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RGICS ISSUE BRIEF

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Environmental concerns in India: Plastic Pollution, Deforestation & Water Crisis

KEY MESSGAES

Plastic Pollution

- Around 330 million tones of plastics are generated annually globally that takes around 500-1000 years to degrade.

- Major causes of plastic pollution include, excessive dependence on single plastic items, increased production of plastic bottles (more than 480bn plastic drinking bottles were sold in 2016 across the world while the numbers are likely to increase by 583.3bn by 2021),improper disposal of plastics and finally the failure to recycle or up cycle such plastics.

- In India, 5.6 million tonnes per annum (TPA) of plastic waste is generated in country of which around 70% of the total plastic consumption is discarded as waste. . The Central Pollution Control Board (CPCB) 2017 report suggests that the country generates around 25,940 tonnes of plastic waste a day.

- As per studies, Plastic Waste (PW) generated in 60 Cities had little or no processing, except cities such as Ahmedabad and Pune. This is the case even with solid waste. As per a recent *IndiaSpend* study, even though 25 Indian states/UTs have some form of ban on polythene carry bags, implementation remains the missing key.

- As per rules, management of solid waste is the responsibility of the Urban Local Bodies who are currently suffering from lack of infrastructure and technology, insufficient financial resources and support from the government and since SWM is a state subject, the responsibilities of ULBs have further narrowed down.

- The plastic industry is one among the rapidly growing industries in India. As per the National Accounts Statistics 2015 of the Ministry of Statistics and Programme Implementation estimation, the average production and consumption of plastic products between 2011-12 and 2015-16 at 707 million metric tonnes (MMT) per year.

- According to recent media reports, water flowing down from the Himalaya is diverted for industrial use and domestic use and in turn gets polluted as it flows through the cities and towns. On one of the major implication of waste in mountains is that such solid waste, such as plastic can end up in rivers, lakes or wetlands after it enters sewage systems, or washed down by rainwater, or blown away by wind.

- As per studies, around 80% of marine pollution comes from land-based activities which include plastic debris and the direct discharge of industrial waste & sewerage in the marine environment has proved to be harmful to wildlife, under water habitat and also to humans .It is estimated that between four and 12m metric tonnes of plastic makes its way into the ocean each year. This leakage of plastics into the oceans is a consequence of inadequate and inefficient wastewater and solid waste collection

- As per the Ministry of Environment recent report, 267 species worldwide, including 44% of all seabirds, 43% of all marine mammals, 86% of all turtles as well as fish species are affected by marine litter. Also, plastic dumped into oceans move up the food chain causing several health hazards like cancer, endocrine problems, etc in humans.

- The UN Environment Report 2018 points out that in order to tackle the roots of the problem, it is essential for the governments to improve waste management practices and introduce financial incentives to change the habits of consumers, retailers and manufacturers, enact strong policies that push for a more circular model of design and production of plastics.

KEY MESSGAES

Deforestation

- The post-independence Forest Policy of 1952 recommended that India brings 33% of its total geographic area under natural forests. However, various reports show the mark to have hardly gone anywhere near 22 per cent.

- Government data shows that over the years large areas of forest lands have been lost to industrial and other projects granted clearance by the environment ministry. During the years 2001-2017, a total of 9,48,552 hectares of forest lands were lost to over 18,000 projects – including industry, mining, encroachments, etc. – which were granted clearance under the Forest Conservation Act.

- The biennial State of Forest Report has repeatedly shown only marginal improvement in the total forest cover across the country. During 2001-2017, the forest cover increased merely by 0.99 percentage point while tree cover by 0.37 percentage points, a combined increase of 1.36 percentage points.

- The technology used to assess forest cover is flawed, since it also counts plantations as forests. But while natural forests grow without human intervention, constitute a mixture of species and are thus rich in biodiversity; plantations in most cases might be monoculture and harbour comparatively lesser biodiversity. This gives us a false picture of the actual forest cover.

- Forests have a key role to play in mitigating climate change by sequestering and storing more carbon than any other terrestrial ecosystem. A loss of forest cover thus has negative implications in terms of climate change. This is significant since India is one of the largest carbon emitting countries in the world – at 4.7 per cent, India saw the second largest absolute increase in CO2 emissions in 2016. In contrast, Russia and the US managed to decrease their emissions by 2 per cent, Japan by 1.3 per cent, and both Brazil and the UK by 6 per cent.

- Around 275-300 million people in India's rural areas directly depend on climate-sensitive sectors and natural resources for their subsistence and livelihoods. For many tribal communities, minor forest produce are a chief source of cash income. Thus, the loss of forest cover, and the negative impact on the climate, would push the forest dwellers further to the margins owing to their very low adaptive capacity.

- Loss of forest cover also leads to desertification, i.e. land degradation in arid, semi-arid, and dry sub humid areas resulting from various factors, particularly loss of natural vegetation. This would have an impact on groundwater tables by reducing the soil's capacity to allow water to percolate in the event of a rainfall.

- This is worrying in the context of a nationwide trend of receding ground water tables. India uses an estimated 230 cubic kilometers of groundwater per year – over a quarter of the global total – while more than 60 percent of its irrigated agriculture and 85 percent of drinking water supplies are dependent on groundwater. Between January 2015 and January 2016, merely 3% wells registered a rise in water level exceeding 4 metres. Out of 13244 wells analysed, only 35% showed any rise while 64% showed a fall in water level.

- To resolve these issues, the government must **(i)** prioritise larger social and environmental interests over market-friendly reforms; **(ii)** further decentralise the process of forest policy-making by giving more power to the forest gram sabhas; **(iii)** develop newer technology to ensure maximum precision while identifying forest cover which excludes plantations; **(iv)** promote community participation along with sustainable and climate smart agricultural to prevent desertification; and **(v)** work towards a full-fledged anti-desertification programme on the lines of China.

KEY MESSGAES

Water Crisis

- As India's population continues to grow at an exponential rate and ground water tables steadily decline, the country's excessive dependence on ground water for its water supply needs to be curtailed for sustaining a stable water table across the country.

- The existing freshwater supplies have been severely contaminated mainly due to urban and industrial sewage. Pollution of major rivers remains a serious concern as the number of polluted rivers went up to 275 from 127 in the last five years. As incidence of arsenic contamination, as measured by number of affected habitations, doubled between 2013 and 2016, the issue of ground water contamination has also become a major issue.

- As major reservoirs across the country have started drying up, dynamics related to water sharing changed leading to interstate conflicts regarding water sharing have also increased. Tribunals have been set up for the resolution of disputes related to water sharing of Cauvery and Krishna rivers among others.

- Reports state that due to widespread contamination of surface as well as ground water contamination, 76 million Indians do not have access to clean drinking water and only 26.9 million households have piped water in their houses, thus compromising on their sanitation. 21 % of the country's communicable diseases are also spread due to contaminated and untreated waste water.

- Apart from political and economic ramifications, there is huge human cost to unavailability of water which has resulted in mass migrations due to environmental concerns.

- The government's response to the emerging water crisis has been in the form of policies and agendas like the National Climate Action Plan and National Water Policy including specific targeted action plans like Namami Range for cleaning up of Ganga. However administrative inefficiency and apathy as well as lack of community cooperation have resulted in these schemes not delivering the desired goals.

Environmental Concerns in India
Section one: Plastic Pollution

PART-1

Background

Plastics are an essential part of today's modern society. From food packaging to electronics to drinking water, plastic can be found in almost everything. Plastic is produced in most global economies, with 85 per cent of production concentrated in three economies: the United States, Europe and Asia. In 2014, for example, 45 per cent of world plastic production took place in Asia (with China accounting for 26 per cent) followed by Europe with a 20 per cent share, and the North American Free Trade Agreement (NAFTA) with a 19 per cent share. This increasing use is reflected in the rate of increase in global plastic production: in 1964, 15 million tonnes of plastics were produced, in 2014 that had increased to 311 million tonnes. Because of their durability, low-recycling rates, poor waste management, a significant portion of the plastics produced worldwide enters easily into our ecosystem. As a result, it also constitutes around 10-15% of the total weight of municipal waste, dumped by a large number of countries. In India itself, the plastic processing sector comprises over 30,000 units involved in producing a variety of items with per capita consumption increasing and more and more pope adopting it in every-day life. According to the World Economic Forum, plastic production is expected to double again in 20 years, and to almost quadruple by 2050.

However plastic also has numerous disadvantages, mainly the presence of toxic substances that may adversely affect humans and other organisms. This means due to the presence of a large number of hazardous chemicals in plastic materials that can be easily found in consumer products have a negative impact on humans and the environment and exposure to such chemicals can be a direct health problem. Therefore, plastic pollution today, is one of the biggest environmental threats.

Further, according to a recent UN Environment report titled, "Single Use Plastics- Road Map to Sustainability" that tracked 60 governments and their action against plastic waste[1] highlighted that: only 9% of all plastics ever produced have been recycled, while 12% have been incinerated and a full 79% have ended up in landfills, dumps, or the environment.

- The report talks about plastic bags as a primary cause of concern as they have been found blocking waterways and worsening natural disasters, blocking sewers and providing a breeding site for disease-carrying insects, and blocking the stomachs and airways of animals.

- When it comes to plastic ban and related laws, around 50% of the countries that have implemented bans or levies do not have sufficient data to assess the environmental impact of the policies; while of the other 50%, 30% of the bans significantly reduced the use of plastic bags within a year and 20% had little impact, either due to poor enforcement or lack of alternatives.

[1]http://www.ipsnews.net/2018/05/world-environment-day-highlights-deadly-cost-plastic

Plastic Waste in India: An Introduction

I. What is plastic pollution?

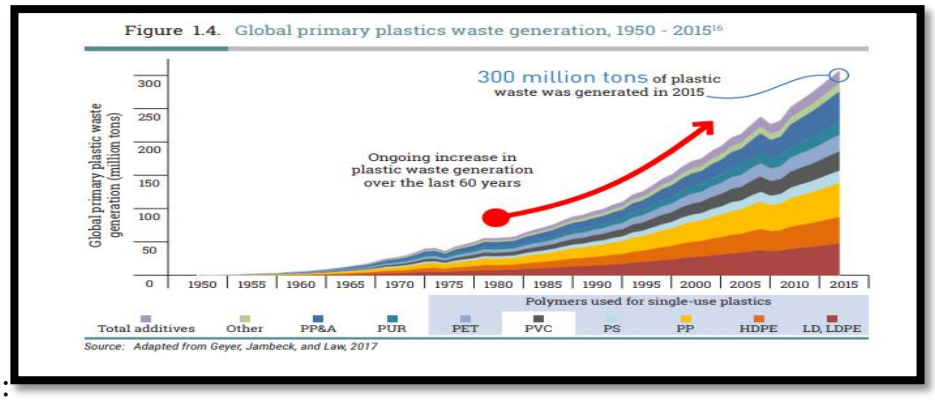
Plastic pollution is defined as the accumulation of excessive man-made plastic products in the environment which create problems for wildlife and their habitats as well as for human populations. Plastics today, are an integral part of society and have varied applications. It counts for around 10%- 15% of all the municipal solid waste generated (depending on country), and currently poses an enormous fraction by volume reaching up to 40%. Discovered in 1898, polyethylene is perhaps the most harmful of trash produced (several additives found in plastic, such as phthalates, adipates, and even alkylphenols, have been recognized as toxic materials) to over 330 million tonnes annually globally[2] and takes around 500-1000 years to degrade. Although plastic has multiple uses, its waste can easily clog up our rivers, oceans, lands and adversely affects the biodiversity. The increased use and production of plastic in developing and emerging countries is a particular concern over the last few years, considering most of them do not have a well-developed waste management infrastructure to deal with its proper decomposition. As of today, some 9 billion metric tons of plastics have been produced and spread around the world and as per estimates if current production and waste management trends continue, then by 2050, there will be 12 billion tonnes of plastic in natural environments.

The most common single-use plastics found in the environment include cigarette butts, plastic drinking bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, and even foam take-away containers. Major causes of plastic pollution include, overuse of single plastic items[3], increased production of plastic bottles (more than 480bn plastic drinking bottles were sold in 2016 across the world while the numbers are likely to increase by 583.3bn by 2021)[4],improper disposal of plastics and finally the failure to recycle or up cycle such plastics.

[2] https://committee.iso.org/files/live/sites/tc61/files/The%20Plastic%20Industry%20Berlin%20Aug%202016%20-%20Copy.pdf

[3] According to The World watch Institute estimates, 4-5 trillion plastic bags were produced in 2002, ranging from large trash bags to thick shopping totes to flimsy grocery sacks while the value used is the upper estimate of 5 trillion mainly because they are strong, cheap and hygienic ways to transport goods

[4] https://www.theguardian.com/environment/2017/jun/28/a-million-a-minute-worlds-plastic-bottle-binge-as-dangerous-as-climate-change



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Source: https://wedocs.unep.org/bitstream/handle/20.500.11822/25496/singleUsePlastic_sustainability.pdf?sequence=1&isA

II. India and Plastic Pollution

In India, around 70% of the total plastic consumption is discarded as waste while 5.6 million tonnes per annum (TPA) of plastic waste is generated in country- that is about 15,342 tonnes per day (TPD) with an increasing fraction of this plastic waste is found in rural areas. While as per the Central Pollution Control Board (CPCB) 2017 report, the country generates around 25,940 tonnes of plastic waste a day and around 94% are thermoplastic, such as PET (polyethylene terephthalate) and PVC (polyvinyl chloride) that are recyclable, the remaining belong to thermoset and other categories of plastics, such as sheet molding compound (SMC), fibre reinforced plastic (FRP) and multi-layer thermocol, which are non-recyclable. On the other hand, according to Plastindia Foundation, in 2017-18 alone India had consumed 16.5 million tonnes of plastic, 43% of which is used in packaging and are single-use plastic clearly indicating at the excess consumption that is overriding India's capacity to recycle (Venkatesh 2018). Similarly according to the Central Pollution Control Board (CPCB), plastic consumption in the country went up to three lakh tonnes in 2000 from 61,000 tonnes in 1996 and is predicted to increase up to 178 lakh tonnes in 2018[5].

III. Laws regarding Plastic Pollution in India

India, today struggles to manage its plastic waste. Huge amount of plastic is dumped into oceans and rivers, choking drains killing the animals, fishes etc due to plastic ingestion. Starting in 1999, India implemented the **Recycled Plastics (Manufacture & Usage) Rules with the aim to** control the packaging of food products in recycled plastics and to manage the severe littering problem. Some of the provisions include: the use of recycled and virgin colored poly bags for non-food applications was allowed but discouraged for packaging food item; all carry bags of size less than 20 microns were to be banned and the guidelines for the recycling of plastics were made mandatory. These rules were later replaced by the Plastic Waste (Management and Handling) Rules

[5] https://www.deccanchronicle.com/nation/current-affairs/100618/plastic-pollution-rises-regardless-of-ban.html

in 2011 that listed out regulations regarding the use, collection, segregation, transportation and disposal of plastic waste.

In 2016, the government introduced the Plastic Waste Management Rules that apart from extending the minimum thickness of plastic carry bags has been increased from 40 microns to 50 microns, extended the responsibility of the plastic producers and generators to create an effective waste management system, including collection, recycling, and a phase-out of plastic which could not be recycled. They allocated responsibilities to all the stakeholders and provided that all the tasks mentioned under the rules be implemented within six months of their notification. The Centre has recently amended the rules further and as per the environmentalists, the rules will only benefit the Industries, promotes easy access to plastics by omitting Rule 15[6] and dilutes the previous EPR provision only escalating the gravity of the environmental crisis surfacing in India (Shekhar 2018).

Table 1: Regulations on Production, Use and Management of Plastic Waste and Their Implementation

Year	Regulation	Major Implications
1999	The Recycled Plastics Manufacture and Usage Rules, 1999	Minimum thickness of polythene bags—20 microns
2002	The Recycled Plastics Manufacture and Usage (Amendment) Rules, 2002	Minimum size of polythene bags—8x12 inches
2006	Maharashtra Non-biodegradable Garbage (Control) Act	Minimum thickness of polythene bags—50 microns
2011	Implementation of Maharashtra Carry Bag (Manufacture and Usage) Rules, 2006 and the Plastic Waste (Management and Handling) Rules	Minimum thickness of non-polythene bags—40 microns
2016	The Plastic Waste Management Rules	Rules for collection, segregation and recycling, producer liability; minimum thickness of plastic bags—50 microns
2018	Maharashtra Plastic and Thermocol (Manufacture, Usage, Sale, Transport, Handling and Storage) Notification, 2018	Banning use of single-use plastics

Source: https://www.epw.in/journal/2018/24/commentary/maharashtras-war-plastic.html

IV. Problems Relating to Plastic Waste

Implementation of the Law: According to the Central Pollution Control Board's (CPCB) annual reports (analysed by the TOI)[7], the rules (2011-16) remain nowhere close to being implemented universally. While over 50% of the States did not adhere to the plastic waste management between the years 2011-16, over 80% of the States did not constitute the mandatory state level advisory (SLA) body which was to monitor the implementation on plastic waste norms.

- Between the years 2011-12, 2 out of 34 States and UTs formed the body while none of the States presented recommendations of the body for managing plastic waste. However States like Kerala,

[6] As per rule 15 (Explicit pricing of carrying bags) of the Plastic Waste Management Rules, 2016, every vendor, who sold commodities in a carry bag would have to register with their respective urban local body and pay a minimum fee of Rs 48,000 per annum (4000/month) after the announcement of the bye-laws. The seller could charge the consumer for the price of a plastic cover.

[7] https://timesofindia.indiatimes.com/city/nagpur/poor-state-ment-plastic-rules-which-remained-on-paper/articleshow/64455402.cms

Maharashtra, Madhya Pradesh and Tripura assured that the body is being formulated. 11 states submitted their action plan in 2011-12.

