



Studies on the Impact of floods and droughts on GDP growth and Human Development at Local Levels in India, and to suggest the use of flood water to fulfill irrigation demands in drought prone areas

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ABSTRACT

This research aimed at investigating and examining the flood and drought levels and their frequency in India and how they negatively impact GDP growth and human development of the population in that distinct state. Potential suggestions are shared to deal with natural calamities by filtration techniques to purify flood water and the transportation of flood water to the drought affected areas. Analyzing the calamities which have occurred in the past 20 years, it has been noticed that there are ravaging impacts of floods and droughts on all aspects of human life and authors decided to explore solutions for these surging setbacks associated with them. Keeping these goals in mind, firstly the cataclysmic effects of floods and droughts in various parts of India were researched. Secondly, the most effective purification techniques out of the numerous ones present in published literature were documented and how these will be effective in the target to filter the contaminated flood water making it safe for domestic and commercial uses was highlighted. The techniques like Reverse osmosis, Mechanical filtration and Activated carbon filtration are taken into consideration in research and their pros and cons have been enumerated with respect to the types of contaminants they treat and how effective they are. The increment in the capital generated by each of these is portrayed in the form of a graph. Lastly, various methods of transportation of the filtered water from the flood affected areas to the nearby drought affected areas are discussed for the efficient utilization and circumvention of wastage of water.

KEY WORDS: Floods, droughts, GDP growth, human development, filtration of flood water, transportation of flood water, reverse osmosis, mechanical filtration, activated carbon filtration, aqueducts, container shipment, towing

1.INTRODUCTION

Agriculture being the paramount source of livelihood for approximately 58% of India's population [1] requires a great amount of water. The main aim of the study is water conservation, filtration, and transportation during natural calamities like floods and droughts in order to make water utilization simple, efficient, and cost effective. Some previously conducted studies show that the extreme floods and droughts would further increase in the 21st century because of global climate change and intensification of anthropogenic activities [2-3]. The study focuses on 3 main flood and drought prone parts of India -north India (Rajasthan and Uttar Pradesh), east India (West Bengal and Jharkhand) and south India (Tamil Nadu and Kerala). The hypothesis of the study includes altering and combining the common methods of conservation, filtration, and transportation of water to help change the agricultural outlook, thereby reducing the impact of floods and droughts in India.

Over the past decade, flood water has tremendously impacted people [4], property, and landscape with consequent economic loss of billions of dollars, along with poor access to safe drinking water with increased exposure to untreated wastewater. Contaminants like chemicals, metals, fuel, soil, pesticides, animal wastes, bacteria and other potential pollutants travel along with the flood water and infiltrate and contaminate ground water. In many places groundwater is being used for surface purposes. For this reason, it is of utmost importance to find the best way to treat this water so that it can be of domestic and commercial use. The following study aimed at studying impact of floods and droughts on GDP growth and human development at a local level in India, and to design the filtration and transportation of Flood water.

MATERIALS AND METHODOLOGY

The authors felt an immense need to analyze the potential of the current system of water preservation and to provide a reasoning on the best technique used for purification of flood water. Observations were made on the situations in India on the lines of floods and droughts and their effects on the population present there. The authors have used the method of secondary data analysis and archival study in this research.

An extensive and comprehensive research was conducted with the help of authorized documents (including Google scholar, articles from international water resource association and other reliable websites) along with all the published literature and books on the above said topic. Pre-existing data was collected from various sources and conclusions were formed based on this research.

Table 1: Major drought prone areas of India [6]

STATE	YEAR	REASON	LOSS/DEATH	POPULATION EFFECTED	EXTRA INFORMATION
<i>Tamil Nadu</i>	2016 - 2017	Subdued rainfall of the northeastern monsoon (82% decrease) Depletion of water in Kaveri River	250 farmers died	21 districts out of 32 were affected	144 farmers out of 250 died due to suicide and the other 106 due to starvation and natural causes (mainly heart attacks due to stress)
<i>Rajasthan</i>	2002 - 2003	Failure of rainfall from southwest monsoon	Approx. 90 deaths	All 32 districts were affected	Southwest monsoons accounts for 91% of Rajasthan's annual rainfall.
<i>Jharkhand</i>	2018 - 2019	Delayed onset of monsoon	20 deaths due to starvation	18 out of 24 districts were affected	Koderma, Bokaro, Chatra, Deoghar, Garhwa, Khunti and Pakur were said to have had a 40%+ decrease in annual rainfall collected which affected standing crops.
<i>Andhra Pradesh</i>	2018	Subdued rainfall	7 lakh farmers migrated to other areas	9 out of 13 districts were affected	The entire state received 32% deficient rainfall between June 2018 and April 2019, affecting the main kharif and rabi crops.
<i>Odisha</i>	2020 - 2021	Rainfall was 29% less than normal	-	26 out of 30 districts were affected	Odisha has experienced drought 8 times in the last 20 years making it a severely drought prone area.

