These plastics are made to be more degradable through the use of different additives, which help them degrade when exposed to UV rays or other physical stressors. However, biodegradation-promoting additives for polymers have been shown not to significantly increase biodegradation.

Although biodegradable and degradable plastics have helped reduce plastic pollution, there are some drawbacks. One issue concerning both types of plastics is that they do not break down very efficiently in natural environments. There,

degradable plastics that are oil-based may break down into smaller fractions, at which point they do not degrade further.

Incineration

Up to 60% of used plastic medical equipment is incinerated rather than deposited in a landfill as a precautionary measure to lessen the transmission of disease. This has allowed for a large decrease in the amount of plastic waste that stems from medical equipment. If plastic waste is not incinerated and disposed of properly, a harmful amount of toxins can be released and dispersed as a gas through air or as ash through air and waterways. Many studies have been done concerning the gaseous emissions that result from the incineration process.

Policy

Agencies such as the Environmental Protection Agency and the Food and Drug Administration often do not assess the safety of new chemicals until after a negative side effect is shown. Once they suspect a chemical may be toxic, it is studied to determine the human reference dose, which is determined to be the lowest observable adverse effect level. During these studies, a high dose is tested to see if it causes any adverse health effects, and if it does not, lower doses are considered to be safe as well. This does not take into account the fact that with some chemicals found in plastics, such as BPA; lower doses can have a discernible effect. Even with this often complex evaluation process, policies have been put into place in order to help alleviate plastic pollution and its effects. Government regulations have been implemented that ban some chemicals from being used in specific plastic products.

In Canada, the United States, and the European Union, BPA has been banned from being incorporated in the production of baby bottles and children's cups, due to health concerns and the higher vulnerability of younger children to the effects of BPA. Taxes have been established in order to discourage specific ways of managing plastic waste. The landfill tax, for example, creates an incentive to choose to recycle plastics rather than contain them in landfills, by making the latter more expensive. There has also been a standardization of the types of plastics that can be considered compostable. The European Norm EN 13432, which was set by the European Committee for Standardization (CEN), lists the standards that plastics must meet, in terms of compostability and biodegradability, in order to officially be labeled as compostable.

Non-usage and reduction in usage

The Ministry of Drinking Water and Sanitation, Government of India, has requested various governmental departments to avoid the use of plastic bottles to provide drinking water during governmental meetings etc. and instead make arrangements for providing drinking water that do not generate plastic waste. The state of Sikkim has restricted the usage of plastic water bottles (in government functions and meetings) and styrofoam products.] The state of Bihar has banned the usage of plastic water bottles in governmental meetings.

The 2015 National Games of India, organized in Thiruvananthapuram, was associated with green protocols. This was initiated by Suchitwa Mission that aimed for "zero-waste" venues. To make the event "disposable-free", there was ban on the usage of disposable water bottles. The event witnessed the usage of reusable tableware and stainless steel tumblers. Athletes were provided with refillable steel flasks. It is estimated that these green practices stopped the generation of 120 metric tonnes of disposable waste.

Creating Awareness

On 11 April 2013 in order to create awareness, artist Maria Cristina Finucci founded The Garbage Patch State at UNESCO–Paris in front of Director General Irina Bokova. First of a series of events under the patronage of UNESCO and of Italian Ministry of the Environment. International organisations have also been raising awareness of plastic pollution.

Pollution in Pakistan has become a major environmental and economic concern, mainly due to poor pollution management, lack of awareness among public and week enforcement of environmental policies.

In Pakistan pollution is also spreading due to rapid industrial growth. The burning of materials made of plastic cause pollution. Pollution can build up in water sources and make it difficult for marine life. This was revealed in a research report conducted on Plastic Pollution, and presented by the students of Mohammad Ali Jinnah University Karachi at an Economic Festival held at university's campus.

Every year 5 to 13 million more tonnes of plastic end up in the oceans and a whopping 80 percent of that waste pour in from 20 countries.

The plastic pollution spreads environmental degradation and upsets the existing ecosystem; in Pakistan causes an estimated damage of 13 billion dollars to marine ecosystem annually, and damage to tourism, fishing and shipping industries of around $1.3 billion.

Urbanization and population growth has resulted in increased demand of plastic products and since these products were much cheaper and affordable as compared to metal, wood and ceramics, their use was increasing day by day. He warned that the reckless disposal of plastic products posed a serious threat to the environment, particularly the wildlife. The use of plastic products should be discouraged and inappropriate dumping of plastic waste on beaches or in public places should be stopped.

For controlling plastic pollution in the country, it was recommended to establish a hydro cracking plank; to make strict laws for controlling pollution, to ban plastic bags in the country and to promote use of paper bags.

Steps against plastic pollution

ABOUT two years ago, a groundbreaking initiative was launched in Morocco. Called Zero Mika, the initiative announced a ban on plastic bags. The ban did not

apply to all plastic bags. Those used to gather household trash and agricultural and industrial products, as well as isothermal bags for maintaining medicine and other medical supplies at certain temperatures, were exempted from the ban.