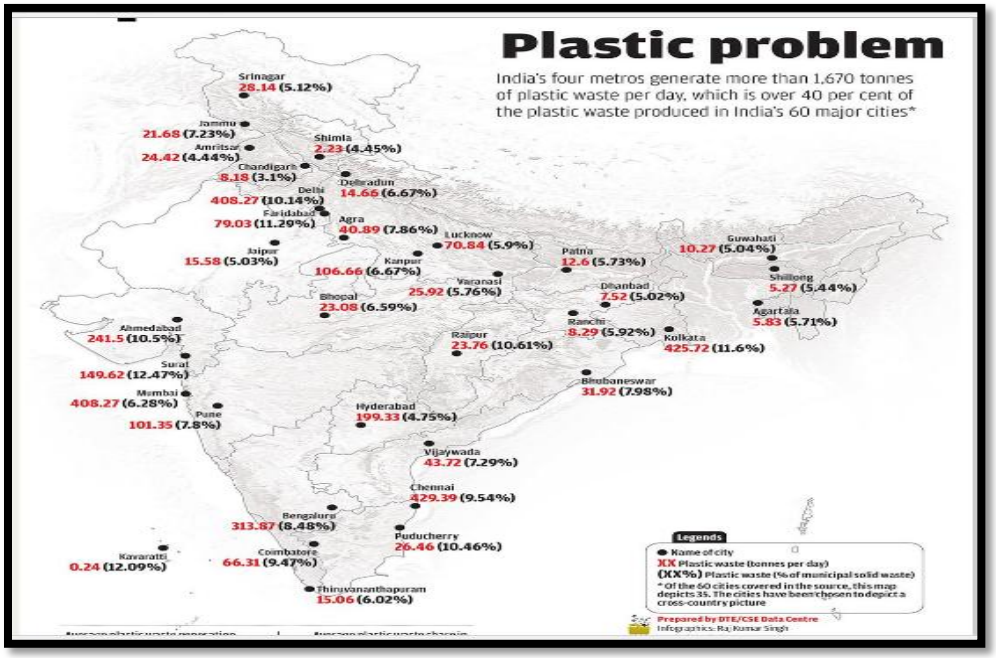
- Between the years 2012-13, Madhya Pradesh was the only State to form the body increasing the total number of states which constituted the body to 8 while none of the states submitted the body's recommendations. 9 states submitted their action plan in 2012-13.
- For the year 2013-14, only 1 out of the 5 states which formed the body submitted recommendations.
- In 2014-15, the number of states submitting recommendations increased to 5. Fourteen states submitted their plans in the annual reports of 2013-14 and 2014-15.
- The number of States submitting recommendations was 3 in 2015-16. 3 States submitted their plans in the annual reports of 2015-16.
- States such as Maharashtra, Gujarat and MP were the highest generator of plastic waste while Goa, Manipur, Meghalaya and Tripura, the amount of plastic waste saw a reduction.
- As per the 2016 annual report: out of 35 SPCBs/PCCs, only 24 SPCBs/PCCs have provided information on implementation of Plastic Waste Management, 2016, there were around 312 unregistered plastic manufacturing/recycling units in Andhra Pradesh, Assam, Jammu & Kashmir, Jharkhand, Manipur, Punjab, Tamil Nadu, Telangana, Uttrakhand and Uttar Pradesh, most of the States/UTs were not following the rule of plastic carry bag labelling, especially in case of the carry bags available with the street vendors and small retailers hence this was a case of non complaint with rule '14(1)', and majority of the States/UTs have not constituted such a monitoring body yet. The States/UTs, who have constituted SLA Body, are not convening meetings on regular basis to monitor the progress of implementation of these rules.
- Most States and Union Territories (UTs) had not set up a proper monitoring system for use of carry bags as per the guidelines.
- Over 18 States had so far had imposed a partial or complete ban on single-use plastic. In 2018, Maharashtra joined the list. Together the complete ban on plastic is in effect across 25 states and union territories in the country.

According to a study, "Assessment and Quantification of Plastic Waste Generated in 60 Cities in 2015-16, there is little or no processing of either Municipal Solid Waste (MSW) or plastic waste or PW in most Indian cities and the metropolises, except cities such as Ahmedabad and Pune[8]. Similarly in Haryana which was one of the first states to ban sale, manufacturing and use of plastic bags in the country in 2011. In 2014, the district administration also announced a ban on almost all kinds of plastic bags. Later in August 2017, the NGT had announced a fine of Rs 5,000 on anyone found to be carrying a 'thin' plastic bag (less than 50 macrons).However in a reply to an RTI petition, MCG has informed that no individual, entity or company has been penalised for using plastic[9]. In Karnataka, there is only a blanket ban on manufacture, storage, distribution and use of plastics such as carry bags, banners, plastic plates, cups and spoons. Yet, the ban is ineffective in several areas though it is certainly making some impact in some parts, as per media reports. In the State of

[8] http://citizenmatters.in/india-plastic-waste-world-environment-day-6800

[9] https://timesofindia.indiatimes.com/city/gurgaon/no-one-fined-for-using-plastic-bags-in-3yrs-rti/articleshow/64725103.cms

Gujarat too, there is zero implementation of plastic waste management[10]. As per the recent *IndiaSpend* study, even though 25 Indian states/UTs have some form of ban on polythene carry bags, implementation remains the missing key[11].Recently as per media reports, the civic body in Nagpur, had seized 2,502 kg plastic from distributors, retailers, vendors and shopkeepers with a penalty of Rs 6,53,100 despite ban on the usage of plastics[12].



Sustainability of plastic waste management: Municipal solid waste management (MSWM) is an essential element towards sustainable development that comprises of segregating, storing, collecting, relocating, processing, and disposal of solid waste to minimize its adverse impact on environment. Therefore in a country where rising incomes, rapidly growing but unplanned urbanisation, and changing lifestyles have resulted in increased volumes of materials such paper, plastic, other inorganic materials etc has led to an increase in volume of solid waste management from 6MT in 1947 to 48MT in 1997 and is expected to reach to around 300MT per annum by 2050 with 1, 00,000 MT waste per day, an unmanaged MSW under any circumstance becomes a challenge (Rajkumar Joshi 2016).

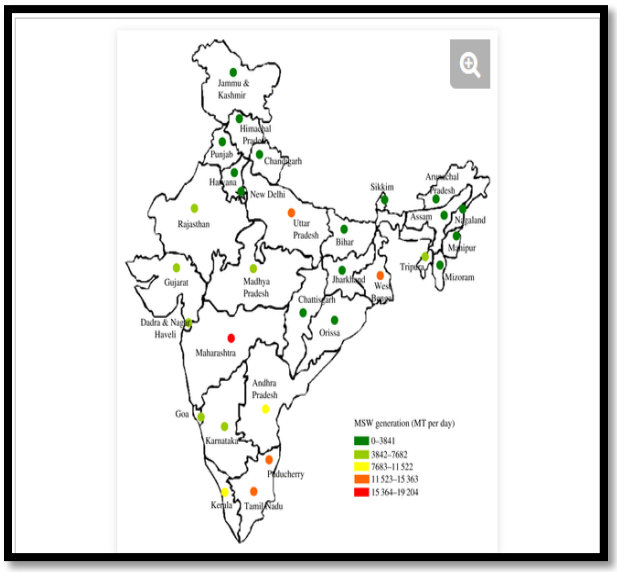
[10] http://www.dnaindia.com/ahmedabad/report-gujarat-govt-yet-to-implement-plastic-waste-management-activist-2622185
[11] http://www.indiaspend.com/cover-story/25-indian-states-ban-plastic-bags-yet-600-truckloads-of-plastic-discarded-every-day-31602
[12] https://timesofindia.indiatimes.com/city/nagpur/10-out-of-11-authorities-sitting-idle-on-plastic-ban-only-nmc-at-work/articleshow/64799697.cms

Table 3. Change in composition of municipal solid waste with time (in %)

Year	Biodegradables	Paper	Plastic/rubber	Metal	Glass	Rags	Others	Inert
1996	42.21	3.63	0.60	0.49	0.60	-	-	45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.02	25.16
2011	42.51	9.63	10.11	0.63	0.96	-	-	17.00

Source: Planning Commission Report.

As per rules, management of solid waste is the responsibility of the Urban Local Bodies which are currently suffering from lack of infrastructure & technology, insufficient financial resources and support from the government, private companies and nongovernmental organisations and since SWM is a state subject, the responsibilities of ULBs have further narrowed down.[13] As a result, none of the cities in India can claim 100% segregation of waste at dwelling unit and on an average only 70% waste collection is observed, while the remaining 30% is again mixed up and lost in the environment. Further, the lack of segregation of plastics waste, the absence of organized systems of collection and efficient aggregation, poor economic value in low-grade (thin) plastics, and the livelihoods associated with plastics production have been the key categories of challenges[14].



Source: http://rsos.royalsocietypublishing.org/content/4/3/160764

[13] https://timesofindia.indiatimes.com/india/india-generates-100000-metric-tonnes-of-waste-per-day/articleshow/57917862.cms
[14] file:///C:/Users/RGICS/Downloads/Resource%20book_Plastic%20Waste%20Management%20(3).pdf

Easy access to plastic polythene bags: The plastic industry is one among the rapidly growing industries in India. As per the National Accounts Statistics 2015 of the Ministry of Statistics and Programme Implementation estimation, the average production and consumption of plastic products between 2011-12 and 2015-16 at 707 million metric tonnes (MMT) per year[15]. Further the study conducted by the Delhi School of Economics, in developing countries indicate that a blanket ban may not be the best possible solution: instead 82% of consumers would switch from plastic bag use to own bag use if they were charged explicitly for the bags (Somanathan 2011). As per the UN Environment Report 2018, 1 to 5 trillion plastic bags is consumed worldwide each year, which roughly amounts to a **maximum ten million plastic bags per minute**. Further the report also warns that if current consumption patterns do not improve, there will be about **12 billion tons of plastic litter in land-fills and natural environment by 2050**[16]. The Solid Waste Management Rules, 2016, provided for legislation under which ULBs to penalize citizens in the form of spot fines for littering or failing to comply by the provisions of the rules however the recent amendment 2018 has done away this fine provision. For instance, in States like Maharashtra[17] and Delhi[18] who are high generators of plastics, despite complete plastic banns plastic polythene bags are still very much in force suggesting the ban is not the right solution. Similar is the situation in States like Jammu and Kashmir that has already banned bags made of polythene but to little effect[19]. According to Swati Singh Sambyal, Programme Manager for Environmental Governance, a ban on plastic bags would only work if the manufacture was stopped and cheaper alternatives made available[20]. Also according to environmental activist Clinton Vaz, the implementation of plastic bans in other parts of the country has also been difficult because of the structure of imposing fines.[21]

Therefore, the above data indicates that the main reason for the increasing plastic pollution in India is mainly due to absence of an effective waste management system and poor enforcement of laws. It is because of implementation issues that tonnes of plastic end up being dumped into oceans, rivers, mountains etc and the drains are getting choked and animals, fish and other aquatic animals are dying of plastic ingestion. Moreover, plastic also contributes towards ground, air and water pollution.

[15] https://indianexpress.com/article/explained/questions-on-plastic-limited-data-diffused-focus-in-parliament-replies-world-environment-day-5073313/

[16] https://www.livemint.com/Politics/XGUoRwiD5w31AEF1ztngPJ/10-mn-plastic-bags-consumed-per-minute-worldwide-enough-to.html

[17] https://www.thehindu.com/news/cities/mumbai/stay-ban-till-options-are-available-plastic-bag-makers/article23428413.ece

[18] http://www.tribuneindia.com/news/sunday-special/perspective/ban-no-solution/613109.html

[19] https://www.livemint.com/Politics/yRUayI4UltyLgWOvmKqvSN/Despite-statelevel-bans-plastic-bags-still-suffocate-India.html

[20] https://in.reuters.com/article/india-environment-plastic/despite-state-level-bans-plastic-bags-still-suffocate-indias-cities-idINKCN1GC0TE

[21] https://scroll.in/article/872612/why-have-laws-to-completely-ban-plastic-bags-failed-in-india

Part II- Sources of plastic pollution

V. Plastic generated by local people:

According to an international journal, *Science*, in its study on plastic highlights that 79% of the total plastic waste of 6,300 million metric tons (MMT) is accumulated in landfills or in the natural environment (river system and oceans)[22]. As a result of India's booming population and rapidly expanding urban areas have infected its rivers that are badly polluted and choked by untreated sewage, plastic waste etc. These plastic additives (about 66% of plastic waste is mixed waste that include poly bags and pouches that are used to pack food) are mainly coming from the residential localities that eventually end up in rivers, seas etc. This is mainly due to the lack of an effective solid waste disposal infrastructure that people are forced to dump the waste which either gets buried or left as it is. In such a case, plastic collected in these landfills degenerates into its smaller components that reach into the soil and water. In fact such unmanaged landfills can also lead to groundwater contamination. For instance,

- Despite a decade-long ban on polythene carry bags in Jammu, plastic continues to choke drains in the city, creating a problem during rains. This is not only because of the residential colonies but commercial establishments who are also dumping polythene waste in public places and drains, leading to overflowing of sewage in several localities[23]. The State generates more than 700 tonnes of solid waste every day.
- Assam generates 2.99 lakh kilogram of plastic waste every day with 37,000kg of waste generated every day in Guwahati alone, posing a major threat to the environment out of which only 60 per cent is recyclable. This present practice of mixing plastic wastes with biodegradable solid waste is ruining the solid waste management system and creating large tracts of waste land and toxic land[24].
- Chandigarh produces 450 metric tonnes of garbage each day, however no study has been conducted so far to analyse the generation of plastic waste[25]. As per media reports, a park that on the edge of a residential neighbourhood was found to be drowning in plastic waste and garbage from the households highlighting the negligence of the civic bodies[26].
- Coming down to south; Karnataka, that has banned plastic bags in March 2016 generated 1,29,000 tonnes of plastic waste that year while Andhra Pradesh, generated 1,28,480 tonnes of plastic waste with no bans in place[27]. Telengana too, generates around 450-500 tonnes of plastic every day[28]. In

[22] https://economictimes.indiatimes.com/news/environment/pollution/79-of-plastic-in-landfills-water-bodies/articleshow/59764892.cms
[23] http://www.tribuneindia.com/news/jammu-kashmir/polythene-clogs-drains-flood-threat-looms-large/604466.html
[24] https://www.telegraphindia.com/states/north-east/plastic-threatens-to-choke-assam-235436
[25] http://www.tribuneindia.com/news/chandigarh/cpcc-doesn-t-have-plastic-data/600899.html
[26] https://timesofindia.indiatimes.com/city/chandigarh/sector-8-park-turning-into-dumping-zone/articleshow/64835759.cms
[27] https://www.deccanchronicle.com/nation/current-affairs/100618/plastic-pollution-rises-regardless-of-ban.html
[28] http://www.newindianexpress.com/cities/hyderabad/2018/jun/05/in-hyderabad-only-a-days-plastic-waste-is-recycled-out-of-scrap-generated-in-a-year-1823847.html

Vijayawada Telengana, around three irrigation canals passing through the city were filled with streams of pollution, with unchecked dumping of garbage and effluents into them as there is no proper solid waste management programme in the city.[29]

- Bhubaneswar generates about 15,330 tonnes of plastic every year with around 400 metric tonne of solid waste generated in the city- nearly 7 to 10 tonne of waste comprises polythene, plastic articles and similar constituents[30].
- In a media report last year, as a result of heavy rains in Hyderabad, plastic items and other littered trash flowed with the water choking the drains and formed huge lumps of plastic that prevented water from making it through the sewer pipes. In most areas of the city, plastic bags and litter on roads flowed with rain water and gradually turned into blocks hampering flow of rain water causing water stagnation on the road obstructing traffic flow[31].

VI. Plastic generated by tourists:

Apart from the local population, tourists are also responsible for littering plastic in the environment. The hill economy is largely dependent on tourism which unfortunately leads to garbage generation that is left behind in the mountains by the tourists.

- As many as 1.96 crore tourists, including 4.7 lakh foreigners, visited Himachal in 2017 tourist destinations, including Manali, Rohtang, Dalhousie, Dharamshala and Shimla, are found covered up with plastic waste during the peak tourist season. The Manali town alone produces nearly 10 tonnes of garbage every day, produces nearly 50 tonnes in peak tourist season[32].
- Plastic bottles, wrappers and polythene are found most parts of the Himalayan range in Himachal Pradesh and Uttharakhand states of North India which are open to tourists and trekkers. According to the tourists who visited these areas generated as high as 84% of the total waste generated in 2005 while in 2015 the percentage stood at 35%. There are also chances that these non-biodegradable plastic wastes absorb heat resulting in rise in temperature and melting of glaciers, aggravated by global warming which then go to form "water bombs" or lakes posing a threat of flooding[33].
- Similar is the case in the Leh district in the Indian state of Jammu and Kashmir where last year 277,255 visitors dumped tons of plastic waste littering a ridge near Khardung La pass, where tourists pass through to Nubra Valley and Pangong Lake. As per the locals, the waste often gets carried away by the wind and some of it ends up in the River Indus[34].
- The growing problem of plastic waste and its disposal has for long been a cause of the islands as well. For instance, Andaman and Nicobar which is also one of the top tourist destinations in the country.

