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# Indore: A City of Epicures and Waste Management

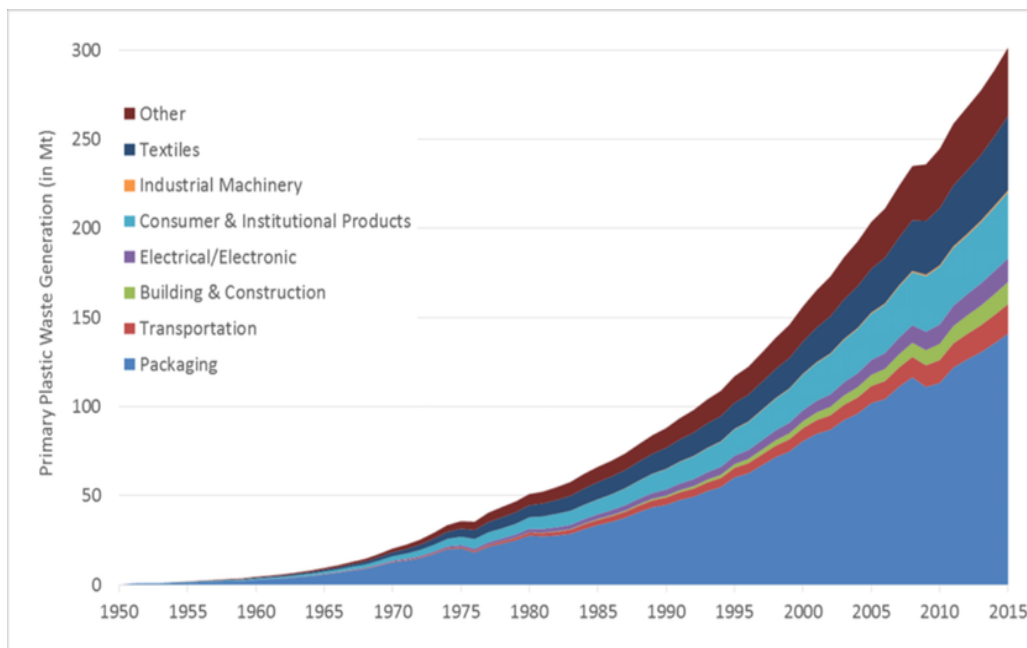
-Hanshika Adyani

## ABSTRACT

*"I only feel angry when I see waste. When I see people throwing away things we could use."*  
– **Mother Teresa**

Indore widely known for food and its lovers, has laid an excellent effort towards laying a foundation for a better tomorrow as a city. Over the past years it has successfully played its job by instigating hope in the young members of this society as they could revolutionize the way this society functions. It has also achieved the feat of being the cleanest city in India for three times in a row, now. Being eye witness to the development catalyzed by the cleanliness, I got motivated that a city can be developed to a great extent by managing its waste. The cities, we are currently living in, are now facing the most foundational challenge of proper management of waste to meet the global standards.

There still is high need for effective, efficient and economically practical solutions which are innovative and revolutionize this city, in fact, the world.



Graph: Waste generated by different sectors

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## Identification of the problem of current situation

India alone generates more than 1,00,000 metric tonnes of solid waste every single day, out of which less than a quarter gets recycled. Due to lack of effective and efficient waste management system, infrastructure and innovative technology, most of the waste, which could have been reutilized, ends up in landfills or polluting water bodies.



Also, an estimated 62,000 million litres sewage is generated per day, while the treatment capacity across India is only 23,277 million litres or 37% of sewage generated, directly justifying **'More than 60% of sewage generated in India remains untreated.'** This sewage effects the environment and humans, plants and animals' health critically. Not only does it contaminate water and cause diseases like jaundice, typhoid and more, but also stunt plant growth and create blockages in development.

In the research I have focused and tried to find solutions for the following problems:

- Plastic is being utilized at alarming rates, and still its disposal and waste management remains down the hill,
- Contamination of water bodies across India due to immersion of Plaster of Paris idols after various festivals,
- Floral waste from temples remains untreated and is disposed of into rivers polluting them furthermore,
- Introduction of bioremediation and phytoremediation has been done but implementation still remains a problem.

## Suggested Solutions

To implement the new ideas the waste secluded in certain sections has to be brainstormed upon and further applied efficiently in those sectors to get an effective output. Accordingly, THE SECTORS WHICH I FOCUSED ON, and proposing some management techniques are as follows:

- i. City Waste
- ii. Religious Waste
- iii. Domestic Waste

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To curb the problems of unethical disposal of waste, some smart and innovative solutions, which can be considered are as follows:



- Utilizing plastic waste generated for construction purposes, as researches say plastic roads and plastic houses are quite durable and environment-friendly,
- Creating an effective measure for proper immersion of idols made of Plaster of Paris,
- Intervening floral waste with technology to serve a greater purpose, by making environment-friendly incense cones out of floral waste compost,
- Implementing bioremediation and phytoremediation on a large scale, as it is one of the most economical techniques presently used for treating most organic fuel-based contaminants such as coal tar and liquor, petroleum and other carcinogenic hydrocarbons like benzene and naphthalene and some inorganics.
- Using biogas to replace car fuel, LPG, electricity, in fact, by converting cow manure into methane biogas via anaerobic digestion, the millions of cattle in the India would be able to produce billions of kilowatt hours of electricity, enough to power millions of homes across India.

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## CITY WASTE

### Plastic Road

#### NEW TECHNOLOGY FOR MAKING ROADS

A new technology has been introduced to construct roads with plastic. This technology will help in utilizing the waste plastic to make something useful and advantageous. These roads are roads made either entirely of plastic or of composites of plastic with other materials. Plastic roads are different from standard roads in the respect that standard roads are made from asphalt and concrete, which consists of mineral aggregates and asphalt.



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## NEED

We all know about the increase in the amount of plastic in our daily lives. Plastic is a material created by man but it's also something that can't be destroyed without the release of harmful products. The majority of waste created by humans contains plastic waste which ultimately chokes stray animals to death, clogs drains and only leads to trouble for both us and the environment. The clogged drains lead to flood while the plastic in the fields hinders germination, thereby preventing rainwater absorption. There is an increase in pollution levels because people throw plastic on land surfaces, ponds and whatnot, which causes land and water pollution. They also burn plastic which causes air pollution. As a result, not only is the earth getting adversely affected, but also us, the human beings.