RESULTS

3.1.1 Drought data

In the last 19 years, droughts have caused immense devastation of agriculture and food security in various states of India [5]. The data in Table 1[6] presented focuses on the time span, the cause of the drought, the losses incurred by the droughts and its effect on population and their recovery throughout the years.

3.1.2 Flood data

Over the last ten years floods have considerably increased the water levels of several states in India [5] which has created concern over crop growth and consequently food security. Floods are some of the main causes of crop destruction as they cause soil erosion by removing the top fertile layer of soil. The data presented in Table 2 [6] focuses on the time span, the cause of the flood, the losses incurred by the floods and its effect on population and their recovery through the years.

The authors studied the effects of floods and droughts on agriculture and crop growth with its economic impacts. They apprehended the lengths taken by the public to recover and how the ill effects of such natural calamities can cause or worsen mental health issues amongst farmers leading to increased psychological effects and poverty.

With this knowledge, the authors were motivated to obtain solutions to purify this water and assist farmers in their times of need to facilitate their crops which will consequently increase economic strata and GDP growth of an area, and this will improve the socio-psychological status of farmers and other damages incurred by the residents living in agricultural areas

3.2 Methods of filtration of water

Many of the deaths caused by floods may be attributed to the immoderate amount of chemical runoff, metals, sewage, fuel, soil, pesticides, animal wastes, bacteria and other potential pollutants present in the flood water which causes inevitable diseases in humans and other creatures, potentially leading to death.

In order to consume the unfiltered flood water or to use it for commercial and domestic purposes, filtration techniques have been used for centuries. Filtration is a process of removal or separation of suspended solids from the fluid. Some of the salient and most effective filtration techniques employed to treat flood water are reverse osmosis, activated carbon filtering and mechanical filtering.

In this section these 3 processes will be elucidated and their effectiveness towards treating flood water will be compared as per the available published data.

3.2.1 Reverse Osmosis-

Reverse osmosis is a purification process that uses a semi-permeable membrane to filter out unwanted molecules and large particles such as contaminants and sediments like chlorine, salt, and dirt from drinking water. Although reverse osmosis systems are complex and somewhat expensive, they are the only ones that will remove significant amounts of radioactive materials.

In this process, water is pumped in from an outside source and it's forced across a semi-permeable membrane. The contaminants are removed from the water and consequently from the membrane too. RO systems remove most contaminants except organic chemicals (such as fluoride, chlorine, and lead). This system is used in industrial water purification as well as disaster relief and produces clean and portable drinking water. The capital generated by RO systems on a yearly basis is given in Fig 1[9].

Table 2: Major flood prone areas of India [6]

STATE	YEAR	REASON	LOSS/DEATH	POPULATION EFFECTED	EXTRA INFORMATION
Uttar Pradesh	2021	Extended rainfall due to southwest monsoons	58 deaths due to severe weather	24 districts out of 75 were affected	Rainfall of southwest monsoons caused nearly 1123 villages in 18 districts to be flooded. The government deployed 353 motorboats and vehicles for search and rescue missions.
West Bengal	2017 (July-August)	Increase of water levels in the Ganga River accompanied with heavy rainfall	23 deaths	14 out of 23 districts were affected	About 11,974 hectares of land under paddy cultivation, and 23,096 hectares under vegetable cultivation had been underwater. The government had set up 311 relief camps in which 47,000 people took shelter, they set up 131 medical camps.
Kerala	2018	Heavy rainfall	483 deaths, 140 went missing	All 14 districts were affected	35 out of 54 dams increased the water levels and caused severe landslides. Over 483 people died, and 140 went missing. <i>.1,247,496 people found shelter in relief camps because of the horrible impacts of the flood.</i>
Andhra Pradesh	2016	Extended rainfall	17 deaths	4 out of 13 districts were affected	More than 17 trains were cancelled on the Chennai-Vijayawada grand trunk route as the flood overflowed on the railway track at Padugupadu and about 20 people went missing during this crisis.