[29] http://www.newindianexpress.com/cities/vijayawada/2018/feb/18/vijayawada-residents-turn-canals-into-plastic-waste-dump-yards-1774975.html
[30] http://odishatv.in/odisha/plastic-use-rampant-in-smart-city-bhubaneswar-304903
[31] https://swachhindia.ndtv.com/hyderabadrains-authorities-blame-plastic-waste-turning-localities-lakes-13309/
[32] https://timesofindia.indiatimes.com/city/shimla/hill-state-struggles-with-plastic-mountains/articleshow/64455834.cms
[33] https://www.ibtimes.co.uk/himalayan-range-faces-ecological-threat-plastic-littered-by-tourists-trekkers-1462891
[34] https://scroll.in/article/884169/in-photos-as-tourism-grows-so-does-trash-in-ladakhs-pangong-lake

According to the Central Pollution Control Board (CPCB) estimates, Port Blair, the capital of Andaman and Nicobar islands generates 76 tonnes waste per day, of which 10 per cent is estimated to be plastic waste that has largely impacted the water bodies. According to the recent Marine Fisheries Census programme conducted by Fishery Survey of India (FSI), plastic debris was found in all along the shore regions of little and Great Nicobar. As per recent studies, the seas near these islands are considered as one of the dirtiest in the world.

VII. Use of plastic in our every-day life

There are different plastics that people use in their daily lives[35]. However, these materials when dumped into the environment, causes a severe environmental impact on human life in return.

- **Plastics and Packaging:** Since plastic is light weight and has the ability to be molded into any form, it is widely used for packaging material for food and non-food packaging. Firstly, the food stays fresh longer when packed in plastic, it reduces waste by reducing the amount of spoiled food that must be discarded and decreases the amount of preservatives needed to keep food fresh. Plastic packaging is also convenient for consumers: clear plastic lets shoppers view the item they are purchasing and plastic packaging is easy to open. Apart from food, it is also used in packing of medicines, and other products from contamination and germs when it is displayed and handled.
- **Plastics and Transportation:** Plastic is both lightweight and durable and is used in manufacturing cars, trucks, and other vehicles. Plastics make up ten percent of new vehicle's total weight, and over 50 percent of their volume.
- **Plastics and Electronics:** Plastic is used in making cables and cords on everything from computers to paper shredders to keep electronics powered. Plastic insulation for cables and electrical equipment keeps equipment cool and protects users from over-heating. Household appliances, from toasters to DVD players, use plastic to make them lightweight and affordable. The liquid crystalline plastics in LCD flat screen televisions give beautiful pictures and save energy, using less power than traditional cathode ray tube screens. The touch screens on mobile phones, computers, and other electronics are made of polycarbonate film. The tiny microphones in mobile phones are made of polymers for their shock-resistance. Handsets and earpieces are lighter and more comfortable because of plastics.

[35] http://www.pepctplastics.com/resources/connecticut-plastics-learning-center/perfect-plastic-how-plastic-improves-our-lives/

Common Plastics and their Uses

Polymer Resin	Characteristics	% of All Plastics (1991)	Common Uses	Products Made from Recycled Resins
High-density polyethylene	Tough, flexible, translucent	14.6	Beverage bottles, pipe, cable, film	Motor oil bottles, detergent bottles, pails
Low-density polyethylene	Moisture-proof, inert	18.3	Trash bags, coatings, plastic bottles	Trash bags, pallets
Polyethylene terephthalate	Tough, shatter-resistant, gas permeation-resistant	2.3	Soft drink, detergent, and drink bottles	Carpets, fiberfill, non-food bottles, containers
Polypropylene	Stiff, heat- and chemical-resistant	13.2	Auto battery cases, screw-on caps, food tubs, film	Auto parts, batteries, carpets
Polystyrene	Brittle, clear, rigid, good thermal properties	7.8	Housewares, electronics, fast food packaging, food utensils	Insulation board, office equipment, reusable cafeteria trays
Polyvinyl chloride	Strong, clear, brittle unless treated with plasticizer	14.5	Sporting goods, luggage, pipes, auto parts, miscellaneous packaging	Drainage pipes, fencing, house siding

Source: The League of Women Voters. The Plastic Waste Primer: A Handbook for Citizens. New York: Lyons and Burford, 1993.

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3299092/

VIII. Burning of Plastic:

Incineration of plastic waste in an open field is a major source of air pollution that produces dioxins or toxic substances effecting human health and increases the risk of heart disease, aggravates respiratory ailments such as asthma and emphysema and cause rashes, nausea or headaches, and damages the nervous system (Rinku Verma 2016). For instance, despite the fact that India has banned burning of plastic in open, in Kerala, more than half of the population in disposes useless plastic by burning, according to a survey conducted by Kerala state literacy mission authority- 44.65% of population burn used plastic while 30.56% throw it outside and 24.79% abandon plastic waste on their house premise[36].

IX. Industry sewage full of plastic:

As per recent media reports, the Nanakramguda lake in Hyderabad situated near the road-side near Wipro at Nanakramguda of IT Corridor, is filled with plastic waste, food waste and other garbage materials being littered into the lake posing a serious threat of extinction[37].

[36] https://timesofindia.indiatimes.com/city/thiruvananthapuram/most-keralites-dispose-plastic-by-burning-survey/articleshow/58627206.cms

[37] https://telanganatoday.com/plastic-waste-chokes-lake-at-nanakramguda-of-hyderabad

Part III-The impact of plastic on the environment

X. Plastic Waste in the Mountains and Hills

Mountains in India are a major source of water, energy, food and livelihood for people living in the mountains and in the plains. For instance more than 1.4 billion people depend on water from the rivers of the Himalaya, that covers atleast 10 hill States viz., Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and two partial hill, states - Assam and West Bengal. Nearly 50 million people reside in the Indian Himalayan Region (IHR) alone with the eastern rivers like the Ganges, that are dependent on rain and groundwater. Apart from providing water, mountains have a significant role in the climate change, act as a natural barrier that protects India from its neighbours, several sites which can be used for producing hydroelectricity, forest produces as well as source of income for many small farmers who survive on agriculture on its land, attract tourists and are also the source of valuable minerals. For instance,

1. According to recent media reports, water flowing down from the Himalaya is diverted for industrial use and polluted as it flows through the cities, even though the water is needed for human use. For instance, A recent clean-up drive of 12 Himalayan states initiated by two NGOs, Integrated Mountain Initiative (IMI) and Zero Waste Himalayas, was conducted for two purposes: to collect as much waste as possible in a single day in the Himalayan foothills and analyze the trash. The report submitted by the NGO revealed statistics of plastic waste polluting the mountains that eventually end up reaching the oceans through the rivers flowing its rivers. As per the report, the analysis of the water revealed four lakh pieces of plastic (97%) waste, while 62.67% was identified as 'multilayered plastic' or polymer-based, non-recyclable food packaging and around 17% was plastic-layered paper, such as paper cups, and plastic-polystyrene utensils. In Darjeeling and Kalimpong, nearly 70% was multilayered plastic, while other non-branded plastic made up. The Himalayan Cleanup further conducted a brand audit in order to identify the top brands polluting the mountains and demanded that they take responsibility for the waste through Extended Producer Responsibility (EPR) mechanisms. As per the audit, Pepsico was at the top of the list, accounting for about 25% of all the waste generated by multinational corporations in the region, while Parle Products topped the list of Indian brands.

2. As per media reports, decades of commercial mountaineering- trekking have turned polluted Mount Everest. In 2017 climbers in Nepal brought down nearly 25 tonnes of trash and 15 tonnes of human waste -- the equivalent of three double-decker buses -- according to the Sagarmatha Pollution Control Committee (SPCC)[38]. Both Nepal and Tibet have made efforts to address the issue. For instance, for the past five years, teams from the Nepal have paid around US$4000 deposit which is refunded if each climber brings back at least eight kilogrammes of rubbish while in Tibet, climbers are required to bring down the same amount and are fined US$100 per kg if they don't[39].

[38] https://economictimes.indiatimes.com/news/environment/pollution/mount-everest-the-high-altitude-rubbish-dump/articleshow/64619372.cms

[39] https://www.stuff.co.nz/travel/news/104854465/mount-everest-a-rubbish-dump-locals-say

3. In the Nilgiri hills, Ooty the issue of plastic pollution has been in the limelight for quite some time now in order to maintain its ecological balance40. Recently, the Tamil Nadu government has announced the ban on plastic was announced on the occasion of World Environment Day 5 June and it will be implemented from next year. However, a few plastic materials used for packing milk, curd, oil and medicine have been exempted from the ban. The solid waste generated in the town includes inorganic wastes of plastics, glass, and miscellaneous products- as per data; Ooty town generates about 1577 metric tons of solid waste per annum at the rate of 4.38 metric tons per day with large number of plastic paper bags that collect near the eastern end of the lake41.According to V. Sivadass of the Nilgiris Environment and Cultural Service Trust, plastic bottles, carry bags, silver foil food packs and disposable plates are the major polluting materials in the district as a result of which there have been incidents of deer and other animals dying after swallowing plastic carry bags abandoned by the tourists while liquor bottles thrown into the forests harming animals[42].

XI. The Impact of Plastic in Mountains

One of the far-reaching implications of waste in mountains is that such solid waste, such as plastic can end up in rivers, lakes or wetlands after it enters sewage systems, or washed down by rainwater, or blown away by wind. Rivers are the key pathways to lowlands and coastal areas – for water, sediments, pollutants and litter. Once rivers have discharged their content into the ocean, it becomes 'marine litter'. Waste that was once disposed of on a mountain can find itself on the floor of submarine canyons[43].

According to Christian Schmidt and Stephan Wagner of the Helmholtz Centre for Environmental Research in Leipzig, (Germany) research, around 57 of world's rivers ferry between 0.4 and 40 lakh tonnes of plastic waste down to the open oceans every year. According to their study, a combination of large rivers and huge populations along their banks are together responsible for unusually high amounts of untreated plastic waste going into the oceans.[44]Media reports further suggest that around 10 rivers all around the world are responsible for carrying 90% of the plastic that ends up in the ocean. Among the list are some of the biggest Indian rivers including Indus, Brahmaputra and the Ganges that carry the second and sixth highest amounts of plastic debris to the ocean that flow from these regions. This mainly due to the absence of a solid waste management system, that waste flows down with the melting glaciers, and floats into natural drains and is then carried by our river systems into the sea.

- For instance pollutants (polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons (PAHs) found under glaciers in the Himalayas are seen flowing through the river Ganga and its tributaries, into the ocean as per the study (Brij MohanSharmaa 2015). Further, the scientists from the Norwegian

[40] https://yourstory.com/2015/08/plastic-ban-ooty/
[41] http://shodhganga.inflibnet.ac.in/bitstream/10603/108580/13/13_chapter%205.pdf
[42] https://www.thehindu.com/news/cities/Coimbatore/plastic-wastes-mar-beauty-of-ooty/article7697029.ece
[43] http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/04%20Publications%20-%20Press%20-%20Gallery/Documents%20and%20Publications/WasteMountains_screen.pdf
[44] https://india.mongabay.com/2018/01/12/indus-brahmaputra-and-ganga-among-the-top-10-plastic-waste-carrying-rivers/

Institute for Water Research (NIVA), Research Centre for Toxic Compounds in the Environment (RECETOX) at Masaryk University in the Czech Republic and The Energy Resources Institute (TERI),India who analysed the air and river water samples, as well as deposits along the Ganga and its major headwaters, report that in the central Gangetic plains, compared to pollutants discharged from lower parts of the river basin, the pollutant load from glacial meltwater can be as low as 2% but also as high as 200%. (Thethirdpole.net 2015).

- Plastic pollution can also clog drainage systems, which are very important for channelling excess water and prevent flooding, especially after heavy rainfall. When water pipes are blocked by plastic debris, the diverted water can cause local flooding, which, in turn, has the potential to transport more plastics.
- The open garbage system in India is a huge menace to the well-being of animals including wildlife.- According to researchers from the Wildlife Institute of India, in a study published in January this year, researchers analysed the diet of red foxes from five locations in three states across the trans-Himalayas and one location in the Dachigam National Park, Kashmir. In locations close to human habitation, such as Spiti Valley, Ladakh and Chiktan village in Kargil, between 30-55% of the food red foxes ate came from human sources which include *discarded meat bones, fruits, dead livestock, cereals and inedible things like plastic, paper or rubber*. *However, food items like plastics and medicines are harmful to the animal*[45].
- *In Chennai,* plastic material found in elephant dung in Mudumalai forests in the Nilgiris a few months ago and plastic spotted in bison dung in Sirumalai forests of Dindigul division, Chennai indicate that the huge amounts of plastic waste littering forests in the state , mainly dumped by tourists, is affecting wildlife, even causing death.[46]
- Every year, thousands of pilgrims trek through dense forested hills in the Pamba River basin to the abode of Lord Ayyappa during the annual pilgrimage. Sabarimala is part of Kerala's Periyar Tiger Reserve, a rich biodiversity home to several species of wild animals and plants. When a group of wildlife and environment volunteers from the state visited the path leading to Sabarimala a few days ago, they found huge amount of plastic waste in the forest, including wrappers, bottles, carry bags, etc Even though the Kerala High Court banned the use of plastic in Sabarimala in 2015, the order is not being implemented properly. Another issue, Johnson pointed out, was that since the sewage plant is situated on an acre of open land; this often attracts wild animals which end up eating from garbage[47].
- According to the Environment Ministry statistics, at least 30 kilograms of plastic can be found from the stomach of every cow or buffalo which dies in India[48].

[45] https://india.mongabay.com/2018/05/03/dumpster-diving-red-foxes-and-fast-food-eating-macaques/
[46] https://timesofindia.indiatimes.com/city/madurai/Plastic-waste-dumped-inside-forests-by-tourists-kills-animals-officials-alarmed/articleshow/50875612.cms
[47] https://www.thequint.com/news/india/elephant-dies-in-kerala-after-eating-plastic-who-is-to-blame
[48] https://www.ndtv.com/india-news/30-kg-plastic-can-be-found-in-every-dead-cow-buffalo-in-india-says-union-environment-minister-750361

XII. Plastic Waste in Water

The oceans cover 3/4th of the Earth and hold 97% of the planet's water that provides the mankind with food, oxygen, jobs etc and even regulates the climate. They are a major source of livelihood for millions with economies of cities and entire regions dependent on them that lives within the coastal zone, while the ocean-based businesses contribute more than $500 billion to the world's economy. As per studies, around 80% of marine pollution comes from land-based activities which include plastic debris and the direct discharge of industrial waste & sewerage in the marine environment has proved to be harmful to wildlife, under water habitat and also to humans .It is estimated that between four and 12m metric tonnes of plastic makes its way into the ocean each year. This figure is only likely to rise, and a 2016 report predicted that by 2050 the amount of plastic in the sea will outweigh the amount of fish.[49]

Reports blame 80% of the ocean's pollution on pollutants like plastic, which kills thousands of ocean-inhabitants each year. This leakage of plastics into the oceans is a consequence of inadequate and inefficient wastewater and solid waste collection. As per researchers, 20 countries account for 83% of mismanaged plastic waste that enters the ocean and India is one of them ranked at number 12th-it generates around 5.6 million tonnes of plastic waste annually, while the country accounts for 60% of plastic waste dumped into the world's oceans every year(World Bank). Further according to a 2014 research paper, 'Plastic Pollution in the World's Oceans' there are more than five trillion pieces of plastic floating in our oceans. These 5.25 trillion pieces of plastic are three size ranges-micro plastic (less than 4.75 mm), meso plastic (4.75-200 mm) and macro plastic (above 200 mm). They have also been found to exist in around 83% of drinking water samples collected from all over the world and India ranks third after the US and Lebanon in this regard.

In 2014, the Ocean Conservancy carried out an International Coastal Cleanup, combing beaches which show that plastic drinks bottles, food wrappers, bottle caps, straws and stirrers, plastic bags and plastic lids are amongst the top ten most common items collected in these oceans. As per the report, out of the five trillion pieces of plastic floating in our oceans, the North Pacific Ocean has two trillion pieces of plastic floating around it, while the Indian Ocean contains one trillion pieces of plastic.[50] Also, the Bay of Bengal which provides marine living resources by producing 6 million tons of fish is suffering from plastic pollution. With huge amount of plastic waste is found on its shorelines (Sakhuja 2016). Most According to Marcus Eriksen' research, the Bay of Bengal is more polluted than the Indian Ocean gyre[51].This is because several large rivers that empty into the bay carry vast tides of untreated sewage, plastic, industrial waste and effluent from the agriculture and aquaculture industries[52].

- The Yamuna River is now the river is one of the most polluted rivers in the world especially around New Delhi that dumps 58% of its waste into the river that affects around 70% of Delhi drinking treated water of the Yamuna River. The main reason behind its present condition is the lack of sufficient sewage mechanisms while most of the sewage treatment facilities are left either underfunded or not functioning

[49] https://www.theguardian.com/environment/2017/jun/29/if-you-drop-plastic-in-the-ocean-where-does-it-end-up
[50] https://citizen.co.za/news/south-africa/1144757/indian-ocean-second-most-polluted-in-the-world/
[51] https://www.cbsnews.com/news/worlds-oceans-plagued-by-269000-tons-of-plastic-pollution/
[52] https://www.theguardian.com/environment/2017/jan/31/bay-bengal-depleted-fish-stocks-pollution-climate-change-migration

properly; in fact as per CAG only 15 out of 32 sewage treatment plants are working below their capacities. As a result, turtles, different species of fish, crocodiles and an abundance of aquatic plants and phytoplankton when enter Delhi, they start to die. Besides these even fresh water Gangetic Dolphins can be found in some stretches of the river near Hamirpur, in Uttar Pradesh[53].