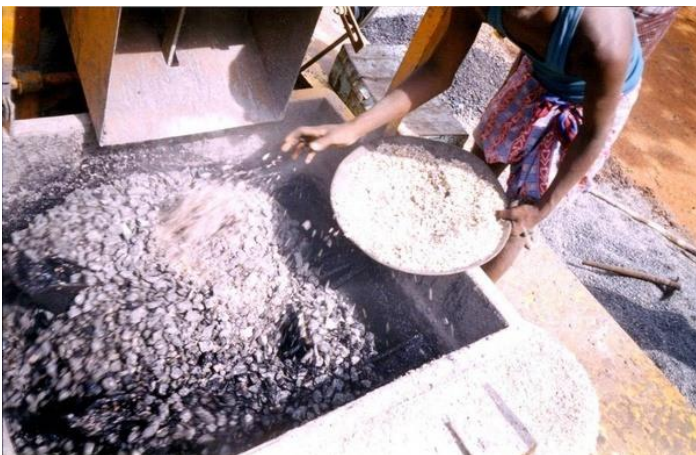
## ADVANTAGES

- Plastic roads have a small hollow space in them to allow the ease of wiring, connecting pipes, etc.
- Heating can prevent roads from freezing and can also help evaporate water from the surface. So, the roads will not be covered with snow in the mountainous regions.
- Since plastics come with various chemical and physical properties, roads can be engineered to meet specific customized requirements (e.g. weather and wear resistance).
- Plastic roads can be made into interlocking pieces that can be assembled or disassembled very quickly. This makes on-site construction much faster and convenient (up to 25 times faster than the traditional methods)
- Plastic roads can be built from waste plastic - the majority of which is usually put into landfills, incinerated, or pollute the environment. Landfilling and incinerating plastic are both problematic methods of managing plastic waste.
- Bitumen-composite roads need not be especially discriminating with the plastics used, thus increasing the reuse of all types of plastic.
- Using less asphalt saves resources. Asphalt concrete requires petroleum which is becoming scarcer.
- The use of plastic in road construction reduces the amount of asphalt used. This is beneficial to the environment since asphalt is responsible for 2% of global carbon emissions.
- Plastic-bitumen composite roads have better wear resistance than standard asphalt concrete roads. They have better flexibility which results in lesser wearing and thus, less need for repair. They have lower maintenance, and absorb sound better.
- Cost effective: Using recycled, post-consumer plastics is cheaper than using asphalt.

## THE PROCESS OF MAKING THESE ROADS

1. **Cleaning:** The plastic is cleaned with water and dried.
2. **Shredding:** The collected plastic is cut into a size of 2.36 mm to 4.75 mm by using a shredding machine.

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3. **Heating:** The aggregate mix is then heated to 165 to 170 Degree Celsius and transferred to a mixing chamber whereas the bitumen is heated up to 160 Degree Celsius to prevent weak bonding.
  4. **Coating:** At the mixing chamber, the shredded plastic gets coated uniformly over the aggregate within 30-60 seconds and shows an oily look.
  5. **Construction:** The plastic waste mixture is combined with the bitumen mixture and the resulting aggregate is used for constructing the road when the temperature of the mixture is about 110-120 degree Celsius.



## CONCLUSION

Plastic is a non-biodegradable waste and using it for road construction can actually solve various problems at a global level. With the advancement of technology and engineering techniques, nothing seems to be impossible. Till now, it's quite clear that we, the humans have ruined the environment in every possible way through the overuse of technology and now it is high time we use the same technology to fix the problems that we created.

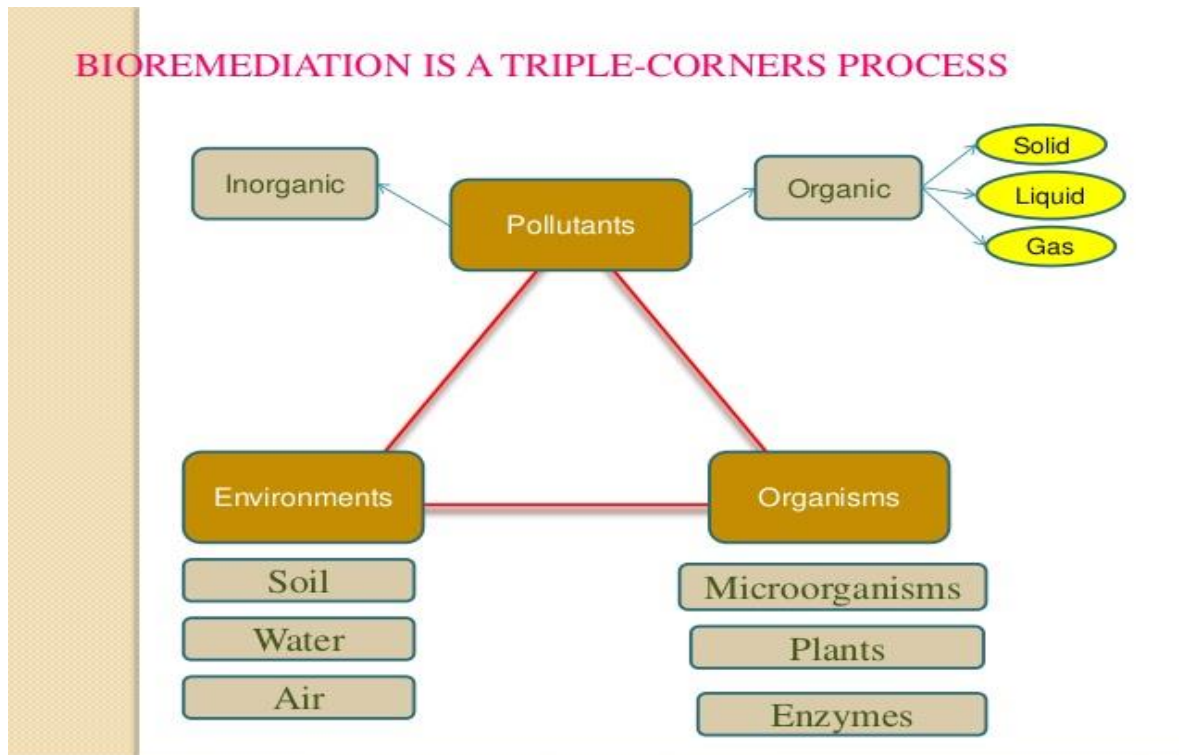
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# Remediation

## A. BIOREMEDIATION

### WHAT IS BIOREMEDIATION?

Bioremediation refers to the process of using microorganisms to remove the environmental pollutants or prevent pollution. The removal of organic wastes by microbes for environmental clean-up is the essence of bioremediation. Microorganisms used to carry out bioremediation are called bio remediators. Bioremediation is a waste management technique that involves the use of microorganisms to neutralize pollutants from a contaminated site. It is one of the most economical techniques presently used for treating most organic fuel-based contaminants such as coal tar and liquor, petroleum and other carcinogenic hydrocarbons like benzene and naphthalene and some inorganics.