3.2.2 Activated carbon filtering-

Activated carbon is an interesting substance as it absorbs the impurities in contaminated water, thus making it the only water treatment method which removes organic chemicals such as benzene and pesticides. An important note regarding activated carbon is that it has a saturation level i.e., it won't be able to absorb any more impurities at a certain threshold.

Organic compounds will stick to the activated carbon filter as contaminants are polar compounds that have attractive properties. Activated carbon filters

are extremely porous and have a very large surface area which makes them very efficient at reducing foul taste and odors and the other particles in the water.

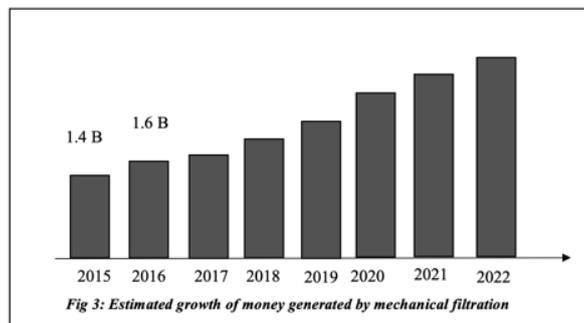
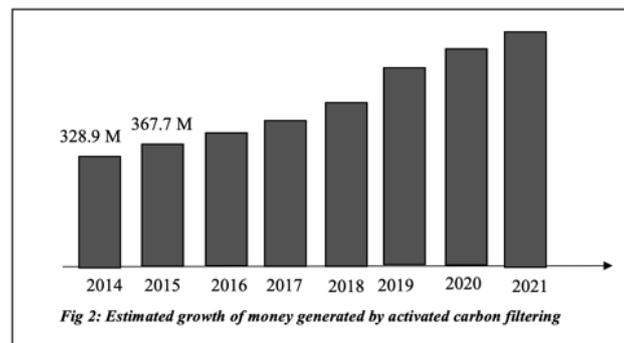
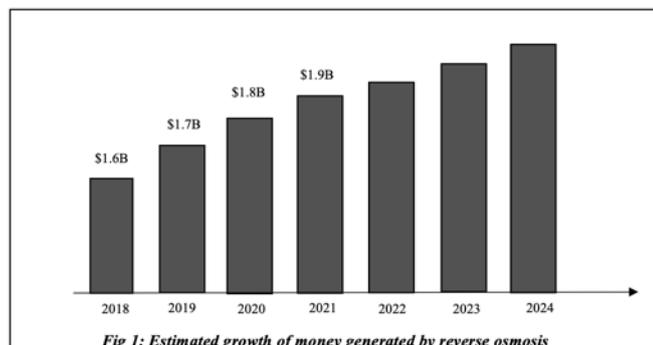
The low flow rate of the filter gives more time for the contaminants to adhere to the filter. Hence, one of the drawbacks of this process is greater time consumption. The capital generated by Activated carbon systems on a yearly basis is given in Fig 2 [9].

3.2.3 Mechanical filtration–

Mechanical filtration is based on forcing the fluid through a filter element to separate deferred solids from the liquid. This process is an up-to-date method having a modern approach and is most extensively used in industrial filtration.

This technique involves forcing the fluid through a filter element to remove or separate suspended solids from the fluid. The force is created by a pump and filter elements like cartridge filters, bag filters, porous sintered metal elements, etc. are used.

The capital generated by mechanical filtration systems on a yearly basis is given in Fig 3 [9].



3.2.4 A relative comparison of all 3 methods along with their characteristics to choose the best technique for filtration of flood water.

Analyzing this data, it has been concluded that more than one filtration technique is required to make the water potable and safe for all other purposes. Thus, to discuss findings, we will be presenting our conclusions in 2 different aspects. If water purification is required at a small scale, like filtering water for one family or for one-time consumption, methods that are portable and cheap are required. Thus, mechanical filtration followed by activated carbon filtration the optimum method. This will ensure nearly complete filtration of the otherwise harmful flood water if used for domestic and commercial purposes, especially drinking.