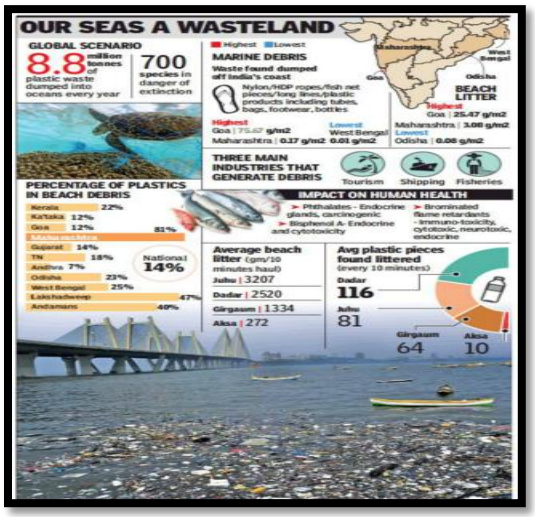
- The Ganga originates in the Himalayas in Uttarakhand, flows for 2,525km passing through five Indian states-Uttarakhand, Uttar Pradesh, Jharkhand, Bihar and West Bengal before discharging into the Bay of Bengal. The Ganga basin covers 26% of the country.[54]. As a result, the bay's ecosystems is getting disrupted by other environmental pressures and its fish stocks have come down terribly having a negative impact on agriculture and aquaculture industries for more than 200 million people who live along the Bay of Bengal's coasts majority of them who are dependent on its fisheries. Further, 1.3 million toilets have already been constructed in rural areas near Ganga to reduce sewage inflow into Ganga but even though the coverage of household toilets in these villages was 99% improvement, there was no difference in the river water quality in the whole Ganga basin because the solid and liquid wastes are not managed in a planned and scientific way (MDWS).
- The Brahmaputra River originates in Tibet and flows through three countries as a major source of water in east and north-east India that culminates in Bangladesh. In Assam, it flows for a length of 640 kilometres, the largest among India's states. With the increase in the urbanisation[55] and industrialisation of the state, the river is now among the most polluted ones. For instance, Dibrugarh, generates a significant amount of 75 to 80 metric tonnes of garbage every day. The Municipal Corporation of Dibrugarh, in the absence of a modern scientific landfill dumps its daily waste in an area called Maizan, a few metres away from the river's bank. In monsoons, garbage from the landfill often flows into the river, polluting its water. In 2014, the Assam Pollution Control Board found out that nearly 700 households in Guwahati alone had drainage lines directly connected to the river, which carried sewage from the households to the river without any treatment. Continuous disposal of untreated sewage has rendered many parts of the Brahmaputra contaminated.
- As per a study based on the status and composition of beach litter in India (P. Kaladharan* 2017), plastic litters such as single use carry bags and sachets of soft drinks, edible oils, detergents, beverages were recorded highest from Goa coast and the lowest from Odisha. The registered highest mean percentage was registered from Maharashtra (81 %) and the lowest mean from beaches of Andhra Pradesh (7%). The two island Union Territories registered 40% (Lakshadweep) and 47% (Andamans) of plastics over the total debris, while the national average was only 14%. The plastic debris then either stays on the coastline or is flown further into the oceans further impacting the marine ecosystem, the aqua life and eventually human health. According to experts, this plastic debris is eaten by whales to turtles and coral reefs to sea birds – and potentially humans through the food chain.[56]

[53] https://swachhindia.ndtv.com/delhis-waste-responsible-killing-aquatic-life-yamuna-river-2095/

[54] https://www.livemint.com/Politics/KW6MIOrOvMvZvEGeozwifJ/CAG-slams-Centre-for-failing-to-utilize-funds-for-Ganga-reju.html)

[55] Between 1951 and 2011, the number of urban centres with population of over 1 lakh increased from 12 to 214 in Assam, as per statistics from the Ministry of Urban Development.

[56] https://www.hindustantimes.com/india-news/goa-s-beaches-most-littered-in-the-country/story-FvhdNraluXW9QuBWRFaHPI.html



Source: https://timesofindia.indiatimes.com/city/mumbai/maharashtra-tops-in-plastic-waste-on-beaches-food-chain-under-threat/articleshow/63838373.cms

XIII. The Impact of plastic waste:

Marine plastic pollution has a wide range of, economic, health and social impact on life. For instance the environmental damage to marine ecosystems has been estimated at $13 billion per year. Other costs include the clean-up operations, the repair and replacement of damaged vessels and gear, reduced fishing catches, and a decline in coastal tourism and impact on related industries. The marine wildlife (more than 700 species) is impacted by plastic pollution through entanglement, ingestion, bioaccumulation, and changes to the integrity and functioning of habitats. Some of the marine species that are most deeply impacted by plastic pollution are sea turtles, seals and sea lions, sea birds, fishes, whales and dolphins[57]. An average of 34 pieces of plastic particles is found per bird. Further as per the Ministry of Environment recent report, At least 267 species worldwide, including 44% of all seabirds, 43% of all marine mammals, 86% of all turtles as well as fish species are affected by marine litter. Also, plastic dumped into oceans move up the food chain causing several health hazards like cancer, endocrine problems, etc in humans. Further, according to researchers, fishes may be seeking out plastic debris in the oceans as the tiny pieces appear to smell similar to their food[58]- Matthew Savoca, of the National Oceanic and Atmospheric Administration explains that,

"*When plastic floats at sea its surface gets colonised by algae within days or weeks, a process known as biofouling. Previous research has shown that this algae produces and emits DMS, an algal based compound that certain marine animals use to find food. [The research shows] plastic may be more deceptive to fish than previously thought. If plastic both looks and smells like food, it is more difficult for animals like fish to distinguish it as not food."*

[57] http://www.onegreenplanet.org/animalsandnature/marine-animals-are-dying-because-of-our-plastic-trash/
[58] https://www.theguardian.com/environment/2017/aug/16/fish-confusing-plastic-debris-in-ocean-for-food-study-finds

According to studies, environmental impact can be wide ranging and have both direct and indirect consequences. For instance, where direct impacts implies when marine life is been physically harmed by marine debris through ingestion or entanglement (e.g., a turtle mistakes a plastic bag for food) or marine debris physically alters a sensitive ecosystem (e.g, a fishing net is dragged along the ocean floor by strong ocean currents and breaks and smothers a coral reef), environmental impacts can also be indirect, such as when a marine debris cleanup results in ecological changes (P.Pavani 2014).

a) Ingestion: Seabirds, sea turtles, fish, and marine mammals etc often ingest/eat marine debris that they mistake for food. This in return can lead to either starvation or malnutrition when the marine debris collects in the animal's stomach causing the animal to feel full or internal injuries and infections. Since plastic contain toxic chemicals that can also harm reproductive failure in fish, shellfish, or any marine life and even death.
b) Entanglement: Entanglement in some cases can lead to suffocation, starvation, drowning, increased vulnerability to predators, or other injury. It can constrict an entangled animal's movement which results in exhaustion or development of an infection from deep wounds caused by tightening material.
c) Ecosystem Alteration: Not only sea animals, plants and other sensitive ecosystems can all be harmed by marine debris. For instance, plants can be smothered by plastic bags and fishing nets.

Part IV

Impact of Plastic Pollution on Human Life

XIV. Economic Impact:

a) **Plastic Industries:** One of the first steps in curbing plastic pollution should be to ban plastic in the market. However looking at the present growth rate of the material, it is not going to be an easy task. The *Indian plastic industry* is among the fastest *growing* industries in India[59].This growth is a direct result of the increased plastic consumption around the world which is expected to increase from 12 million tonnes to 20 million tonnes by 2020. However in such a case, any ban of plastic would not only result in loss of revenue but loss of livelihoods of those depending on the manufacturing units. In the case of Maharashtra, according to the Plastic Industries, the state-wide plastic ban, including carry-bags and thermocol will result in a loss of up to Rs 15,000 crore which also includes a GST loss of Rs 800 crore and more than 4 lakh jobs in around 2,150 manufacturing units in the state[60]. The most affected will be the SME players who produce plastic products worth Rs 50,000 crore. At present, plastics contribute about 35 per cent to the State's GDP. However since most of the states including Maharashtra does not provide its citizens with an alternative, due to which plastic is still being widely used. Similarly in Delhi, the ban plastic came into effect on January 1, 2017. Yet one of the major reasons why the ban is ineffective till date is that the Delhi Government has not yet passed any law or guidelines regarding the plastic ban[61].

a) **Tourism Industry**: The tourism industry on the other hand is the largest service industry in India, with a contribution of 6.23% to the National GDP and providing 8.78% of the total employment. However, many tourist activities can have environmental effect which includes plastic pollution, which can result in lost revenue from tourism. In severe cases, marine debris can even cause beach closures. The costs to remove and dispose of such plastic debris can be high and the loss of tourism can be even higher. For instance, as a part of a state-wide beach cleanup drive, the Maharashtra Maritime Board (MMB) has ensured the removal 8,382 tons of trash from 72 beaches along the Konkan coastline under MMB's project Nirmal Sagar Tat Abhiyan which is a coastal protection and management program with a total of Rs 4 crore invested for the project, and beaches in the state were divided into A category beaches, Rs15 lakh to B and Rs10 lakh to C on the basis of their footfall (population visiting these beaches)[62].

[59] In the last 70 years, 8.3 billion tonnes of plastic have been produced.

[60] https://www.thehindubusinessline.com/news/national/plastic-ban-industry-stares-at-loss-of-15000-cr-and-3-lakh-jobs/article24246393.ece

[61] https://swachhindia.ndtv.com/delhi-plastic-ban-poor-implementation-means-plastic-still-commonly-used-5986/

[62] https://www.hindustantimes.com/mumbai-news/heading-to-the-beach-these-are-the-10-most-polluted-beaches-in-maharashtra/story-RPlRqhQSSb5JhlfNIsHKVK.html

XV. Health Impact:

There are different ways in which that plastic is dangerous for humans. For instance, direct toxicity from plastics comes from lead, cadmium, and mercury. These toxins have also been found in many fish in the ocean, which is ultimately very dangerous for humans who eat them. Diethylhexyl phthalate (DEHP) contained in some plastics, is a toxic carcinogen. Other toxins in plastics are directly linked to cancers, birth defects, immune system problems, and childhood developmental issues. Other types of toxic plastics include BPA or health-bisphenol-A (often used in food and beverages containers, such as water bottles) along with phthalates. Further the polymer chains of BPA breaks down and enters the human body in many ways from drinking contaminated water to eating food that is exposed to the broken down toxins. Specifically, BPA can harm the human hormonal function[63].

- According to a new study, high amount of plastic micro particles were found in the flesh of fish eaten by humans .According to the team of scientists from Malaysia and France discovered at least 36 tiny pieces of plastic in the bodies of 120 mackerel, anchovies, mullets and croakers which could be released into people's bodies after they ate the fish. The plastics found included nylon, polystyrene and polyethylene[64]. Several studies indicate a similar situation of fishes in India.[65] For instance, according to a 2015 study on commercial fish species sourced from three reservoirs in the Cauvery Delta, found high level unsafe iron, zinc, lead and chromium, among other metals, in the fish. The study concluded that the concentration of metals in the fish suggested a risk for humans (S.Dhanakumar 2015). In another study, the shrimp collected from the Subarnarekha River that flows through Jharkhand West Bengal, and Odisha, was found to be contained with heavy metals in concentrations. (Soma Giri 2014).Heavy metals aren't the only toxic contaminants people might be ingesting along with their fish. A 2016 study on fish collected in Hyderabad was also found to be contaminated with polychlorinated biphenyls (PCBs) that if eaten, could lead to a lifetime cancer risk (Bhatnagar 2016).

- Apart from fish, major study conducted by micro-plastic researcher Sherri Mason reveals that the world's leading brands of bottled water are contaminated with tiny plastic particles that are likely seeping in during the packaging process. Around 250 bottles of water across Brazil, China, India, Indonesia, Kenya, Lebanon, Mexico, Thailand and the United States were tested in which plastic was identified in 93% of the samples, which included major name brands such as Aqua, Aquafina, Dasani, Evian, Nestle Pure Life and San Pellegrino. The plastic debris included nylon, polyethylene terephthalate (PET) and polypropylene, which is used to make bottle caps[66].

[63] https://serc.carleton.edu/NAGTWorkshops/health/case_studies/plastics.html
[64] https://www.independent.co.uk/environment/plastic-microparticles-fish-flesh-eaten-humans-food-chain-mackerel-anchovy-mullet-a7860726.html
[65] https://www.huffingtonpost.in/dushyant-krishnan-/some-of-the-fish-you-eat-in-india-can-make-you-very-sick_a_23363223/
[66] https://www.hindustantimes.com/health/90-bottled-water-brands-contaminated-globally-says-report/story-v8NXUsXCL8inIjrC1WiA1I.html

Also as per scientists, recycling plastic also has a major impact on human health. According to their research hazardous chemicals such as lead can easily enter into food-contact items and other everyday products because manufacturers are using recycled electrical equipment as a source of black plastic[67]. Apart from human health, there can be harmful to the marine and coastal environment either through the spread of the products as litter or as micro-plastics.

Sanitary waste disposal is a serious concern in India because the plastic used in these napkins are not bio-degradable and lead to health and environmental hazards. According to the National Family Health Survey (NFHS) 2015-16, around 48% rural women an 77% urban women today use sanitary napkins. Recent data provided by Menstrual Health Alliance India around 45% of the total household garbage, primarily consists of sanitary napkins[68]. However, in a recent interview, Swati Singh Sambyal, Waste Management Manager of Centre for Environment Science said,

"*Most of the sanitary napkins in India are just thrown in the garbage or flushed down the toilet. It is havoc environmental challenge as these pads take around 500-800 years to biodegrade. And every used sanitary napkin carries two grams of non-biodegradable plastic. So the amount of non-biodegradable plastic accumulated every month is very high, a factor strong enough to raise concern over the crisis which environment is facing currently".*

[67] http://www.dnaindia.com/science/report-how-recycling-is-causing-harmful-chemical-to-appear-in-everyday-items-2620306
[68] https://www.hindustantimes.com/fitness/plastic-based-sanitary-pads-are-not-only-harmful-to-the-environment-but-also-your-body/story-Kk4wrI6QOyJCkP7bwEh0rI.html

Part V

Way Forward

Plastic is used in everyday life in many forms, often providing functionality that cannot be easily or economically replaced by other materials. Plastic products have brought benefits to society in terms of economic activity, jobs and quality of life. However the present condition- the excess use of plastic has in developing and emerging countries has now become a major concern as it can contains hazardous chemicals and also attracts and concentrates other chemicals. Presently, plastic is polluting our oceans, depleting wildlife, and damaging our health. According to the Toxics Link study 2014, the reasons behind the increased use is twofold: first, the easy availability and cost-effectiveness of plastic carry bags, particularly those dealing with perishables like vegetables and meat; and, second, the low level of consumer awareness of the environmental problems created by plastic waste[69]. According to scientists of National Institute of Oceanography (NIO), "*Resolving the plastic debris problem is important. Solutions to the plastic debris can only be achieved through combination of actions*"[70]. Actions include enforcement of legislation against marine pollution by plastics, accentuate recycling, find alternate to the current plastic products and clean-up the existing debris. Similarly, also highlighted in the UN 2018 report, in order to tackle the roots of the problem, it is essential for the governments to improve waste management practices and introduce financial incentives to change the habits of consumers, retailers and manufacturers, enacting strong policies that push for a more circular model of design and production of plastics. Further apart from effective law, efforts by the government, such as Swachh Bharat Mission, Smart Cities scheme etc that were supposed to curb the growing hazards caused by plastic by implementing effective alternatives have failed to do so. ‘

- Some of the States have however taken steps to utilize these excess plastic into something useful. For instance, according to scheme was started in 2017 called “Suchitwa Sagaram”, or “Clean Sea” in Kerala fishermen are trained to collect the plastic and bring it back to shore. As a result, fisherman have managed to remove 25 tonnes of plastic from the Arabian Sea, including 10 tonnes of plastic bags and bottles, according to a UN report[71]. Further, whatever plastic waste reaches the shore is then collected by people from the local fishing community and fed into a plastic shredding machine. This shredded plastic is finally, converted into material that is used for road surfacing. Similarly in 2002, the Jambulingam Street was one of the country’s first plastic roads in Chennai. There are more than34, 000 kilometres of plastic roads in India, mostly in rural areas, with approximately half of them in the southern state of Tamil Nadu[72]. These roads are not only cost-effective, but also help create employment opportunities to those involved in constructing these roads.

[69] https://www.epw.in/journal/2018/24/editorials/plastic-calamity.html
[70] https://www.firstpost.com/world/reduce-reuse-and-recycle-scientists-suggest-novel-way-to-curb-marine-pollution-by-plastics-2642834.html
[71] https://www.unenvironment.org/news-and-stories/story/fishing-plastic-sea
[72] https://theprint.in/governance/keralas-fishermen-are-making-roads-out-of-plastic-collected-on-sea/76815/

- Sikkim too, in 1998 became the first Indian state to ban disposable plastic bags. Recently in 2016, it banned the use of packaged drinking water in government offices and government events and the use of Styrofoam and thermocol disposable plates and cutlery in the entire state in a move to cut down toxic plastic pollution and tackle its ever-increasing garbage problem. Apart from this, the state has a system of buying back plastic from consumers.