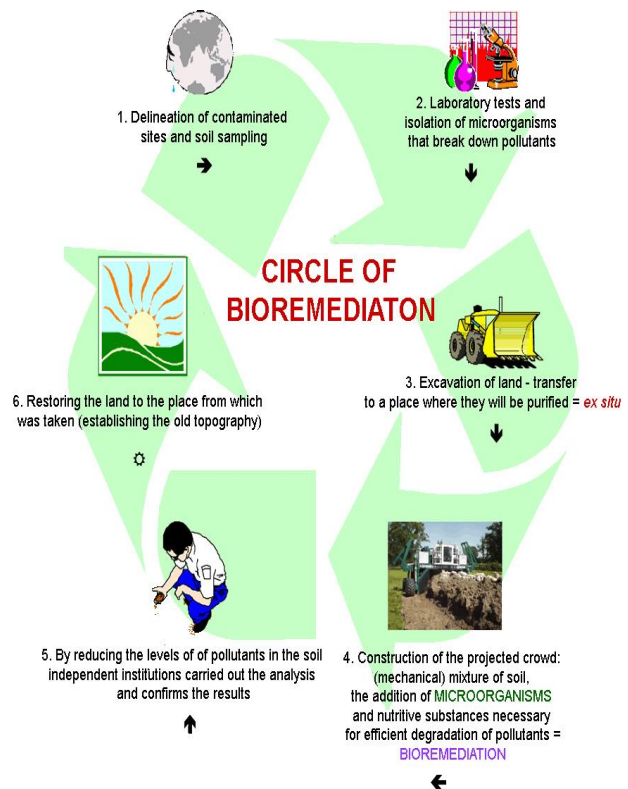
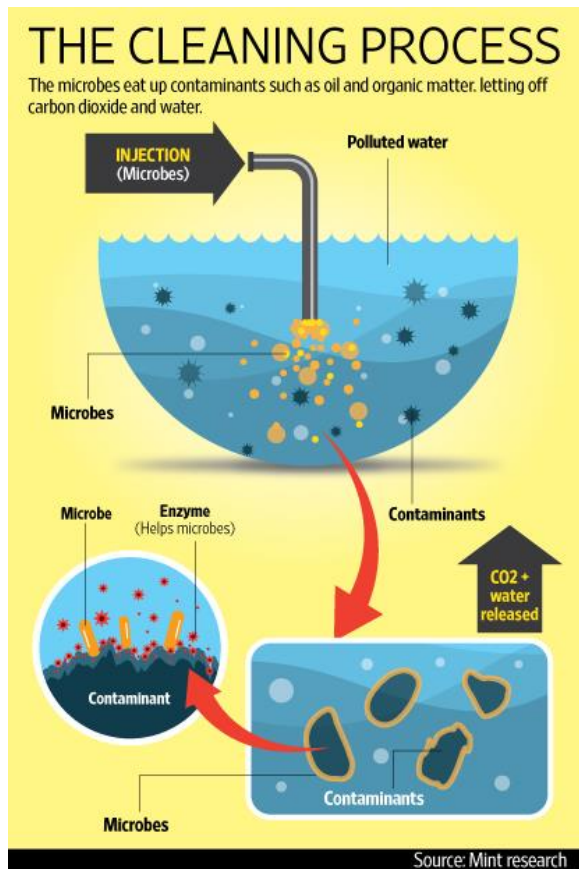


## HOW DOES BIOREMEDIATION WORK?

Bioremediation occurs when microbes come in contact with contaminants such as oil, gas, or diesel in a suitable environment.

Ideal environmental conditions include a balance of temperature, surface pH, available moisture and other factors.

To start the bioremediation process, microbes secrete enzymes, just like the human body produces saliva and stomach bile to digest food. These enzymes break down contaminants into smaller pieces. The microbes are then able to consume the broken-down contaminants as a source of food and energy. As a byproduct of the digestion process, microbes release water, carbon dioxide and other non-harmful amino acids. In suitable environments with ample food supply, microbes reproduce, and create additional microbes to further aid in the removal of additional contaminants, and the cycle repeats until the food source is depleted.





# Soil Characteristics before and after Bioremediation

Parameter	Test results		
	Before bioremediation	After bioremediation	Nearby soil
Texture of soil	Loamy	Loamy	Loamy
Soil pH	7.77	7.42	7.51
Soil bulk density	0.99 g/cm <sup>3</sup>	1.21 g/cm <sup>3</sup>	1.21 g/cm <sup>3</sup>
Soil water holding capacity	61 %	75 %	74 %
Electric conductivity	2.25 mS/cm	1.59 mS/cm	1.48 mS/cm
Total soil nitrogen	0.07 %	0.11 %	0.08 %
Organic carbon	1.92 %	1.66 %	1.62 %
Available phosphorous in soil	11 ppm	19 ppm	9 ppm
Potassium in soil	124 ppm	150 ppm	120 ppm

## ENVIRONMENTAL CLEAN UP PROCESSES USING BIOREMEDIATION:

1. **IN SITU:** *In situ* bioremediation refers to the bioremediation process which is performed at the original site of the contamination. *In situ* bioremediation concept is mainly used to treat contaminations in soil and ground water. However, the remediation rate and the effectiveness of the process depend on different factors. They are as follows:
  - The type of the contaminant concern
  - Site-specific characteristics
  - Contaminant distribution and concentration
  - Concentration of other contaminants
  - Microbial community of the site
  - Temperature
  - pH of the medium
  - Moisture content
  - Nutrient supply

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The manipulation of above factors is not highly feasible in *in situ* bioremediation. However, in enhanced *in situ* bioremediation, some manipulations such as aeration, adding nutrients, controlling moisture content, etc. are used to enhance the activity of organisms and increase the rate of degradation. But in intrinsic *in situ* bioremediation, natural processes are allowed to happen without altering the conditions or adding amendments.