The ban did, however, apply to the largest contributor of plastic bag pollution — bags used for carrying groceries and other purchased items. In short, bags that are easily and unthinkingly discarded on the streets.

The Zero Mika (zero plastic) law implemented by Morocco aims to reduce the polluting effects of the many tonnes of plastic bags that are produced every year. According to reports, Morocco has seized 420 tonnes of plastic bags since the implementation of the ban.

In choosing to take active steps against plastic pollution, Morocco and other countries that have implemented plastic bag bans have chosen to be part of the solution rather than the problem. Few people, including many reading this article today, realize that an average single-use plastic bag takes 1,000 years to decompose.

Pakistanis, most of whom do not live by the sea, find it hard to care for the health of the oceans that they may never have seen, let alone the fate of generations to come.

At the same time, one can only hope that they may be convinced to care for what they see. A cursory glance at any part of Pakistan is guaranteed to reveal the ugly spectre of a plastic bag or several plastic bags either hanging from phone and electric wires, waving merrily from rubbish heaps and clogging gutters, or simply blowing around in the wind in a street or alley.

The bags are everywhere, and the rich and poor and concerned and completely thoughtless can all see for themselves just how horribly they transform the environment. If civic concern cannot galvanise them into action, perhaps a concern for the fact that nearly every view in every part of the country has been tainted by the plastic bag can bring about some action.

This is the reason why the example of Morocco is particularly pertinent. Unlike in Balochistan, which supposedly already announced such a ban, but whose enforcement seems lax if not non-existent, and the Sindh government, which had also announced such a ban but has since forgotten about it, Morocco has actually devoted resources to ensuring that it remains one.

It is not that the country has not faced a struggle in the form of a black market in which plastic bags are sold illegally, following the legislation that was passed with fines imposed on violators. The main point is that the bags are banned and their numbers are being drastically reduced since the time before the ban. That in itself is a victory.

Others are following suit. The Indian state of Maharashtra, whose coastline also borders the Arabian Sea, fed up with watching debris pile up on the beaches and in drains and city streets, has imposed a ban on all plastic goods. The ban imposed

by the state government lays out exemptions for items such as garbage bags, packing for processed goods, milk pouches, medical supplies and other essential items. The use of plastic for any other purpose, given the thoughtless convenience of not having to use an alternative, will not be allowed.

Early reports showed an eagerness to comply; vegetable and fruit sellers on the streets of Mumbai had put up small handmade signs asking people to please bring bags from home, as they were no longer permitted to provide them.

There was, of course, a time in South Asia before the plastic bag became ubiquitous, a time when jute and cane baskets and rope bags or reusable plastic baskets were used to transport things. Unlike the Western world, admittedly the largest producer of plastic waste, Pakistanis only have to remember old habits, not necessarily learn new skills.

If the plight of the seagulls and the fish and the birds doesn't move you, then just look outside, up and down and around. Wouldn't it be simply wonderful, completely amazing, to never ever have to see the black and blue and striped shreds of plastic as the backdrop to every moment, every scene and every site?

Efforts to reduce the use of plastics

Efforts to reduce the use of plastics and to promote plastic recycling have occurred. Some supermarkets charge their customers for plastic bags, and in some places more efficient reusable or biodegradable materials are being used in place of plastics. Some communities and businesses have put a ban on some commonly used plastic items, such as bottled water and plastic bags.

- Many of the plastic products used only once and thrown away;
- No Planned Plastic Collection System by Municipal authorities;
- Recycle Management poor in urban and rural areas;
- Urbanization, usage and increase in plastic waste;
- Plastics do have a stronger management and policy rules;
- Lack of interest in maintaining clean environment;
- What to do with this waste? in Many of the peoples' mind;
- Plastic gets accumulated in water and land, it takes 500 years for it to decay;
- ***Plastic pollution kills sea species, birds, animals and harmful to human beings with health related risks***;
- The clogging of drains (sewage and storm) in urban areas are higher percentage ratio due to higher plastic wastage is found;
- Irrigation Canals and agricultural lands are more vulnerable in rural areas.