Environmental Concerns in India
Section two: Deforestation

Part I
Background

The ecological, social, and economic importance of forests in any country like India cannot be overstated. First, in the midst of a raging air pollution crisis, forests act as large scale carbon sinks, removing carbon dioxide from the atmosphere and storing it as leaves, stems and roots. Second, there are a large number of forest dwellers in India who depend on forests for livestock grazing, collection of fire wood, agriculture, non-timber forest products, and other subsistence needs. Thirdly, Indian forests are known for their complex floral and faunal biodiversity. According to the C.P.R. Environmental Education Centre, India has about 8 percent of the world's biodiversity on 2 percent of the earth's surface, making it one of the 12 mega-diversity countries in the world. Of about 1.75 million species globally identified, around 1, 26, 188 species have been reported so far from India.[73]

In this context, the loss of natural forests in India is particularly troubling; being one of the most significant challenges India has been facing for many decades. Government data shows that over the years large areas of forest lands have been lost to industrial and other projects granted clearance by the Ministry of Environment, Forests and Climate Changed (MoEF&CC). On the other hand, the biennial State of Forest Reports – released by the Forest Survey of India (FSI), an organisation under the MoEFCC – have repeatedly shown only marginal improvement in the total forest cover across the country. The post-independence Forest Policy of 1952 recommended that India brings 33% of its total geographic area under natural forests.[74] However, the reports show the mark to have hardly gone anywhere near 22 per cent. Multiple research findings by environment experts – including studies in the Eastern Ghats, Sikkim Himalayas, Teesta River Basin, etc. – indicate that the reduction of forest lands in India is a matter of huge concern.[75]

Part II.
Key Issues

(i) Causes of Forest Loss

Deforestation is caused due to multiple factors, which include expansion of farming land, logging and fuel wood, overgrazing, mining, industry, etc. In terms of India, however, the most important factor has been the commercialisation of forests as a result of post-independence economic strategy that reserved forests for industrial use. Haeuber (1993) argues that this economic strategy emphasised industrial demand over other demands and productive uses of forest resources and virtually all forest resources were reserved for industrial use.[76] This rings true when one looks at the case of Jharkhand. Chakravarty et al. (2012: 9) note how "massive

[73] http://www.cpreec.org/pubbook-threat.htm
[74] http://www.fao.org/docrep/ARTICLE/WFC/XII/0729-C1.HTM
[75] https://india.mongabay.com/2018/05/15/reports-say-forest-cover-decreasing-contrary-to-government-claims/
[76] https://www.jstor.org/stable/4192258?origin=JSTOR-pdf&seq=1#page_scan_tab_contents

and unchecked mining of coal, iron ore and bauxite in Jharkhand ... caused large scale deforestation and created a huge water scarcity."[77]

Data shows that industrial projects have been one of the major reasons for decreasing forest cover. According to data compiled by the with *e-Green Watch*, during the years 2001-2017, a total of 9,48,552 hectares of forest lands were lost to over 18,000 projects – including industry, mining, encroachments, etc. – which were granted clearance under the Forest Conservation Act (see Table 1).[78] An analysis of the same data undertaken by *Indiaspend* in 2016 showed that since the 1980s, forests close to 15,000 sq kms had been lost to 23,716 industrial projects and encroachments. During this period, of the total forests cleared, the largest area was given over to mining (4,947 sq km), followed by defence projects (1,549 sq km) and hydroelectric projects (1,351 sq km), according to data from the Compensatory Afforestation Fund Management and Planning Authority (CAMPA).[79]

Table 1: Forest Land Diverted during 2001-2017 under the FCA (hectares)

Year	Total Land Diverted across states and UTs	Total number of Projects under FCA
2017	7,824.132	429
2016	2,972.764	278
2015	8,504.605	279
2014	25,847.677	626
2013	22,675.235	814
2012	20,397.169	925
2011	24,404.303	1,450
2010	60,599.2	1,625
2009	1,18,206.183	1,635
2008	76,751.552	1,628
2007	89,073.728	1,638
2006	2,51,126.393	1,865
2005	54,737.576	1,491
2004	52,527.144	955
2003	23,298.524	678
2002	44,772.225	864
2001	64,840.009	923
TOTAL	**9,48,552 (app.)**	**18,103**

Source: e-Green Watch

[77] https://cdn.intechopen.com/pdfs/36125/InTechDeforestation_causes_effects_and_control_strategies.pdf
[78] http://egreenwatch.nic.in/FCAProjects/Public/Rpt_State_Wise_Count_FCA_projects.aspx
[79] http://www.indiaspend.com/cover-story/23716-industrial-projects-replace-forests-over-30-years-82665

(ii) Stagnant Growth of Forest Cover: What the data shows

Every two years, the Forest Survey of India (FSI), an organisation under the Ministry of Environment, Forest and Climate Change (MoEFCC), releases 'State of Forest Report,' the aim of which is to assess the country's forest resources by providing state/district wise data on forest cover of the country and the changes thereon compared to the previous years.

A data analysis of the last 17 years shows that the growth of both forest cover and tree cover in the country has remained more or less stagnant.[80] Forest Cover refers to all lands more than one hectare in area, with a tree canopy density of more than 10 percent irrespective of ownership and legal status. Such lands may not necessarily be a recorded forest area. It also includes orchards, bamboo and palm.[81] Tree Cover refers to the estimated area comprising of tree patches, which are less than one hectare and isolated trees outside the recorded forests.[82]

The forest cover is further classified in terms of canopy density classes:

a) **Very Dense Forests (VDF)**: forests with tree canopy density of 70 per cent or above

b) **Moderately Dense Forests (MDF)**: forests with tree canopy density between 40 per cent and 70 percent

c) **Open Forests (OF)**: forests with tree canopy density between 10 per cent and 40 per cent

d) **Scrub**: degraded forests with tree canopy density of less than 10 per cent

e) **Non Forests (NF)**: any area not included in the above categories

During 2001-2017, the forest cover increased merely by 0.99 percentage point while tree cover by 0.37 percentage points, a combined increase of 1.36 percentage points (see Table 1). Meanwhile, the share of MDF in the total forest cover saw a decline of 3 percentage points.

[80] Difference between forest cover and tree cover
[81] https://data.gov.in/keywords/forest-and-tree-cover
[82] http://fsi.nic.in/isfr2017/isfr-tree-cover-2017.pdf

Table 2: Total Forest and Tree Cover during 2001-2017 (%)

Year	VDF (a)	MDF (b)	OF (c)	**Total Forest Cover (A=a+b+c)**	**Tree Cover (B)**	**Total Forest and Tree Cover (C=A+B)**
2017	2.99	9.38	9.18	**21.54**	**2.85**	**24.39**
2015	2.61	9.59	9.14	**21.34**	**2.82**	**24.16**
2013	2.54	9.70	8.99	**21.23**	**2.78**	**24.01**
2011	2.54	9.76	8.75	**21.05**	**2.76**	**23.81**
2009	2.54	9.71	8.77	**21.02**	**2.82**	**23.84**
2005	1.66	10.12	8.82	**20.60**	**2.79**	**23.39**
2003	1.56	10.32	8.76	**20.64**	**3.04**	**23.68**
2001	12.68[83]		7.87	**20.55**	**2.48**	**23.03**

Source: The India State of Forest Reports, Ministry of Environment, Forest, and Climate Change

State/UT-level data shows us that between 2005 and 2017, there was just 2.62% increase in the all India forest cover. Many states – especially north-eastern states of Arunachal Pradesh, Nagaland, Tripura, Mizoram – saw large scale reduction of forest cover, offsetting the gains achieved in the other states.

[83] Till 2001, dense forests were not divided into 'very dense' and 'moderately dense.'

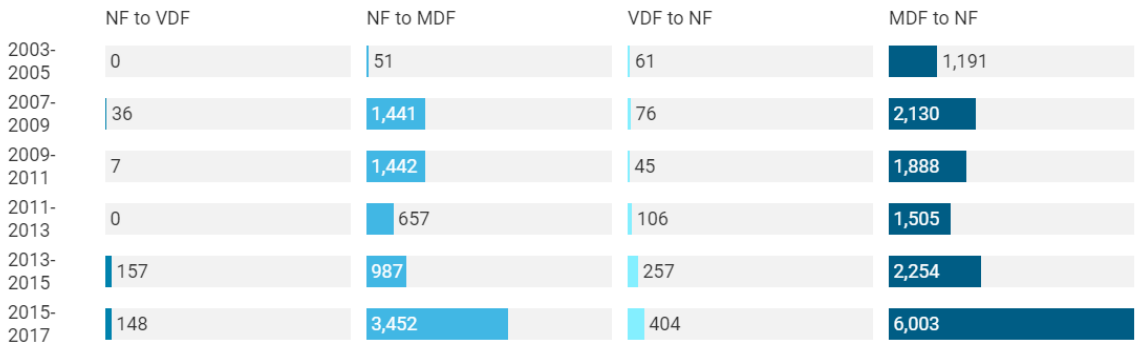
Table 3: State/UT-wise forest cover changes between State of Forest Report 2005 and India State of Forest Report 2017 (sq. kms)

State/UT	2005 Forest Cover	2012 Forest Cover	Change
Andhra Pradesh & Telangana	45,231	48,566	3,335
Arunachal Pradesh	67,472	66964	-508
Assam	27,758	28105	347
Bihar	6,807	7299	492
Chhattisgarh	55,929	55547	-382
Delhi	177	192.41	15
Goa	2,156	2229	73
Gujarat	14,604	14757	153
Haryana	1,604	1588	-16
Himachal Pradesh	14,666	15100	434
Jammu & Kashmir	22,689	23241	552
Jharkhand	22,722	23553	831
Karnataka	36,200	37550	1,350
Kerala	17,284	20321	3,037
Madhya Pradesh	77,739	77414	-325
Maharashtra	50,661	50682	21
Manipur	16,952	17346	394
Meghalaya	17,205	17146	-59
Mizoram	18,600	18186	-414
Nagaland	13,665	12489	-1,176
Orissa	48,755	51345	2,590
Punjab	1,660	1837	177
Rajasthan	16,012	16572	560
Sikkim	3,357	3344	-13
Tamil Nadu	23,314	26281	2,967
Tripura	8,173	7726	-447
Uttar Pradesh	14,346	14679	333
Uttarakhand	24,493	24295	-198
West Bengal	12,970	16847	3,877
A & N Islands	6,663	6742	79
Chandigarh	17	21.56	5
Dadra & N. Haveli	216	207	-9
Daman & Diu	6	20.49	14
Lakshdweep	26	27.1	1
Puducherry	42	53.67	12
Grand Total	**690,171**	**708,273**	**18,102**

Source: Lok Sabha

An analysis of available data for 2003-2017 by Amita Bhaduri reveals even worrying details. During these years, 14,971 sq km of MDF and 949 sq km of VDF (15,920 dense forests in total) were converted into NF (see Table 2). For VDF and MDF, 42% and 40% of this conversion took place respectively in 2015-17 alone.[84]

Table 3: Conversion of Forest Classes during 2003-2017



Source: Amita Bhaduri, India Water Portal

(iii) Flawed Definition of 'Forest Cover': What the data does not show

An assessment of the adequate forest cover over the years requires an adequate definition of what exactly constitutes forest cover. However, experts argue that the present definition, which defines forest cover as any area more than one hectare in size that has more than 10% green canopy, includes not only natural forests, but also plantations like tea and coffee gardens, orchard, etc.[85] This conflation of natural forests with plantations is seriously flawed owing to fundamental differences between the two. Natural forests grow without human intervention, constitute a mixture of species and are thus rich in biodiversity. On the other hand, plantations in most cases might be monoculture and harbour comparatively lesser biodiversity. This fundamental difference has been highlighted by many scholars. According to Taki et al. (2011), any replacement of natural forests with plantations may have adverse effects on biodiversity conservation and restoration."[86] Matz (2003) argues that

[84] http://www.indiawaterportal.org/articles/centre-fails-see-wood-trees
[85] https://scroll.in/article/868606/hold-the-celebrations-marginal-increase-in-indias-forest-cover-is-masking-massive-deforestation
[86] https://www.nature.com/articles/srep00132

plantations cannot offer the same degree of ecological and environmental functions and services as can natural forests.[87] Thus, plantations and natural forests cannot be kept on the same level.

This conflation is also counterproductive since it neutralises the loss in the former with gains in the latter. Ravindranath et al. (2012) argues that while India experienced significant forest loss during 2005-2009, the total area estimates reported by the FSI actually showed a gain of 1.49 m ha for the same. Further, if one were to subtract plantations from total forest cover, India's native forests were actually declining at the rate of 0.8% to 3.5% per year for 2000–05.[88]

This flawed definition also prevents us from holding the government accountable since it can claim an increase in the forest cover – even though marginal – as a success when the increase might be in plantations. For instance, the marginal 0.99% increase was celebrated by the Environment Minister Harsh Vardhan as a success in the context of the global trend of decreasing forest cover during the last decade.[89] Data in Table 2 shows that this increase can partly be attributed to the massive conversion of 3,452 sq km of NF to MDF. This conversion in unlikely unless it has taken place in plantations, since two years is too less a time for non forest areas to grow into dense forests with canopy density of 40-70 per cent.

(iv) Impact: Climate Change and Livelihoods

As per the FSI, forests have a key role to play in mitigating climate change by sequestering and storing more carbon than any other terrestrial ecosystem and thus acting as an important natural 'brake' on climate change.[90] A loss of forest cover thus has negative implications in terms of climate change. As Archana K. (2013) argues, one of the consequences of deforestation is the release of carbon – held in forests – into the atmosphere, either immediately if the trees are burned, "or more slowly as un-burned organic matter decays." Out of the total biomass initially held in forests, "only a small fraction ... ends up stored in houses or other long-lasting structures." Adding to this, small amounts of methane and carbon monoxide may also be released with decomposition or burning.[91]

This assumes significance in the light of India's increasing annual carbon emissions. According to data published by the Netherlands Environment Assessment Agency, at 4.7 per cent, India saw the second largest absolute increase in CO2 emissions in 2016. In contrast, Russia and the US managed to decrease their emissions

87 https://books.google.co.in/books?id=br0SGSdkCv4C&pg=PA88&dq=differences+between+natural+forest+and+plantation+monoculture&hl=en&sa=X&ved=0ahUKEwi2pLup1v_bAhVFVisKHYYWBWQQ6AEIMjAC#v=onepage&q=differences%20between%20natural%20forest%20and%20plantation%20monoculture&f=false

88 http://admin.indiaenvironmentportal.org.in/files/file/REDD%2B.pdf

89 https://www.thehindu.com/sci-tech/energy-and-environment/indias-forest-tree-cover-up-by-1-in-2-years-centre/article22732640.ece

90 http://fsi.nic.in/isfr2017/isfr-carbon-stock-in-india-forest-2017.pdf

91 http://www.iosrjournals.org/iosr-jestft/papers/vol4-issue2/D0422428.pdf

by 2 per cent, Japan by 1.3 per cent, and both Brazil and the UK by 6 per cent.[92] Further, according to estimates of the CICERO Center for International Climate Research in Norway, India's CO2 emissions grew by an estimated 4.6 per cent in 2017, indicating virtually no change as compared to the previous year.[93]

Further, according to Majra et al (2009), countries like India, owing to their geographic location, are considered to be particularly vulnerable to climate change. A large number of people in rural areas "directly depend on climate-sensitive sectors (agriculture, forests, and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods."[94] This population is anywhere between 275 million to 300 million, if not more,[95] living in 1.73 lakh villages located in and around forests

Moreover, for many tribal communities, minor forest produce are a chief source of cash income. The tribal population of the country, as per 2011 census, is 10.43 crore, constituting 8.6% of the total population. 89.97% of them live in rural areas and 10.03% in urban areas.[96]

Table 4: State/UT-wise distribution of tribal population (Census 2011)

S. No.	State/UT	Population	Percentage of State/UT population to total population
1	Jammu & Kashmir	1493299	11.9
2	Himachal Pradesh	392126	5.7
3	Uttarakhand	291903	2.9
4	Rajasthan	9238524	13.5
5	Uttar Pradesh	1134273	0.6
6	Bihar	1336573	1.3
7	Sikkim	206360	33.8
8	Arunachal Pradesh	951821	68.8
9	Nagaland	1710973	86.5
10	Manipur	1167422	40.9
11	Mizoram	1036115	94.4
12	Tripura	1166813	31.8
13	Meghalaya	2555861	86.1
14	Assam	3884371	12.4

[92] http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2017-summary-trends-in-global-co2-and-total-greenhouse-gas-emissions-2983.pdf
[93] https://www.carbonbrief.org/guest-post-why-indias-co2-emissions-grew-strongly-in-2017
[94] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2822161/#CIT4
[95] http://www.moef.nic.in/sites/default/files/redd-bk3.pdf
[96] https://tribal.nic.in/ST/StatisticalProfileofSTs2013.pdf

15	West Bengal	5296953	5.8
16	Jharkhand	8645042	26.2
17	Odisha	9590756	22.8
18	Chhattisgarh	7822902	30.6
19	Madhya Pradesh	15316784	21.1
20	Gujarat	8917174	14.8
21	Daman & Diu	15363	6.3
22	D&N Haveli	178564	52.0
23	Maharashtra	10510213	9.4
24	Andhra Pradesh (including Telangana)	5918073	7.0
25	Karnataka	4248987	7.0
26	Goa	149275	10.2
27	Lakshadweep	61120	94.8
28	Kerala	484839	1.5
29	Tamil Nadu	794697	1.1
30	Andaman & Nicobar	28530	7.5

Further, the forest dwelling tribal population depends on Minor Forest Produce (MFP) – such as bamboo, canes, fodder, leaves, gums, etc. – for both subsistence consumption and cash income through sale. Nearly 75% MFPs are collected from the six States of Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa, Jharkhand and Andhra Pradesh.[97]

[97] https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/8874/ANNAMALAI_0973.pdf?sequence=1&isAllowed=y

Table 4: Economically Important Minor Forest Produce

Seasons	MFPs collected	Economy
January-March	Lac (resin), *mahuwa*, flower and tamarind	Over 75 per cent of tribal households in Orissa, Madhya Pradesh and Andhra Pradesh collect mahuwa flower and earn Rs.5000 a year. 3 million people are involved in lac production.
April-June	Tendu leaves, sal seeds and chironji	30 million forest dwellers depend on seeds, leaves and resins from sal trees; tendu leaf collection provides about 90 days of employment to 7.5 million people, a further 3 million people are employed in bidi processing
July-September	Chironji, mango, mahuwa fruits, silk cocoons and bamboo	10 million people depend on bamboo for livelihood; 1,26,000 households are involved in tussar silk cultivation only
October-November	Lac, kullu gum, resins used in incense sticks	3 lakh person days of employment from collection of gums.