Examples of *in situ* bioremediation technologies include bio-venting, enhanced biodegradation, bioslurping, phytoremediation, natural attenuation, etc.

2. **EX SITU:** *Ex situ* bioremediation is a technique which treats the contaminants away from the location where they were found. Contaminants are excavated or pumped out from the original site and treated inside the controlled environments. A wide range of hydrocarbons is purified by *ex situ* bioremediation. Contaminated soils are excavated and placed on the surface of the ground and treated using indigenous microorganisms. *Ex situ* bioremediation can be controlled and managed by providing required conditions.

Examples of *ex situ* bioremediation processes include composting, soil biopiles, land farming, slurry reactors.

## TYPES OF BIOREMEDIATION:

There are three types of bioremediation and all are used to remove toxic substances and contaminants from the environment whether they are rivers or crude oils.

### **Biostimulation:**

Bio stimulation is the method in which bacteria are motivated to start the process of bioremediation. In this method, first experts release nutrients and other important substances in the soil where there is need or removing the contaminants. These are in the form of gas or liquid. It increases the growth of microbes in that area. As a result bacteria and other microorganisms remove the contaminants quickly and efficiently.

### **Bioaugmentation:**

In some processes of bioremediation, there are some special sites where microorganisms are required to remove the contaminants for example municipal wastewater. Bioaugmentation is used for that purpose.

### **Intrinsic Bioremediation:**

The process of intrinsic bioremediation takes place in soil and water because these two places are always full of contaminants and toxins. This process is also called as **natural attenuation**. It also means use of the microorganisms to remove the harmful substances from soil and water. Especially those sites are treated with this method, which are underground, for example underground petroleum tanks. It is difficult to know if there is a leakage in the petroleum pipes. Contaminants and toxins find their way to enter in these sites and create harmful effects on the petrol. Therefore, only microorganisms can destroy the toxins and clean the tanks. Great care should be taken if some leakage occurs in the petroleum tanks or pipes because it may damage the human health.

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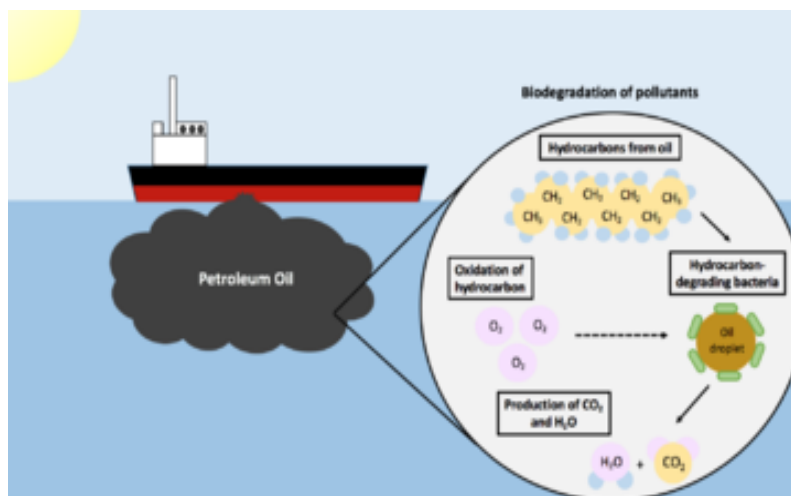
## ADVANTAGES

- 1) Low cost
- 2) Minimal site disruption
- 3) Minimal exposure of public and site personnel
- 4) Simultaneous treatment of soil and water.
- 5) Can prove less expensive than other techniques that are used for clean-up of hazardous wastes.
- 6) Useful for the destruction of a wide variety of contaminants.
- 7) Can be carried out on site; without causing a major disruption of normal activities.

## BIOREMEDIATION OF MARINE OIL SPILLS

Bioremediation is a useful process for removing marine oil pollutants. The application of oleophilic fertilizers is a useful bioremediation strategy. Marine oil spills are very catastrophic events which pose a great threat to the environment. They are mainly composed of oils, petroleum, fuel etc. There is addition of microbial seeding or inoculums that are capable of degrading hydrocarbons. Most microorganisms that are considered for seeding are obtained from enriched cultures, from a previously contaminated site. After the inoculums and the fertilizers are added, environmental modifications and adequate aeration is done. A nutrient source is a prerequisite. Bioremediation for marine oil spills can be approached in two ways depending upon the case at hand. This includes bioaugmentation which involves introducing oil degrading microorganisms to the affected site and also biostimulation which involves adding supplement nutrients to the affected site to aid the existing oil degrading microorganisms.