Effects

- The rural areas are more prone to this type of pollution and the related effects, as a majority of the people from these areas use plastic on a large scale;

- Many stray animals end up eating plastic bags and bottles due to improper disposal systems, and this can cause their death;
- During the rainy season, the plastic rubbish that has fallen on the road gets washed away into the nearby water reservoirs, canals, and drains, leading to their choking up and overflowing. Also, the water quality gets spoiled due to the addition of these synthetic materials;
- When dumped in landfills, plastic materials interact with water and form hazardous chemicals. If these compounds seep down towards groundwater aquifers, they degrade the water quality, leading to groundwater pollution;

Solutions and Preventive Measures

- Though commodities made of plastic are handy, it is time to become aware of the harm that plastic causes to life on Earth. Before the picture turns even uglier; it is better to take some effective preventive measures to reduce this type of pollution;
- To bring a decline in its usage, start using paper or cloth bags for shopping and other purposes as much as possible, and avoid bringing plastic bags at home;
- Understand the severity of the problem of plastic pollution, and know the consequences of dumping plastic in water and on land;
- Ensure proper disposal of plastic;
- Plastic which is disposed of can be recycled and used in many different ways such as for tote bags, wallets, or pouches. There are biodegradable plastic bags available, which can help to a considerable extent;
- These changes might be gradual and even less appealing against the problem; but taking small steps can greatly contribute to the reduction of plastic pollution. It is the time for us to take some preventive steps, and ensure a better life for the future generations.

REMEDY

- Reduce the amount of plastics you use**:**
- at the grocery store;
- aim for foods that come in larger single packages rather than individual ones;
- try to avoid produce wrapped in plastic bags or packaged in plastic trays;
- eliminate your single-use plastics and opt for reusable products;
- cut plastic beverage containers from your life;
- use cups, mugs, reusable water bottles;
- don’t forget your stylish reusable bags when you go for grocery;
- replace any plastic eating utensils, plates and cups with reusable ones –
- **Your monthly grocery bill will benefit too!**
- These changes might be gradual, and even less appealing against the problem; but taking small steps can greatly contribute to the reduction of

plastic pollution. It is the time for us to take some preventive steps, and ensure a better life for the future generations.





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Listing of Papers Presented at Various World Environment Day(s), Commemorated by Pakistan Engineering Congress

Sr. No.	Title of Paper	Name of Author
	2007 – Climate Change:	
1.	Engineering options for Managing and Mitigating Climate Change	Safia Shafiq
2.	An overview of Glacier Depletion in Tibetan	Rehmatullah Jilani
3.	Plateau Climate Change and Sustainable Development	Dr. Qamar-uz-Zaman Chaudhry
4.	Glaciers- The Barometer of Climate Change	Rakhshan Roohi Arshad Ashraf Rozina Naz
5.	Climate Change and Tree-limit status: A case study based on comparison between an optimistic scenario for European mountains and a pessimistic on for Pakistan	Amin U Khan
6.	Adapting to Risks of Climate Change	Shafqat Masood
7.	Impact of Temperature Gradient With Time & Its Variation With reference To Change Of state	Engr. Shaukat Ali Awan
	2008 – Kick the Habit, Towards a Low Carbon Economy:	
8.	Clean Development Mechanism	Muhammad Ashraf
9.	Hydel Power Generation: A Low Carbon Prospect For Prosperous Pakistan	Dr. Allah Baksh Sufi, A. Dastgir and Zahid ul Haq
10.	Re-Utilization of Solid Waste Carbon Saves Economy	Muhammad Khalid Iqbal, Tahira Shafiq & Khursheed Ahmad
11.	Low Carbon Economy – A Pakistan Perspective	Muhammad Daniel Saeed Pirzada
12.	Isotipic and Chemical Characterization of Coal from Selective areas of Pakistan	A .Mashiatullah, T. Javed, R. M. Qureshi, Z. Shah, Z. Latif and Habib-ur-Rehman
13.	ENERCON and Low Carbon Economy	Asif Masood

Sr. No.	Title of Paper	Name of Author
	2009 – Your Planet Needs You-Unite to Combat Climate Change:	
14.	Social and Economic Benefits of Weather, Climate and Water Services	Dr. Qamar-uz-Zaman Chaudhry
15.	Influence of Climate Change on Upper Indus River Flows	Danial Hashmi and Dr. Muhammad Siddique
16.	Vehicular Emissions and their Impacts on Human Health in Karachi – A Case Study	Muhammad Ashiq, Ambreen Kanwal and Said Rehman
17.	Emission Inventory of Lahore – 2007	B.M. Ghauri and A.N. Khan
18.	Accountability of Chemical Industries Towards Sustainable Development	S.E Benjamin
19.	Environmental Issues Related to Water Resources Development and Integrated Water Resource Management in Pakistan	Dr. Muhammad Nawaz Bhutta
20.	E-Waste : An Impending Challenge	Muhammad Daniel Saeed Pirzada and Farkhanda Nahid Pirzada
21.	Unsafe Drinking Water and Health Hazards	Sabir Ali Bhatti and Zia Mustafa
22.	Environmental Management for Menace of Water Logging of Chashma Jhelum Link Canal in Thal Desert Area – A Case Study	Dr. Allah Bakhsh Sufi, Syed Javed Sultan and Atia Dastagir
23.	Impact of Western Economic Policies on the Planet [With Special Reference to Pakistan]	Dr. Zafar Altaf
24.	Drinking Water Quality Berween Source and Point – of – Use in Satellite Town Rawalpindi – A Case Study	Shaukat Farooq, Imran Hashmi and Sara Qaisar
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