Source: Annamalai Venkatraman, National Institute for Rural Development

These forest dwellers – along with dry land farmers, forest dwellers, fisher folk, and nomadic shepherds, have, according to Majra et al, a very low adaptive capacity. In this context, a loss of forest cover has a dual impact on both the natural ecosystem as well as the socio-economic system.

(v) Desertification

According to *State of India's Environment 2017: In Figures*, a book published by the Centre for Science and Environment and *Down To Earth* magazine, nearly 30 per cent of India is degraded or facing desertification. Of India's total geographical area of 328.72 mha, 96.4 mha is under desertification. In eight states—Rajasthan, Delhi, Goa, Maharashtra, Jharkhand, Nagaland, Tripura and Himachal Pradesh—around 40 to 70 per cent of

land has undergone desertification. Additionally, 26 of 29 Indian states have reported an increase in the area undergoing desertification in the past 10 years.[98]

The United Nations Convention to Combat Desertification (UNCCD) – one of the three conventions in the 1992 Rio Earth Summit – defined desertification as "land degradation in arid, semi-arid, and dry subhumid areas [drylands] resulting from various factors, including climatic variations and human activities."[99] Desertification, along with climate change and the loss of biodiversity, was identified as one the greatest challenges to sustainable development during the Rio Summit.[100]

Desertification is said to be a result of multiple interwoven variables. Some argue that it is majorly a result of inherent biophysical features of drylands. Phillips (1993: 631) argues that "the fundamental characteristics of dryland environmental systems ... are a major contributor to desertification" as opposed to "local or regional factors."[101] This lens sees desertification as an inevitable, natural process. Others argue that anthropogenic factors, based on human intervention, are primarily responsible for desertification. Westing (1994), for instance, argues that utilisation of land beyond sustainability leads to land degradation, and ultimately, desertification.[102] Long-term loss of natural vegetation or deforestation counts as one of the many anthropogenic factors responsible for desertification.[103]

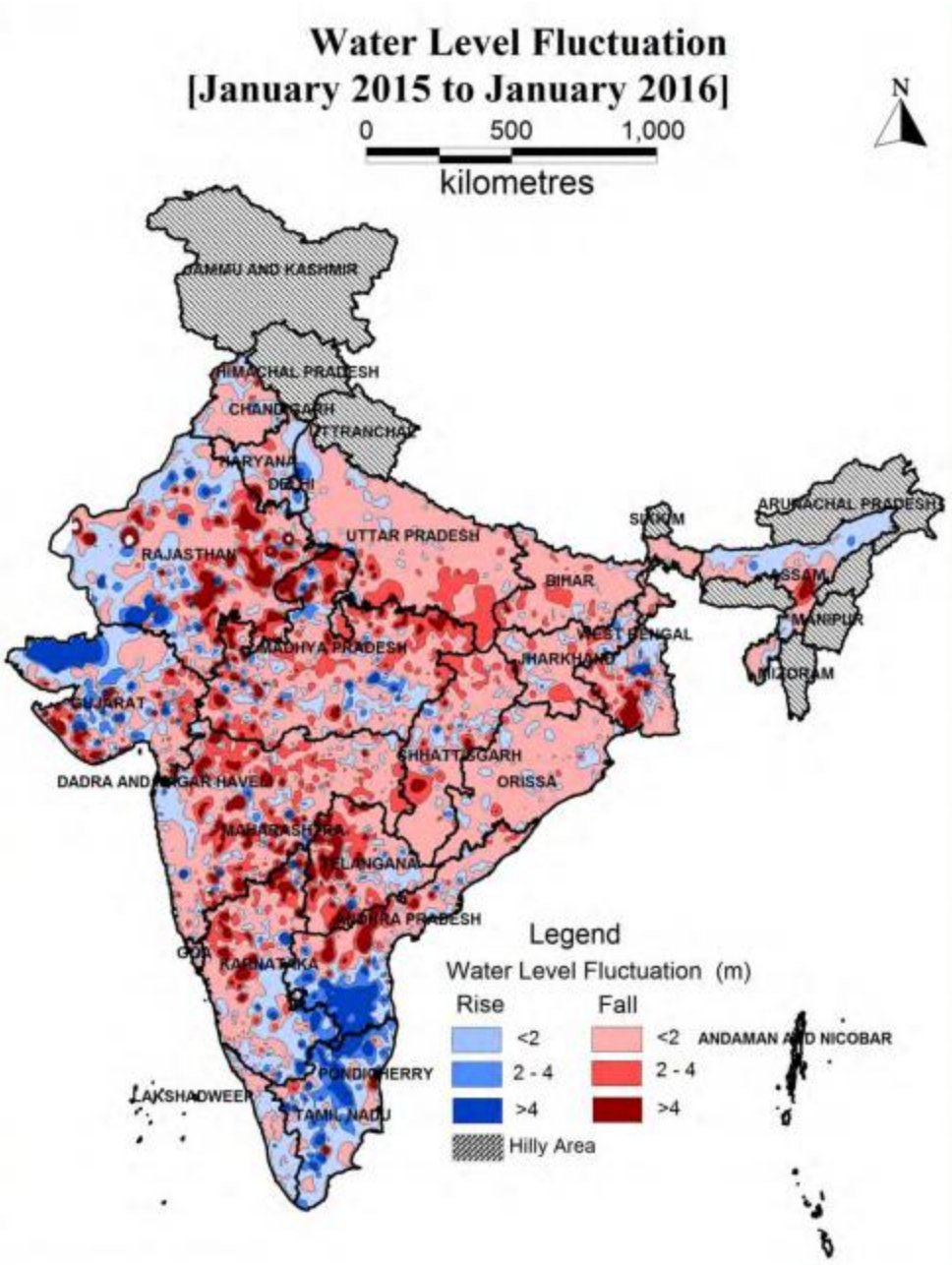
Desertification presents a significant cause of concern for India. As per the fourth edition of the World Water Development Report (WWDR4), 'Managing Water under Uncertainty and Risk,' desertification plays a significant role in weakening groundwater tables. The landscape modifications resulting in desertification tend to worsen soil erosion, thereby reducing the soil's capacity to allow water to percolate in the event of a rainfall. In a scenario where desertification leads to a reduction in groundwater recharge, "accelerated and often rampant exploitation of underground water reserves frequently occurs to meet socio-economic needs, leading to gradual depletion of groundwater and increased water scarcity."[104]

These issues are important since India's groundwater usage is the highest in the world. According to 2012 estimates, India uses an estimated 230 cubic kilometers of groundwater per year – over a quarter of the global total – while more than 60 percent of its irrigated agriculture and 85 percent of drinking water supplies are dependent on groundwater.[105]

Additionally, there has been a nationwide trend of receding ground water tables. The CGWB monitoring report for 2016 revealed that between January 2015 and January 2016, merely 3% wells registered a rise in water level

[98] https://www.downtoearth.org.in/news/desertification-has-increased-in-90-per-cent-of-the-indian-states-58057
[99] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=402
[100] http://publications.gc.ca/Collection-R/LoPBdP/BP/bp317-e.htm
[101] https://www.jstor.org/stable/2563596?seq=1#page_scan_tab_contents
[102] https://www.ncbi.nlm.nih.gov/pubmed/12289925
[103] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=402
[104] http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/wwdr4-2012/
[105] http://www.worldbank.org/en/news/feature/2012/03/06/india-groundwater-critical-diminishing

exceeding 4 metres. Out of 13244 wells analysed, only 35% showed any rise while 64% showed a fall in water level.



The report further gives a comparison of depth to water level of January 2015 to January 2014 in the form of water level fluctuation map (see figure 1). The data is worrying, as it shows that in general there is fall in water level in almost the entire country, barring only a few states such as Assam, Andhra Pradesh, Gujarat, Kerala, Karnataka, Rajasthan and Tamil Nadu. Rise in water level in isolated pockets is observed in the states of Madhya Pradesh, West Bengal, Haryana, and Maharashtra. While fall in the range of more than 2 m is prevalent in all the states in small patches, fall of more than 4 m is prominent in the states of Andhra Prdesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Telangana and West Bengal.[106]

Part III
Way Forward

As noted, although the causes of deforestation are manifold, the most significant in terms of India is the commercialisation of forests for development and industrial use. Therefore, it is important for the government to recognise that market-friendly reforms which involve forest lands should be undertaken keeping in mind the larger social and environmental interests.

It was the recognition of the latter that culminated into the 2006 Forest Rights Act, so that forest-dwelling Scheduled Tribes (FDSTs) and other forest dwellers play an active role in the governance and management of forests. But the role of the gram sabhas under the FRA was undermined through the Compensatory Afforestion Fund Act (CFA), 2016, which does not categorically provide for the consent of the gram sabhas to be sought for implementing afforestation projects and other development works in forest lands. Until the policy-making process is decentralised till the level of the actual stakeholders, environmental clearances for development projects will always supersede the interests of the local. Thus, it is important that the CFA be amended to provide for the necessary consent of the gram sabhas for undertaking industrial and other projects in forest areas.

Secondly, the government should recognise that plantations cannot be an alternative to natural forests. The loss of the latter cannot be compensated by the former. Therefore, it is important for the government to clearly delineate the contours to define 'forest cover' in the FSI reports, excluding plantations from this definition. According to Jean-Philippe Puyravaud et al. (2010), the FSI uses automated algorithms to analyse satellite imagery, which fails that fails to distinguish native forests from tree plantations.[107] Newer methods and better technology needs to be developed by the government to ensure maximum precision while identifying forest cover and reliable data is available to formulate policies for better protection of our forests.

Thirdly, experts argue that water management practises, community participation, and sustainable and climate smart agricultural practices are the major ways to prevent desertification.[108] It is important to note India became

[106] Pg 8, http://cgwb.gov.in/Ground-Water/GW%20Monitoring%20Report_January%202016.pdf
[107] https://onlinelibrary.wiley.com/doi/full/10.1111/j.1755-263X.2010.00141.x
[108] https://www.downtoearth.org.in/news/one-of-the-biggest-threats-to-the-environment-desertification-explained-60305

a signatory to UNCCD on 14 October 1994, ratified it on 17 December 1996 and is thus committed to become land degradation neutral by 2030. This has been reiterated several times by the present government after coming into power in 2014. Responsibilities of the signatories include adopting sustainable land management practices to ensure sustainable productivity of land resources, along with undertaking restoration and reclamation interventions on degraded lands.[109] Although India has multiple policies – such as National Forest Policy 1988; Forest (Conservation) Act 1980; Environment (Protection) Act 1986; National Policy for Farmers 2007; etc. – that enable provisions to address these problems, it still lacks a single, coherent legislative or policy framework to combat desertification.

In this direction, it might be helpful to look at China's 'Law of Prevention and Control of Desertification,' which was introduced in 2002. The law provided a legal framework for the implementation of China's National Action Programme to Combat Desertification, and numerous projects aimed at restoring land at risk. The Law stipulated which activities are prohibited on land experiencing or threatened by desertification, and provided for the creation of reserves where all activities that damage vegetation are prohibited. Further, it provides the legal basis for establishing a system of cost-benefit incentives to encourage land rehabilitation by land-users.[110]

The law helped China reverse the expansive trend of desertification – with the desertified area reportedly shrinking by an annual average of 1,980 square km in the 2010-2014 period as compared to 1,717 square km for the 2005-2009 period and 1,283 square km for 2000-2004.[111] In fact, China's attempts at combating desertification were reportedly lauded by environment minister Harsh Vardhan.[112] Therefore, as suggested by Dr Mansour N'Diaye, Chef de Cabinet, UNCCD, the government might want to consider formulating an anti-desertification programme that gives more legal teeth to the UNCCD.[113]

Although in the long run, the repercussions of reduced forest cover will be felt across the country – including the effects of climate change, reduced quality of air, land degradation, loss of groundwater, etc. – the worse hit would inevitably be the forest dwellers, one of the most socially and economically marginalised sections of the society. Therefore, the environmental impact of deforestation has an intrinsic human impact and thus is linked to the question of social justice. This makes it imperative for both the central and state governments to work together towards expanding forest cover and protecting the constitutional rights of forest dwellers dependent on the forest ecosystem.

[109] http://envfor.nic.in/division/unccd-india
[110] https://futurepolicy.org/healthy-ecosystems/biodiversity-and-soil/chinas-law-of-prevention-and-control-of-desertification/
[111] http://www.xinhuanet.com/english/2017-06/17/c_136373287.htm
[112] https://timesofindia.indiatimes.com/business/india-business/india-loses-23-ha-of-dryland-to-drought-desertification-per-minvardhan/articleshow/63900364.cms
[113] https://www.thehindu.com/opinion/interview/desertification-is-nearly-as-critical-as-climate-change/article3540067.ece

Environmental Concernsin India
Section three: Water Crisis

Part I
Background

India has 4% of the world's total ground water reserves. Despite this,the country has been experiencing a sustained water crisis over the years with little indication of it abating. TheWorking Group II report of the Fourth Assessment of the Intergovernmental Panel on Climate Change designated India as a 'water stressed region' with current utilisable freshwater standing at 1122 cubic meter (cu. m) per year.[114] The same report indicated that as demand in India increases further, utilizable freshwater will fall below the international standard of 1000 cu m per year and per capita. In India, the major sources of water are the rivers and lakes around which different ecological regions are based. The country is drained by twelve major river systems with a number of smaller rivers and streams but it is pertinent to note that there exists a considerable temporal and spatial variation within the country with respect to water availability. For instance, the Ganga-Meghna-Brahmaputra basin covers a land area of 33 per cent and accounts for 60 percent of India's water resources, while the rivers flowing westward only covers 3 per cent of the land area and accounts for 11 per cent of the country's water resources. Therefore, 71 per cent of India's water resources are available to only 36 per cent of the area while the remaining 64 per cent of the population has 29 per cent available.[115] This results in obvious disparities with several regions experiencing annual floods while others are subjected to prolonged droughts. However, apart from the constraints arising out of topographic and distribution pattern, there are several other factors that have together culminated in creating a water starved region.

Why is there a water crisis?

Since the flow in India's rivers is heavily dependent on monsoons, the rainy season is when these rivers are at its annual peak. The northern rivers with sources in the Himalayas see an additional upsurge during the spring snowmelt. However, these natural resources are fast depleting due to the change in climatic patterns. This often results in a paltry monsoon rainfall in many areas along with rapidly declining glaciers and shrinking snow capped mountains.[116] Unpredictable rainfall patterns have led to a repeated cycle of droughts and water shortages. In early October 2017, water levels were 11% below average.[117] A study on 'How droughts and water shortages are hitting India' conducted by Climate Trends revealed that monsoon rain in the country has been below average in five of the last six years and pre-monsoon season has seen 11 percent less rainfall in 2018 than the average. Reservoir levels in Himachal Pradesh are 56 percent below normal for this time of the year and states like Andhra Pradesh and Karnataka have complained of insufficient water for irrigation.[118] According to the data provided by Ministry of Water Resources for changes in ground water estimate based on

[114] https://www.firstpost.com/india/world-water-day-2018-unesco-report-confirms-trouble-for-india-major-water-crisis-predicted-by-2050-4400661.html
[115] https://www.researchgate.net/publication/277479575_Water_conservation_in_India_An_Institutional_perspective
[116] https://economictimes.indiatimes.com/news/politics-and-nation/india-stares-at-water-crisis-urgent-steps-needed-experts/articleshow/63828947.cms
[117] http://202.159.215.252:83/DocumentUploadRoot/DocumentId_13604/05.10.2017_CWC_Bull.pdf
[118] https://drive.google.com/file/d/11IQ2lnvt-QONLlZ9M-DYJNyL7vOsCGcL/view?usp=sharing

monitoring by the Central Ground Water Board (CGWB), **levels of water fell in 8,785 wells (60.7%), rose across 5,609 wells (38.8%), and showed no change in 71 (0.5%)**[119].

Glaciers are also melting at a faster rate. On the other hand, unpredictable monsoons due to global warming have led to drying up of the existing water resources or flooding, worsening the supply of water. **A 2014 report published by the Indian Space Research Organisation (ISRO) says that between 2001 and 2011, the Himalayas lost 0.2 per cent of its glaciers. Another study, published in the same year, by the Diwecha Centre for Climate Change estimates that in 40 years the Himalayas lost about 13 per cent of its glaciers, equivalent to about 443 billion tonnes of ice**.

India's water crisis can also be largely attributed to the industrialisation and human waste flowing into water sources and polluting groundwater as well as rivers and seas. The indiscriminate use of rivers in many areas for disposal of sewage and industrial waste has rendered these rivers non-potable, resulting in excessive reliance on ground water reservoirs. With rapid urbanization and industrialization along with the traditional demand for agriculture, ground water levels as well as reservoirs are already 10% lower in 2018 than in the previous years. In some states, like Himachal Pradesh, Tamil Nadu and Uttarakhand, reservoir levels are less than 50% their usual level. Recent incidents of severe water shortages in hills stations like Shimla this summer have only accentuated the magnitude and urgency of this problem.