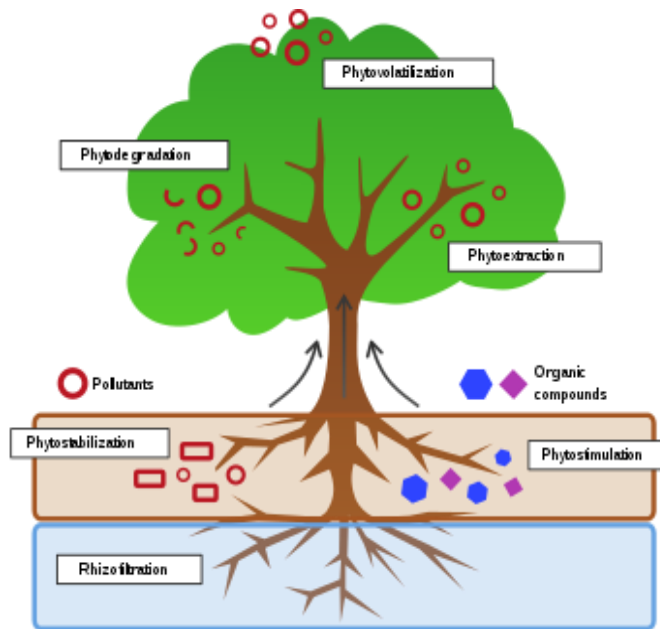
### Bioremediation of oil spills



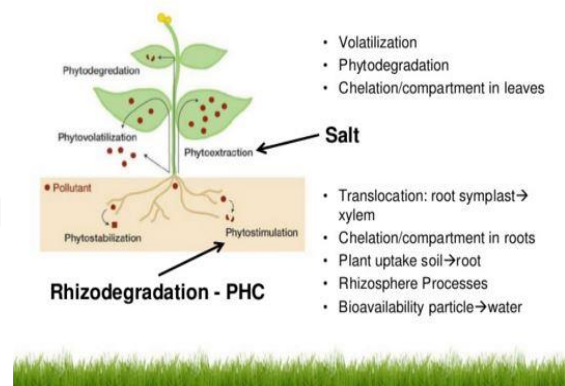
## B. Phytoremediation

### WHAT IS PHYTOREMEDIATION?

Bioremediation through the use of plants which mitigate the environmental problem without the need to excavate the contaminant material and dispose of it elsewhere is called phytoremediation. Phytoremediation is a cost-effective plant-based approach of remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to metabolize various molecules in their tissues. It refers to the natural ability of certain plants called hyperaccumulators to bioaccumulate, degrade, or render harmless contaminants in soils, water, or air. Toxic heavy metals and organic pollutants are the major targets for phytoremediation. Knowledge of the physiological and molecular mechanisms of phytoremediation began to emerge in recent years together with biological and engineering strategies designed to optimize and improve phytoremediation. In addition, several field trials confirmed the feasibility of using plants for environmental cleanup.



### Phytoremediation Processes



### ADVANTAGES

- The cost of the phytoremediation is lower than that of traditional processes both in situ and ex situ
- The plants can be easily monitored
- The possibility of the recovery and re-use of valuable metals (by companies specializing in “phyto-mining”)
- It is potentially the least harmful method because it uses naturally occurring organisms and preserves the environment in a more natural state.

## BEFORE AND AFTER PHYTOREMEDIATION



### **TYPES OF PHYTOREMEDIATION AND HOW THEY WORK:**

**Phytoextraction:**Phytoextraction (or phytoaccumulation) uses plants or algae to remove contaminants from soils, sediments or water into harvestable plant biomass.

#### **Advantages:**

- The main advantage of phytoextraction is environmental friendliness. Traditional methods which are used for cleaning up heavy metal contaminated soil disrupt soil structure and reduce soil productivity, whereas phytoextraction can clean up the soil without causing any kind of harm to soil quality.
- Another benefit of phytoextraction is that it is less expensive than any other cleanup process.

#### **Examples of phytoextraction from soils:**

- **Arsenic**,using the Sunflower, or the Chinese Brake fern, a hyperaccumulator. Chinese Brake fern stores arsenic in its leaves.

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- **Cadmium**, using Willow. As willow has some specific characteristics like high transport capacity of heavy metals from root to shoot, huge amount of biomass production, can use also for production of bio energy in the biomass energy power plant.
  - **Zinc**, using Alpine pennycress, a hyperaccumulator of these metals at levels that would be toxic to many plants. On the other hand, the presence of copper seems to impair its growth.
  - **Lead**, using Indian mustard, Ragweed, Hemp Dogbane, or Poplar trees, which sequester lead in its biomass.
  - **Uranium**, using sunflowers, as used after the Chernobyl accident.
  - **Mercury**, selenium and organic pollutants such as polychlorinated biphenyls (PCBs) have been removed from soils by transgenic plants.

**Phytostabilization:** Phytostabilization focuses on long-term stabilization and containment of the pollutant. Unlike phytoextraction, phytostabilization mainly focuses on sequestering pollutants in soil near the roots but not in plant tissues. Pollutants become less bioavailable and livestock, wildlife, and human exposure is reduced.

**Phytotransformation:** Chemical modification of environmental Substances as a direct result of plant metabolism is called phytotransformation. After uptake of the contaminants, plant enzymes increase the polarity of the contaminants by adding functional groups such as hydroxyl groups (-OH). This is known as Phase I metabolism. In the second stage of phytotransformation, known as Phase II metabolism, plant biomolecules such as glucose and amino acids are added to the polarized xenobiotic to further increase the polarity (known as conjugation). In the final stage of phytotransformation (Phase III metabolism), a sequestration of the xenobiotic occurs within the plant. E.g.: Trinitrotoluene phytotransformation.

**Phytostimulation:** The enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with roots is called phytostimulation. This process is also known as rhizosphere degradation.

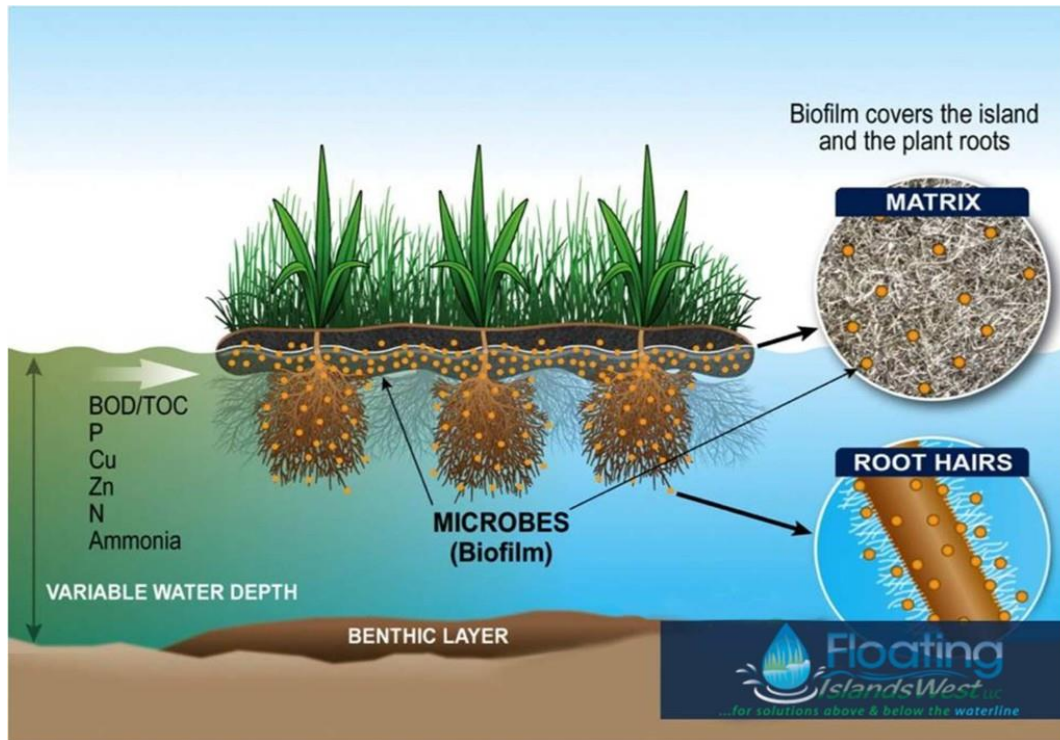
**Phytovolatilization:** removal of substances from soil or water with release into the air, sometimes as a result of phytotransformation to more volatile or less polluting substances.

**Rhizofiltration:** It is the filtering of water through a mass of roots to remove toxic substances or excess nutrients. The pollutants remain absorbed in or adsorbed to the roots.

**The role of genetics:** Genetic engineering is a powerful method for enhancing natural phytoremediation capabilities, or for introducing new capabilities into plants. For example, genes encoding anitroreductase from a bacterium were inserted into tobacco and showed faster removal of TNT and enhanced resistance to the toxic effects of TNT.

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## STUDY ON FLOATING ISLANDS-A TYPE OF PHYTOREMEDIATION



Floating islands (also known as floating treatment wetlands or FTWs) are a new and powerful tool in water stewardship. They biomimic natural floating islands to create a “concentrated” wetland effect. Independent laboratory tests showed removal rates far in excess of previously published data: 20 times more nitrate, 10 times more phosphate and 11 times more ammonia, using unplanted islands. They are also extremely effective at reducing total suspended solids and dissolved organic carbon in waterways.

### HOW IT WORKS

Floating islands are constructed of durable, non-toxic post-consumer plastics and are vegetated with native plants. They float on top of the water, providing a beautiful habitat for birds and animals. But underneath the surface, a dynamic process takes place.

Microbes are responsible for breaking down nutrients and other water-borne pollutants, but to be effective, they need a surface to stick to. The floating island matrix, with its dense fibers and porous texture, is the perfect surface area for growing large amounts of microbes (in the form of biofilm) in a short time. Nutrients circulating in the water come into contact with these biofilms and are consumed by them, while a smaller fraction is taken up by plant roots. Suspended solids slough off into the benthic zone below the island. Organic solids stick to the biofilms and become the base of the freshwater food web.

These floating islands not only provide a way to clean the water bodies but also are a good way to reuse the plastic waste in a way that bides well for the environment.

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## **THE RESULT**

Because floating islands are able to withstand fluctuations in water levels, without becoming stranded or inundated, they are very suitable for the treatment of runoff and drainage, such as urban stormwater, agricultural runoff and other non point-source applications. They represent an inexpensive option to get rid of water pollution. The sticky biofilm which covers the roots and matrix acts as a mechanical filter for fine particulates , while the island itself provides shade to cool the water, and blocks the light that might otherwise encourage sub-aquatic weeds. Overhanging banks act as wave-breakers and allow passage of fish underneath. In a lake or reservoir setting, the conversion of nutrients to periphyton initiates the food chain and contributes to insect and fish growth, which are the hallmark of a healthy and productive ecosystem.

## **THE CONCLUSION OF BIOREMEDIATION AND PHYTOREMEDIATION**

Bioremediation and phytoremediation are effective and economic methods which can be used for treating pollution. These techniques are very eco-friendly and should be used instead of using chemicals like chlorine to treat the polluted sites. Phytoremediation not only cleans up the environment but also provides a habitat for the birds.



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## **RELIGIOUS WASTE**

### **Proper immersion of statues**

Though ecologists strongly argue in favour of clay idols, the demand for PoP Ganeshas has pushed its production and sale. With disinterested lawmakers, NGOs and environmentalists have mellowed down their voices and too believe that banning PoP idols is a very humongous undertaking.

Every year after the Ganesh Chaturthi celebrations, devotees clog water bodies across the country by dumping millions of clay and plaster of Paris idols just as they overwhelm the remover of obstacles with their prayers.



Though ecologists strongly argue in favour of clay idols, the demand for PoP Ganeshas has pushed its production and sale. With disinterested lawmakers, NGOs and environmentalists have mellowed down their voices and administrators too say it is impossible to ban PoP idols.

A quick tour of a market in Delhi, where PoP idols are sold, reveals that they are not only cheaper to produce due to easy availability of synthesized plaster of Paris, worshipers too prefer them because of their intricate design and details. They are not as delicate as the clay ones and are lighter on the pocket as well as to carry.

### **SPIRITUAL ASPECT:**

1. People select idols made of PoP because it is less expensive; however, PoP idols attract very less principle. When the idols made from PoP are immersed in the water, they do not dissolve completely. Due to this, the remains of the idol are collected by the local government body and demolished under bulldozer. This is a grave insult and denigration.

As our gratitude we should ensure the idol is immersed and dissolved completely to gain the maximum spiritual benefit of. The denigration of the idol occurs when it has not fully dissolved after immersion, by becoming a part of it we incur tremendous amount of sin.

2. Idol made of from clay (*shadu* or *chikan* clay) as per spiritual science is most spiritually beneficial for us. Idol made of clay has absolute earth element which naturally attracts and retains the Deity principle for a longer period of time. When these clay idols are immersed they dissolve in the water quickly and they emit *sāttvik* (spiritually pure) frequencies into the environment and this purifies the environment benefitting the society at large.

### **IDEOLOGY:**

We have decided to use sodium bicarbonate (baking powder) or ammonium bicarbonate to dissolve Plaster of Paris idols, which will turn the residue into further useful components.

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## **PROCEDURE:**

One needs to take a container/bucket in which the idol can be immersed in, fill it with water and add ammonium bicarbonate powder which is the same measure as the weight of the idol. Later, mix the mixture and immerse the idol in the solution. After every three hours stir the water. The PoP idol will dissolve in approximately 48 hours."