[119] https://www.hindustantimes.com/mumbai-news/water-levels-fell-in-61-of-india-s-wells-in-last-decade-says-report-by-union-ministry/story-A7Y0uiwMv9TvL4KAR8pzAI.html

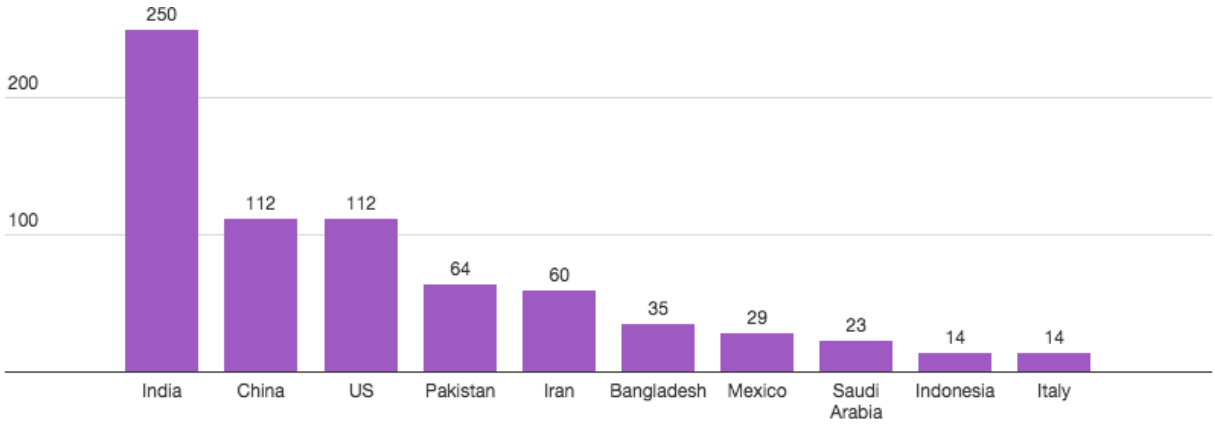
Part II
Key Issues:

I. Ground water depletion:

- **Why is there extensive depletion of ground water resources across the country?**

India's groundwater usage is the highest in the world and supplies 85 per cent of drinking water in rural areas as well as for agricultural irrigation. This implies that the country is almost completely dependent on its ground water reserves to meet its water supply demands. Increasing population and existing climate change scenario is posing a major challenge to the global fresh water resource. In India, the steady rise in population over the decades and the projected growth in the near future is a major issue while tackling water crisis arising out of low ground water resources. Already categorised as a water stressed region in terms of per capita freshwater availability and predicted as the most populous region in the world by 2024 by a UN report, the country is likely to face extreme water scarcity if ground water resources continue to deplete. India is largest user of ground water resources, much above the two most industrialised countries- China and USA.

Ground water dependence per country



Together, these countries account for 72% of the groundwater extracted annually.

- The average annual per capita water availability in 2001 and 2011 was assessed at 1,820 cubic metre (m3) and 1,545 m3, respectively. Over this period, India's population rose 17.6%, from 1.02 billion to 1.21 billion.
- By 2030, India is likely to have 600 million people living in urban areas, up from current level of about 380 million.

State-wise Depth to water Level Distribution and Percentage of Wells for the Period of January-2017

S. No.	Name of State	No. of wells Analysed	Depth to Water Level (m bgl)		Number & Percentage of Wells Showing Depth to Water Level (m bgl) in the Range of											
					0-2		2-5		5-10		10-20		20-40		> 40	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
1	Andhra Pradesh	777	0.00	49.30	163	20.98	337	43.37	207	26.6	61	7.85	6	0.77	3	0.39
2	Arunachal Pradesh	14	0.90	10.12	2	14.29	6	42.86	5	35.71	1	7.14	0	0.00	0	0.00
3	Assam	183	0.02	19.50	27	14.75	119	65.03	32	17.49	5	2.73	0	0.00	0	0.00
4	Bihar	626	0.00	13.25	61	9.74	393	62.78	166	26.52	6	0.96	0	0.00	0	0.00
5	Chandigarh	12	2.72	41.01	0	0.00	3	25.00	2	16.67	3	25.00	3	25.00	1	8.33
6	Chhattisgarh	658	1.00	44.00	17	2.58	239	36.32	331	50.30	59	8.97	11	1.67	1	0.15
7	Dadra & Nagar Haveli	13	0.95	8.88	1	7.69	8	61.54	4	30.77	0	0.00	0	0.00	0	0.00
8	Daman & Diu	11	1.90	6.83	1	9.09	5	45.45	5	45.45	0	0.00	0	0.00	0	0.00
9	Delhi	108	1.20	58.94	8	7.41	18	16.67	26	24.07	29	26.85	17	15.74	10	9.26
10	Goa	60	1.04	14.15	9	15.00	25	41.67	21	35.00	5	8.33	0	0.00	0	0.00
11	Gujarat	833	0.01	59.30	49	5.88	211	25.33	316	37.94	192	23.05	61	7.32	4	0.48

- The water available may decline to 1,341 m3 and 1,140 m3 by 2025 and 2050, respectively, according to a 2013 report by the ministry of environment and climate change.[120]

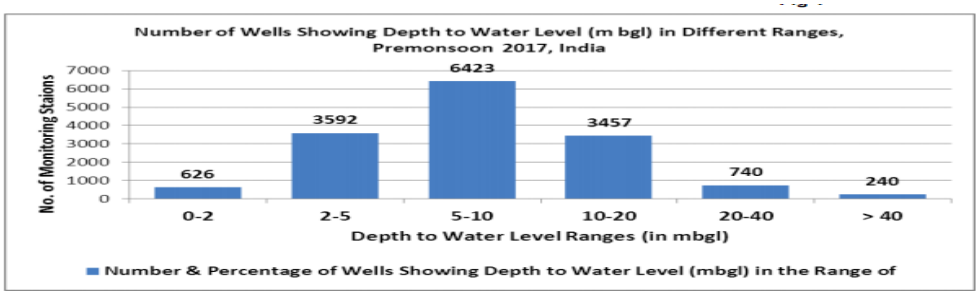
[120]http://mowr.gov.in/writereaddata/nwfl1268291020.pdf

S. No.	Name of State	No. of wells Analysed	Depth to Water Level (m bgl)		Number & Percentage of Wells Showing Depth to Water Level (m bgl) in the Range of											
					0-2		2-5		5-10		10-20		20-40		> 40	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
12	Haryana	240	0.89	50.86	6	2.50	26	10.83	42	17.50	59	24.58	76	31.67	31	12.92
13	Himachal Pradesh	88	0.51	27.90	16	18.18	36	40.91	19	21.59	11	12.50	6	6.82	0	0.00
14	Jammu & Kashmir	231	0.61	34.25	41	17.75	109	47.19	58	25.11	14	6.06	9	3.90	0	0.00
15	Jharkhand	158	0.56	16.50	6	3.80	69	43.67	74	46.84	9	5.70	0	0.00	0	0.00
16	Karnataka	1426	0.07	30.70	106	7.43	409	28.68	585	41.02	309	21.67	17	1.19	0	0.00
17	Kerala	1465	0.10	40.00	119	8.12	421	28.74	650	44.37	248	16.93	27	1.84	0	0.00
18	Madhya Pradesh	1332	0.52	46.81	47	3.53	367	27.55	598	44.89	279	20.95	37	2.78	4	0.30
19	Maharashtra	1665	0.01	50.20	134	8.05	637	38.26	664	39.88	203	12.19	25	1.50	2	0.12
20	Meghalaya	6	0.54	4.84	2	33.33	4	66.67	0	0.00	0	0.00	0	0.00	0	0.00
21	Nagaland	4	1.04	8.26	1	25.00	2	50.00	1	25.00	0	0.00	0	0.00	0	0.00
22	Odisha	1175	0.30	18.10	132	11.23	729	62.04	299	25.45	15	1.28	0	0.00	0	0.00

S. No.	Name of State	No. of wells Analysed	Depth to Water Level (m bgl)		Number & Percentage of Wells Showing Depth to Water Level (m bgl) in the Range of											
					0-2		2-5		5-10		10-20		20-40		> 40	
			Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
23	Pondicherry	4	1.63	5.45	1	25.00	2	50.00	1	25.00	0	0.00	0	0.00	0	0.00
24	Punjab	777	0.75	60.50	16	2.06	95	12.23	181	23.29	221	28.44	257	33.08	7	0.90
25	Rajasthan	1002	0.06	122.10	126	12.57	142	14.17	177	17.66	184	18.36	166	16.57	207	20.66
26	Tamil Nadu	619	0.60	67.98	32	5.17	159	25.69	233	37.64	161	26.01	25	4.04	9	1.45
27	Telangana	599	0.00	69.40	46	7.68	208	34.72	213	35.56	103	17.20	24	4.01	5	0.83
28	Tripura	9	1.24	5.67	3	33.33	4	44.44	2	22.22	0	0.00	0	0.00	0	0.00
29	Uttar Pradesh	790	0.00	43.20	50	6.33	304	38.48	270	34.18	138	17.47	27	3.42	1	0.13
30	Uttarakhand	38	1.62	29.25	2	5.26	14	36.84	10	26.32	11	28.95	1	2.63	0	0.00
31	West Bengal	653	0.42	25.87	43	6.58	310	47.47	201	30.78	81	12.40	18	2.76	0	0.00
Total		15576			1267	8.13	5411	34.74	5393	34.62	2407	15.45	813	5.22	285	1.8

- The tables above indicate that while the depth of grounds water levels in the wells substantially varies from state to state, the noticeable trend of water levels in northern eastern states especially in Tripura and Meghalaya has been in the range of 0-2 m bgl.
- Apart from Rajasthan, Haryana and Delhi, no other state recorded a water table above 40 m bgl. Despite fast depleting ground water reserves due to excessive usage for irrigation and other agriculture related activity, these areas have shown considerable improvement in maintaining their water reserves.

Water level ranges in wells across the country



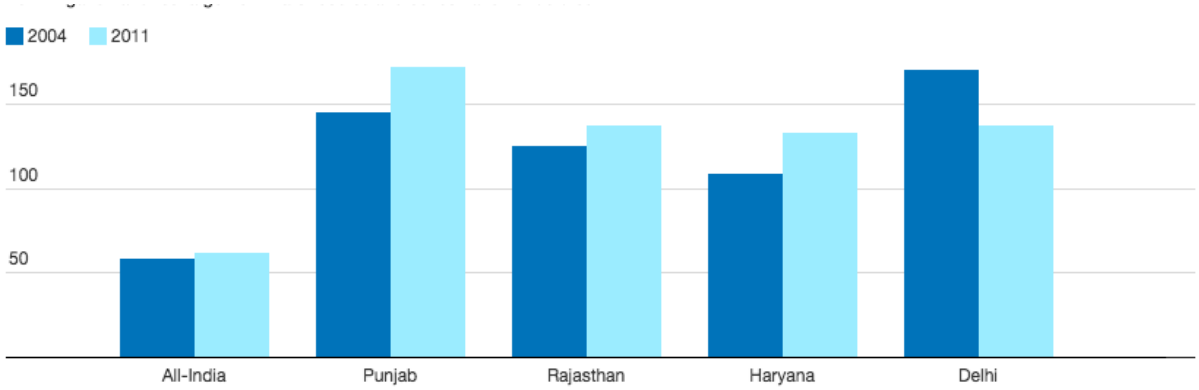
Source: http://cgwb.gov.in/Ground-Water/GW%20Monitoring%20Report_PREMONSOON%202017.pdf

The ground water level data for January 2016 indicate that:

- Out of the total 14974 wells analysed across the country, 1371(9 %) wells are showing water level less than 2 m bgl (metres below ground level)
- 4958 (33%) wells are showing water level in the depth range of 2-5 m bgl
- 5342 (36 %) wells are showing water level in the depth range of 5-10 m bgl
- 2498 (17%) wells are showing water level in the depth range of 10-20 m bgl
- 607(4%) wells are showing water level in the depth range of 20-40 m bgl
- The remaining 198 (1 %) wells are showing water level more than 40 m bgl.[121]

[121] http://cgwb.gov.in/Ground-Water/GW%20Monitoring%20Report_PREMONSOON%202017.pdf

Usage of ground water in agriculture



Source: http://www.niti.gov.in/writereaddata/files/document_publication/2018-05-18-Water-index-Report_vS6B.pdf

- **Impact of declining ground water**

What this implies is that the pressure on water, both for producing more food, feed and fibre as well as for rising urbanization and industrial activity, will be tremendous indicating the widening gap between demand and availability of water. In a recent OECD study on global water risk hotspots, India's north-western region has already been identified as one among the three top most water risk hotspots in agricultural production, the others being north eastern China and south western USA. **Out of the 4 per cent share of global freshwater availability in India, almost 78 cent share of water is consumed by the agriculture sector.**[122] Demand for groundwater is dominated by agricultural irrigation, yet the industry is relatively water inefficient. Government policies of power subsidies and irrigation equipment credits for farmers, while acting as an enabler of India's agricultural growth, have contributed to the overexploitation of groundwater. Against this backdrop, ensuring optimum water productivity for sustainable growth in agriculture is essential is conserving ground water reserves.

In addition to the sustainability issue, inequity in irrigation water use among crops across the country has left a little more than half of Indian agriculture still dependent on rainfall. Government policy to address this issue is politically sensitive. Any cuts to agricultural subsidies may reduce groundwater wastage from a purely economic perspective, but will likely target rural Indians who already suffer greatly from water insecurity. Despite these socio-political implications, India's unsustainable groundwater extraction requires demand-side measures to regulate usage. An improvement in irrigation technology and a shift towards efficient crops in overstressed areas are important measures to reduce demand for groundwater in agriculture.

[122] http://www.niti.gov.in/writereaddata/files/document_publication/2018-05-18-Water-index-Report_vS6B.pdf

II. Water pollution and ground water quality in India

In addition to scarce supply, water quality is a serious threat. Rivers and streams have borne the brunt of the recent urban explosion in India, a nation whose population has nearly doubled in the last 40 years to 1.35 billion. Unplanned growth has led to the use of water bodies as dumping grounds for sewage and industrial effluent.

- **Pollution in surface level water sources**

According to India's Central Pollution Control Board, 63% of the urban sewage flowing into rivers (some 62 billion litres a day) is untreated. In addition, riverbanks, wetlands and floodplains have been claimed over time by infrastructure, slums, offices, and housing developments – all of which has narrowed natural river channels and distorted flow, greatly reducing the ability of India's rivers to buffer flooding.[123] The Central Pollution Control Board (CPCB) has established a network of monitoring stations on rivers across the country. The present network is comprising of 870 stations in 26 States and 5 Union Territories spread over the country. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 189 Rivers, 53 Lakes, 4 Tanks, 2 Ponds, 3 Creeks, 3 Canals, 9 Drains and 218 Wells. Among the 870 stations, 567 are on rivers, 55 on lakes, 9 on drains,12 on canals, 4 on tank, 3 on and creeks,2 on pond and 218 are groundwater stations. The monitoring of water quality at 257 stations is being done on monthly basis, 393 stations on quarterly basis, 216 on half yearly basis and 4 stations on yearly basis. The monitoring results obtained under the programme indicate that organic pollution continues to be the predominant pollution of aquatic resources. The organic pollution measured in terms of bio-chemical oxygen demand (BOD) & coliform count gives the indication of extent of water quality degradation in different parts of India and it reveals that rivers and lakes located in the northern part of the country for instance the Yamuna is highly concentrated with pollutants while the contaminants in east and south, although lesser than the northern rivers have steadily increased over the years. [124]

Data of total 222 CWC water quality sites was analysed across the country and it was found that water quality at 67 locations is beyond the permissible limit.Out of the 67 sites surveyed-

- 14 sites show BOD more than 30 mg/l, falling under severely polluted
- 12 sites show BOD between 10-30 mg/l which also signifies substantial pollution
- 30 sites show BOD 3-10 mg/l
- Other 11 sites are also polluted showing BOD range above the permissible level.[125]

- **Large scale pollution of major rivers**

More than half the major rivers in India are polluted, with the developing economic power unlikely to meet demand for fresh water from its still-growing population unless dramatic measures are taken, a new report by

[123]https://scroll.in/article/869330/as-india-struggles-to-clean-up-its-polluted-urban-rivers-ecological-and-economic-costs-are-mounting
[124]https://unstats.un.org/unsd/environment/envpdf/pap_wasess5a2india.pdf
[125]http://cgwb.gov.in/GW-Assessment/gec.html

government scientists has found. **An assessment by the CPCB reveals that the number of rivers defined as "polluted" in India has more than doubled in the last five years, from 121 to 275**. A primary cause is the quantity of sewage generated by cities and towns along polluted stretches according to the CPCB's report.

A report by WHO stated that the pollution of waterways in Delhi is was six times the WHO's recommended maximum, 12 times US standards and more than twice the level considered safe by Indian authorities. The report found 13 of the world's 20 most-polluted cities to be in India and highlighted its severe impact on the country's waterways with vast quantities of municipal and industrial waste discharged into them every day.[126]

The Ganga flows through densely populated areas of India. Among the big industries located on the banks of Ganga River, 86 are in Uttar Pradesh, three are in Bihar and 43 are in West Bengal. The waste of 29 big cities having population of more than one lakh and 23 medium cities having population ranging between 50,000 to one lakh situated on the banks of river is routinely drained into the Ganga. In most of these cities, there is no sewerage system. Chemical pollutants from waste coming out of the industrial units situated on banks of the river also mix with the water, thus contaminating the water as well as destroying the aquatic habitat. I**n Uttar Pradesh, 59 out of the 86 industries are leather industries, which dispose off poisonous chemicals in heavy quantities. Poisonous industrial wastes including acid, alkaline, sulphate, nitrate etc. also directly mix in the Ganga without any treatment.** Thus, on an average, among the pollutants mixing in Ganga, 80 per cent is domestic waste and 20 per cent is industrial waste. Domestic waste generation especially in the urban areas like Kolkata and the waste of nearby textile industries, paper industries, tanneries etc. is disposed off in rivers too, leading to a systematic destruction of the river ecosystem.

The cost of the damage to India's rivers was made painfully clear in December 2015, when Chennai experienced severe rainfall that overwhelmed its river and canal network. The region's small rivers had been extensively manipulated over the years and had lost their floodplains to urban development, according to a study by CareEarth Trust.[127] Multiple studies have decried the systematic destruction of the Mithi, pointing to a host of assaults. One satellite study found that from 1966 to 2005 the width of the Mithi was reduced by almost 50 percent, while mudflats had shrunk by 70 percent.