## **RESULT:**

The chemical process takes place and the sludge in the form of calcium carbonate as well liquid ammonium sulphate are generated. Calcium carbonate is used to prepare chalks, while ammonium sulphate is considered as fertilizer.

- Ammonium sulphate is a known fertilizer that can be directly applied to the plants. This salt would float on top of the water in aqueous form; it can be used to reduce the alkalinity of the soil.
- Calcium carbonate settles at the bottom, and can be dredged up and used to manufacture cement

## **ADVISORY:**

- Instead of every house bringing an idol, they can be brought in common pandals;
- If anyone wants to bring an idol, they can make it at home using clay;
- Spread awareness to promote the use of clay idols.

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## Floral Waste

### **BREAKTHROUGH FROM THE ORDINARY:**

Ever wondered what happens to those sacred flowers once we are done with our prayers? So, in India, people like to show their religious devotion with flowers. Lots and lots of flowers. Every year, some 800 million tons of blossoms—red roses, yellow marigolds, prickly xanthiums—are deposited at the nation's temples, mosques and sikh gurudwaras, creating a colorful, but tricky waste problem.

Temples should collect the flowers after worshipping, and instead of discarding it, should send to municipal corporations/municipalities for preparing compost and then providing it to farmers. Through this we will approximately collect 1.5 tons of flowers every day. And this is only just the starting figure. For efficient results we should plan to launch in Varanasi, one the holiest sites for Hindus, as well as in Haridwar, Allahbad and Kolkata, all cities along the Ganges River.

Since the flowers have been used for worship, they're sacred, and therefore can't be just sent to landfill. Hindu temples often throw the spent flowers into the River Ganges, a venerated waterway. But this just exacerbates the Ganges's legendary pollution: The flowers are sprayed with pesticides and other chemicals that leach into the environment.

We believe that the waste pickers are a key part of the operation. We will pay these informal "scavengers" to sort the flowers in their different types while taking out unwanted cup holders and garland strings. Hitting two targets from one arrow, these pickers—would mostly be women of lower castes— who would now get at least 150 rupees (more than \$2). Solving the issue of unemployment and promoting women empowerment, both at once.

### **PROCESSES:**

- The flowers are then mixed with organic cow dung and treated with about 17 natural components like coffee residue, corn cobs, etc. These help to increase the nitrogen content in the end-product.

After a few days, earthworms are added to the mix. These worms consume the mixture and lead to the formation of vermicompost after 60 days. In this process, earthworms ingest the organic waste and then excrete it in a digested form. The excreta, called worm cast, is a dark, odorless and nutrient rich material that works as a great soil conditioner. Worm casts or vermicompost is a ready-to-use fertilizer.

- An organic fertilizer plant can be set up which can collaborate with temple trusts to collect their flower waste and convert that in a specially branded fertilizer.

### **IDEOLOGY:**

The idea is to develop a framework for developing bio-fertilizer (organic fertilizer) plants in religious corridors that can convert religious waste into useful bio-fertilizer. This will ensure that the religious waste is not discarded into rivers such as Ganga, Yamuna etc. without hurting religious sentiment around waste disposal.

A typical process flow would be:

- 1) Religious wastes (mainly flowers) would be collected from major temples in the city.

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- 2) This religious waste would be then transported to a bio-fertilizer plant.
  - 3) The bio-fertilizer plant would use rapid composting using technologies such as Vermiculture Technology to turn religious waste into useful organic manure. A typical plant would be able to generate 20-30 ton of such bio-fertilizer per day.
  - 4) This bio-fertilizer can then be supplied to the market for farm distribution or through e-commerce retailers as garden manure.

Such bio-fertilizer plants can be setup through government, cooperative society or private players. They can be piloted as part of the Ganga Cleaning initiative to assess the impact and expanded to other regions accordingly.

## **AREAS OF IMPLEMENTATION:**

The bio fertilizer plant based on religious waste is suitable for India where there are multiple Hindu religious corridors. Some example corridors where such plants can be developed are:

- ☒ Varanasi-Allahabad (70-100 ton per day)
- ☒ Haridwar-Rishikesh (60-100 ton per day)
- ☒ Delhi-Mathura (40-50 ton per day).

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## **DOMESTIC WASTE**

### **Biogas and Mini-Biogas Generator**

#### **TECHNOLOGY OF BIOGAS**

The term Biogas generally refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen.

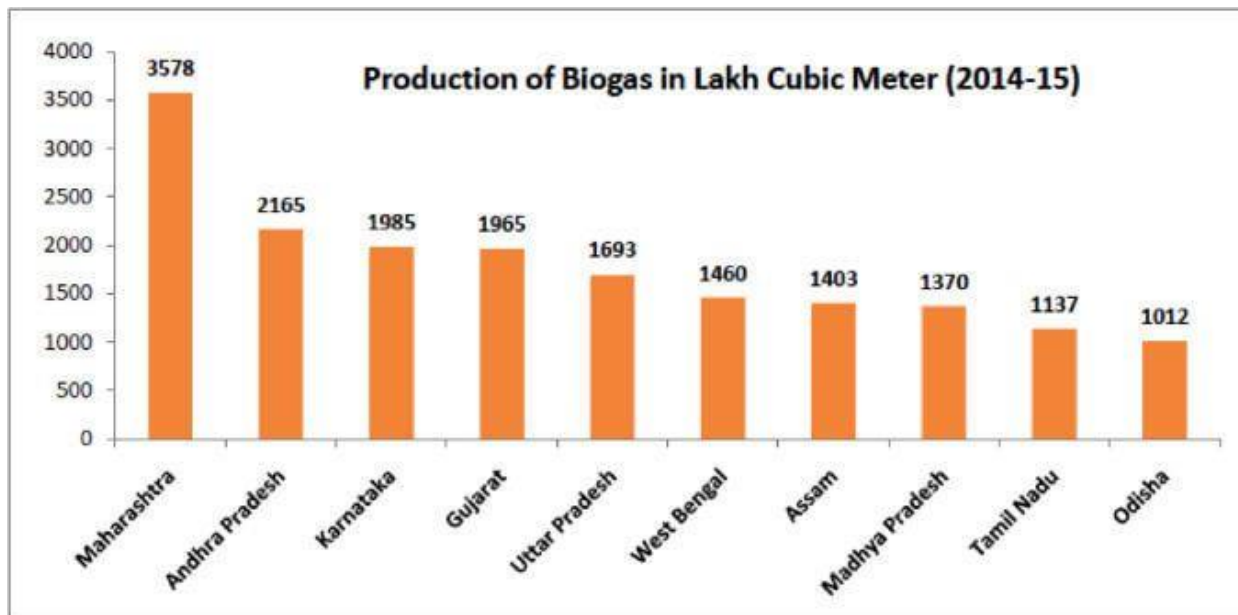
It is a mixture of colorless and odorless gases. Biogas can be produced through fermentation from any degradable material (Substrate) with the help of different types of tiny microbes. It can be produced in a concealed chamber/ digester in the absence of atmospheric oxygen. Biogas is a mixture of different gases, major portion in biogas being methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>). It also contains traces of other gases like hydrogen (H<sub>2</sub>), Moisture (H<sub>2</sub>O), hydrogen sulphide (H<sub>2</sub>S) etc. Improved digesters used for anaerobic digestion can produce biogas with 65% - 75% methane content. Biogas contains water vapor also. It is a renewable source of energy.