- **Contamination of ground water reserves**

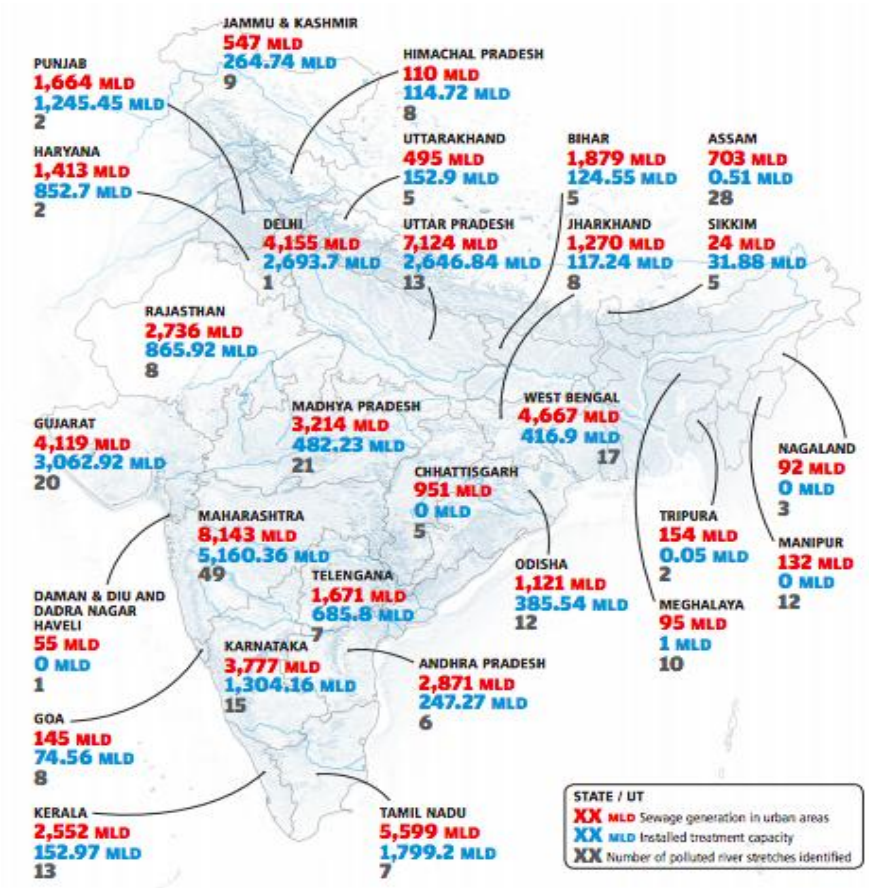
India's groundwater reserves are not only overexploited and 60 percent vulnerable, but also contaminated. The parliamentary report stated that deep-level groundwater is contaminated by sewage, fluoride, arsenic, and uranium. Incidence of arsenic contamination, as measured by number of affected habitations, doubled between 2013 and 2016. The quality of ground water has been compromised and aquifers are in a critical condition across the country.[128]Over-exploitation or stressed aquifers cause a higher concentration of pollutants in groundwater resources and regions with stressed aquifers are generally more susceptible to water quality

[126]https://www.theguardian.com/world/2015/apr/07/half-india-rivers-polluted-new-government-report
[127]http://careearthtrust.org/flood/
[128]http://www.futuredirections.org.au/publication/indias-groundwater-crisis-consequences-unsustainable-pumping/

problems. As ground water contamination is usually the result of over use for irrigation purposes, it is likely that these are concentrated in provinces with large populations and high agricultural productivity, thus adversely affecting agricultural output.

Water in shallow aquifers is generally suitable for use for different purposes and is mainly of Calcium bicarbonate and mixed type. However, other types of water are also available including Sodium-Chloride water. The quality in deeper aquifers also varies from place to place is generally found suitable for common uses. However, recent trends of sample ground water obtained have been found unsuitable for usage due to various contaminations mainly because of geogenic reasons. The main ground water quality problems in India are as follows-

- **Inland salinity**: Inland salinity in ground water is prevalent mainly in the arid and semi arid regions of Rajasthan, Haryana, Punjab and Gujarat. Inland salinity is also caused due to practice of surface water irrigation without consideration of ground water status. The gradual rise of ground water levels with time has resulted in water logging and heavy evaporation in semi arid regions lead to salinity problem in command areas
- **Coastal salinity**: Coastal aquifers have boundaries in contact with seawater and are always under dynamic equilibrium with it. Withdrawal of fresh ground water from these aquifers lead to inequilibrium resulting in intrusion of saline water in coastal aquifers.



Sewage generation in urban area vis a vis treatment capacity

- As can be seen from the representation above, almost all the states generate more sewage in the urban areas than they have the capacity to treat. Installed treatment capacity is far lesser than is required to manage the amount of waste generated.

- The general trend of pollution in water bodies reveal that the rivers in North and Central India are more contaminated than the ones in the rest of the country Assam in the North east and Kerala in South also accounts for the some of the largest polluted river stretches in the country.

Part III
Impact of water crisis

As India stares at an intensifying water crisis, a cascade of negative effects is set off. There will be adverse implications for India's food, water, energy, environment, and health sectors. Nearly half of the country is employed in the agricultural sector and if the current trends continue, by 2030 nearly 60% of Indian aquifers will be in a critical condition. This means that some 25% of the agriculture production will be at risk, aggravating India's employment situation. Apart from economic implications, the political and health factors must also be considered while analysing the impact of such a crisis.

- **Interstate water conflicts**

In many states, poor water management, inefficient irrigation systems and weak government planning have exacerbated the water shortage situation. Major reservoirs in Gujarat began running dry in early 2018 and the Narmada river which is the main source of water in the state, was at its lowest level in 13 years, despite heavy rainfall last year. The government announced that water could not be used for irrigation.[129] Across the state, reservoir water levels were 40% below normal in May 2018. In Andhra Pradesh, water levels in major reservoirs are around half their normal level and parts of the state are facing a drinking-water crisis. The government is spending Rs 103 crore to provide emergency drinking water.[130] This crisis is linked with water shortages in neighbouring Telangana.[131]

[129] http://www.thehindu.com/news/national/other-states/summer-of-discontent-water-crisis-looms-in-gujarat/article23357979.ece
[130] http://www.newindianexpress.com/cities/vijayawada/2018/may/04/rs-10382-crore-to-combat-potable-water-shortage-in-andhra-pradesh-1810007.html
[131] http://www.thehansindia.com/posts/index/Telangana/2018-04-27/Water-crisis-stares-at-Telangana-AP/376951

With water conservation rates and access to water varying vastly from state to states (the north Indian states have reported a faster rate of water depletion and deterioration over the last decade due to over exploitation for agricultural purposes while conservation of water is relatively more complex in the south), the political consequence of the changing dynamics regarding water sharing has been the intensified and more frequent interstate water conflicts especially among the southern states where topography makes conservation and retention of water more difficult. The Cauvery river dispute where both Karnataka and Tamil Nadu has been contesting the proportion of water division and the water sharing between the states is a prime example of such emerging volatile conflicts. Areas in proximity to the Krishna river, Andhra Pradesh, Telangana, Karnataka and Maharashtra continue to be entangled in a dispute despite two legal verdicts on water division. India has also been involved in water sharing disputes with China and Nepal especially over the diversion of the waters of the Brahmaputra which serves as a lifeline to the people in Northeast.

- **Shrinking access to clean water**

WaterAid report in 2016 ranked India among the worst countries in the world for the number of people without safe water. **An estimated 76 million people in India have no access to a safe water supply, and the situation is only getting more serious. The Asian Development Bank has forecast that by 2030, India will have a water deficit of 50 per cent.** The Union Ministry of Water Resources has estimated the country's current water requirements to be around 1100 billion cubic metres per year, which is estimated to be around 1200 billion cubic metres for the year 2025 and 1447 billion cubic metres for the year 2050.[132]

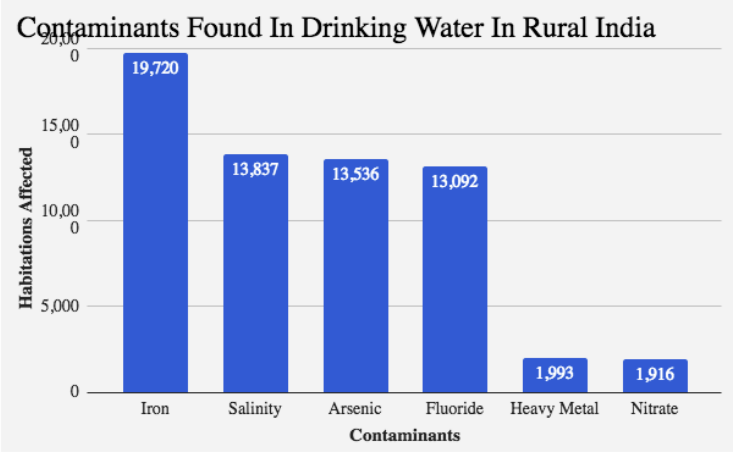
- **Impact on health and sanitation**

According to a government report on access to clean water published in 2017, the goal is to provide 90% rural households with piped water and 80% of rural households with household taps by 2022. **Only 26.9 million out of 167.8 million households (16%) in rural India have piped water.** Of 1.7 million rural habitations provided drinking water under the National Rural Drinking Water Programme, **1.3 million (77%) habitations are fully covered**–i.e, having at least 40 litres per capita per day (LPCD) **330,086 (19.3%) habitations are partially covered** (safe water is available but below 40 LPCD) and **64,094 (3.73%) are "water-quality affected habitations**" in the rural areas as on March 15, 2017, according to this answer to the Rajya Sabha on March 20, 2017.[133]**The alarming condition of water quality is based on the fact that the lack of clean drinking water has put over 11.5 million people of India at a high risk of a bone crippling disease, fluorosis**. The ministry of health and family welfare has identified 19 states which are severely affected by high fluoride content in drinking water, and at least 10 states suffering from arsenic contamination causing Arsenicosis – a disease that affects the lungs, skin, kidneys, and liver due to arsenic poisoning.

- **Untreated waste water**

[132]https://swachhindia.ndtv.com/76-million-dont-have-safe-drinking-water-indias-looming-water-crisis-5606/
[133] Unstarred Question no. 1943, Rajya Sabha, 2017

Apart from access to safe drinking water and piped water for household purposes, contamination and over-extraction of ground water is also emerging as a serious challenge.Groundwater is an essential component of India's water security, not only due to of its predominance in drinking water and agricultural irrigation, but as a "buffer" water resource. It will be increasingly important as monsoon rainfall patterns become more unpredictable due to the effects of climate change.India's untreated wastewater also has serious water security and health implications. Almost 80 per cent of the scarce water supplied to households turns into wastewater, while only ten per cent is adequately treated. Wastewater pollutes the waterways and groundwater sources that India relies on for drinking water. **According to the World Bank, 21 per cent of communicable diseases in the country are related to unsafe water and as such contamination of these sources directly impacts the health of millions in the country.**[134]



Source: http://cgwb.gov.in/WQ/GROUND%20WATER%20QUALITY%20SCENARIO%20IN%20INDIA.pdf

- **Displacement and large scale migration**

Apart from the political and economic fallouts, the human cost of water shortage is also one aspect that needs to be considered. Migration and displacement due to environmental concerns have significantly increased in the last decade with people fleeing their homes in search of better access to basic needs like water. About 330 million people were affected by the drought in 2015-16. Water shortages are frequently cited as a major factor for farmer suicides with the highest numbers of suicides in the drought-hit states of Maharashtra, Telangana and Karnataka.[135]

[134]http://www.futuredirections.org.au/publication/indias-groundwater-crisis-consequences-unsustainable-pumping/
[135] http://www.thehindu.com/news/national/karnataka/successive-droughts-a-main-reason-for-frequent-bouts-of-farm-suicides/article17763648.ece

Part IV
Government response

The problem of water scarcity cannot be analysed and solved in isolation. Like several other affected natural resources, depleting water availability is also directly attributed to the systematic destruction of the ecosystem and it has to be viewed in the context of the larger problem of climate change, industrialisation, pollution etc. India's huge groundwater-dependent population, uncertain climate-reliant recharge processes of natural water resources and indiscriminate land use changes with urbanization are among the many factors that have contributed towards creating a situation of water scarcity and hence the policy response should aim to cover all perspectives.

The Ministry of Water Resources has adopted various initiatives and established institutions dedicated to water conservation and management. The table below gives a brief outline of these commissions and their role-

Institution	Role
Central Water Commission	Initiating and coordinating schemes for the conservation and utilisation of water resources in the country in collaboration with state governments; and monitoring water quality
Central Ground Water Board	Developing and disseminating technology related to sustainable use of ground water; monitoring and implementing policies for the sustainable management of ground water resources; estimating ground water resources
Central Ground Water Authority	Constituted under Section 3(3) of the Environment (Protection) Act, 1986 to regulate and control development and management of ground water resources; can resort to penal actions and issue necessary regulatory directives
Central Pollution Control Board	Implementation of the Water (Prevention and Control of Pollution) Act, 1974 which seeks to restore water quality

Sources: Ministry of Water Resources; Lok Sabha Question 2157, March 10, 2015; PRS.

NAPCC: The National Climate Change Action Plan (NAPCC), submitted in 2008, was the first policy document that recognised the need to incorporate glaciers into water budgeting and policy. The government has also failed to take substantive steps to salvage the shrinking glaciers and have not even conducted a survey of the number of glaciers, the total area they cover, and the total volume of water stored in them. Attempts to establish a national centre for the study of climatic changes and its impact on the mountainous zones have also not materilaised. The failure in incorporating glaciers in policy can partly be attributed to a disconnect between different departments and ministries in the government.

The NAPCC also mentions about the promotion of the National Water Mission through its platform and states that it will "ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states".[136]

[136]http://nwm.gov.in/

Namami Gange: Soon after forming government, the National Democratic Alliance (NDA) declared cleaning of the Ganga a priority. An umbrella programme Namami Gange was created in 2015 and a budget of Rs 20,000 crore was allocated for 2015-2020 and the cleaning of the river and its tributaries started. Namami Gange was even given a status of an authority in 2016.

In August 2017, data from MOWR shows that around 163 projects were sanctioned under Namami Gange, to cover all the ongoing and new initiatives. Out of 163 projects, only 41 projects have been completed so far. Crores of rupees have been devoted for cleaning rivers under the Centre's National River Conservation Plan (NRCP), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart Cities Mission programmes of the Ministry of Urban Development and the "Namami Gange" under Ministry of Water Resources, River Development and Ganga Rejuvenation (MOWR).[137] Till March 2017, around Rs 7,000 crores was spent only for cleaning the Ganga, as noted in an order of the National Green Tribunal.[138]

National Water Policy: The National Water Policy, first introduced in 1987, has been periodically updated by the government to manage water resources. The main emphasis of the latest National Water Policy, 2012 has been to treat water as economic good which the ministry claims to promote its conservation and efficient use. However this was viewed as commodification of water by many and criticism from various quarters reflected a unanimous disapproval of this approach. The government's lethargic attitude towards the issue has left the draft National Water Policy Bill 2016 in a legislative limbo.

Part V
Way forward

As the prospect of water crisis is slowly becoming a reality in various parts of India, it is pertinent for both the government and civil society to take urgent steps. Policies and measures must focus on redrawing the agricultural map of the country and developing methods to switch over to more efficient water practices including drip irrigation. The following steps, also recommended by the Standing Committee on Water Resources in 2015, are few of the initial steps that the government can introduce[139]-

- **Ground water withdrawal for agriculture:** As levels of ground waters are fast depleting due to excessive exploitation for agriculture use as well for meeting the demands of the urban population for for activities like construction of houses, few steps that can help improve the scenario are (i) on-farm water management techniques and adoption of improved irrigation methods, (ii) implementation of 'Master Plan for Artificial

[137] http://www.downtoearth.org.in/news/cleaning-india-s-polluted-rivers-59877
[138] http://www.downtoearth.org.in/news/cleaning-india-s-polluted-rivers-59877
[139] http://www.prsindia.org/administrator/uploads/general/1455682937~~Overview%20of%20Ground%20Water%20in%20India.pdf

Recharge to Ground Water', and (iii) revamping agricultural power pricing structure, as flat rate of electricity adversely affects the use of ground water. A well-defined policy on ground water extraction should also be framed to ensure long-term sustainability.

- **Water under concurrent list of the Constitution**: Water should be shifted from state list to concurrent list so that there is consensus between the centre and states on crucial issues and a comprehensive policy can be formed. This will result in better conservation, development and management of water, including ground water.

- **Census of water bodies and installation of water meets on tube wells:** A complete survey of the water bodies around the country, water availability and its rate of decline must be conducted to have a clear idea of the ground realities. Special programs for the upkeep, maintenance and restoration of water bodies should be implemented with sufficient budgetary allocation. To regulate over-use of ground water for irrigation and drinking purposes, installation of water meters in all tube-wells should be made mandatory on the principle of 'Beneficiary Pays'. This will also result in a reduction in subsidies for farmers.

- **Contamination of ground water by industries:** As conservation and management of water cannot be handled by one agency alone, it is imperative that the Ministry of Water Resources coordinate with other bodies like Central Pollution Control Board and devise effective mechanisms to identify critically polluted areas and take steps accordingly. Steps to minimize and control the dumping of industrial waste into surface water and underground aquifers should also be taken.

Moreover, the existing legal framework derived from common law principles and judicial interpretation that recognises private property rights over water is inappropriate for the emerging status, conflicts and dynamics of water resources. The right to access to clean water as a natural resource vital to life, livelihood and environment must be acknowledged and incorporated and given legal validation. It is also imperative to regulate and improve the quality of water resources to ensure safe and adequate drinking water for everyone and thereby for the realisation of the right to water. Most importantly, stronger laws must be enacted and implemented for environment protection and to respond to contemporary challenges. [140]

[140] http://cgwb.gov.in/Documents/GEC2015_Report_Final%2030.10.2017.pdf