#### **USE OF BIOGAS**

In a world where the use of non-renewable resources is thriving and coal reserves are depleting, biogas is a very good alternative for traditional energy sources. It has the ability to replace car fuel, LPG being used in burning stoves, electricity, in fact, by converting cow manure into methane biogas via anaerobic digestion, the millions of cattle in the India would be able to produce billions of kilowatt hours of electricity, enough to power millions of homes across India. In fact, one cow can produce enough manure in one day to generate 3 kilowatt hours of electricity; only 2.4 kilowatt hours of electricity are needed to power a single 100-Watt light bulb for one day. Furthermore, by converting cattle manure into methane biogas instead of letting it decompose, global warming gases could be reduced by 99 million metric tons or 4%.

#### **ABOUT BIOGAS IN INDIA**

India has the second largest biogas programme in the world. India is constantly researching more about biogas technology. It aims to electrify the 80 million homes without electricity in the country right now with biogas, reduce GHG emissions and meet the power demand that our developing nation has right now. About 80% of rural energy consumption comes from non-commercial sources: about 320 MT of fuel wood, animal dung, agro wastes, etc.



Most of these sources can be converted into biogas which can be used as electricity. This would have many advantages as these areas would become self-sufficient when it comes to electricity. The problem however is that biogas is not being widely used by a lot of people at a home to home basis. Wouldn't it be great if people could use all their vegetable peels, leftover food and other wastes to power their stoves and even generate electricity? You can yourself make a small and portable biogas generator that does exactly the same thing!

## STEPS TO MAKE A BIOGAS GENERATOR AT HOME:

### Materials required:

- Empty PVC can 50 liters capacity.
- Empty PVC can 40 liters capacity.
- 64 mm diameter PVC pipe: about 40 cm long.
- 32 mm diameter PVC pipe: about 50 cm long
- 25 mm diameter PVC pipe: about 75 cm long
- 32 mm diameter PVC pipe: about 25 cm long
- Waterproof seal
- Readymade gas outlet system

### Procedure:

1. Cut the lid portion of the 50 liters PVC can that will act as a digester unit.
2. Do the same with the 50 liters PVC can that will act as the gas holder.
3. Attach the 32mm guide pipe and the 64mm waste inlet pipe to its right on the gas holder both fixed with waterproof seal. Attach the gas outlet system to the left of the guide pipe.
4. Close the feeding pipe with a lid.
5. Put the gas holder can inside the digester unit and attach the guide pipe to the digestive unit as well.

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6. Attach a small pipe at the top of the digester unit. This pipe will act as a slurry outlet.



Initially, cow-dung mixed with water must be fed to the system, which will start the gas formation process. Subsequently, food waste, decomposable organic material and kitchen waste diluted with water should be used to feed the system. The gas holder will rise along the guide pipes based on the amount of gas produced. We can add some weight on top of the gas holder to increase the gas pressure. When we feed the system, the excess digested slurry will fall out through the outlet pipe, which can be collected, diluted and used as organic manure.

Initial production of gas will consist of oxygen, methane, carbon dioxide and some other gases and will not burn. These gases can be released to the atmosphere by opening the ball valve at least three / four times.

Subsequent gas will consist of about 70 to 80 percent methane and the rest carbon dioxide, which can be used in a single bio-gas burning stove.

## THE EMERALD HEIGHTS INTERNATIONAL SCHOOL

Q1. What is the first thing that comes to your mind when you hear the term sustainable development?

Ans: how the world is changing and the future of India

Q2. What are your views on India's rapid advancement towards becoming the leader in renewable energy resources?

Ans: They are doing rapid development.

Q3. What steps do you recommend a civilian to take to curb problems like climate change and global warming?

Ans: Conserve electricity and use vehicles as less as possible,

Q4. Do you think encouraging biogas as an alternative to LPG would be a sensible move in urban areas of India?

Ans: Yes,

Q5. The rivers in India are being polluted at an unimaginable pace, what steps would you encourage us as students to take to protect our rivers?

Ans: Awareness campaigns

Q6. The amount of carbon emissions due to human activities is at an all time high, what are your views on this agenda?

Ans: We must reduce it to save earth.

Q7. In what ways can the common public be encouraged to take steps towards the conservation of the environment?

Ans: Awareness campaigns - and street plays.

Best-wishes -  
Bhagwan

Signature of the participant

P-G. Borbhanekar  
H/74 Malanda Parisar,  
Indore

9424073157

The afore-mentioned questionnaire was filled by respected Padmashree  
Bhalchandra Monde at the Sirpur Lake.



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## **CONCLUSION**

These are the ideas that will shape the future. The growth of technology is inevitable and thus, the faster we adapt to new technologies, the better. This research not only gave me a chance to think about what could be done, but also provided me an equal opportunity to turn my dreams into reality. I always dreamt of creating new things but because of this golden opportunity my thoughts were changed into actions. I heartily thank the school administration for the invaluable opportunity that they have given me. The things I learnt and the ideas I came across will definitely benefit everyone in the future.