Table 3: Differentiation between 3 filtration techniques and their aptness to treat contaminants [Error! Reference source not found.]

Filtration techniques	PROS	CONS
Reverse osmosis	Very effective at purifying water. Treats- bacteria, parasites, protozoa, viruses, Inorganic chemicals, and some radionuclides.	Expensive and not portable. Doesn't treat- most organic chemicals.
Activated carbon filtration	One of the only systems to remove organic chemicals and it's portable. Treats- Organic chemicals and some radionuclides.	Doesn't treat- common threats like bacteria, viruses, parasites, protozoa, and inorganic chemicals.
Mechanical filtration	Portable and cheap. Treats- Bacteria, Parasites, Protozoa, Inorganic chemicals, and Viruses.	Doesn't treat- Organic chemicals and radionuclides.

On the other hand, in agricultural fields where the flood water accumulates underground and the farmers and other residents of the locality consume the groundwater (or water from wells), large scale filtration is required for this massive amount of water. Hence, we found that the use of reverse osmosis is the best option in this situation. After this it was also essential to look for a way to remove the remaining radionuclides and organic chemicals and with this apprehension, we suggest activated carbon filtration to be employed after using reverse osmosis.

3.3 Methods of transportation of water to drought prone areas

It has been noticed that some bordering states have droughts and floods. Hence, the authors suggested that the transport of filtered water from flood-affected areas to drought affected areas could be a viable and practical option. Following this, research was conducted based on the three categories of water transportation shown below:-

- 1- Aqueducts: includes pipelines, canals, tunnels and bridges. Modern aqueducts can be found in countries like Spain, Portugal, Italy, Turkey, and Israel and are used effectively. Aqueducts can be politically difficult when the water transfer distances are large. One drawback is the water diversion can cause drought in the area from where the water is drawn.
- 2- Container shipment: which includes transport by tank truck, or other large vehicles.
- 3- Towing: it is mainly used to pull an iceberg or a large water bag along behind a tugboat. When an iceberg flips, it can cause tsunamis and may even trigger an earthquake.

Table 4: Advantages of container shipment

1. Flexibility	A flexitank is a sturdy container with a large, durable and flexible bag inside which liquids can be stored in and transported in bulk.
2. Standardization	Each container is registered under a special and unique number which allows the container to be tracked easily and located if it is not following the desired path.
3. Costs	Due to advantages of standardization, container shipment offers less cost. Moving the same amount of cargo in a container is 20 times less expensive than using conventional means.
4. Speed	Container shipping networks are well-connected and shipping is much faster than regular cargo shipping even with huge amounts of water.

The major aim is to make the transportation of water fast and efficient to help the people suffering from drought. Thus, inland transport of the water by trucks or other vehicles is suggested and the methods of towing or using ships are not recommendable as the transportation is occurring between bordering states. Simultaneously, it utilizes less amount of time and it's a useful modality to deliver the water to drought affected areas. The advantages of container shipment are shown in Table 4.

Canals and bridges (although more expensive) can also be developed for the long-term solution to droughts. This is an essential step towards ensuring the wellbeing of the farmers and to reduce their economic loss by providing potable water for all purposes and to consequently improve the GDP growth.

DISCUSSION

According to this research, India is a diverse country where hydroclimatic extremes like droughts and floods take place [5-6]. It has also been established that the consumption of the unfiltered flood water will require purification techniques. Reverse osmosis systems have been proved to be the most effective in treating bacteria, parasites, protozoa, viruses, Inorganic chemicals, and some radionuclides [7]. A documented instance of the use of reverse osmosis in purifying polluted flood water was during the 2018 Kerala flood, which was the most ruinous flood in nearly a century. Hundreds scummed to death, and it had devastating impacts on the people and economy. Post-flood, the people were busy rebuilding their lives while wide-spreading diseases and contamination of water resources were some of the after-effects [8].

A water purification system that works on reverse osmosis technology, proved to be a viable solution to purify contaminated water. In Cochin, a truck took the form of a mobile water treatment plant which used RO technology, that was driven to various parts of the city. This is a valid instance which proves that reverse osmosis is an efficacious filtration technique widely regarded across the globe.

CONCLUSION

The entire world experiences natural calamities like floods and droughts. In a vast country like India, these are quite common. During floods the main issue is the transmission of diseases by the consumption of contaminated water which requires filtration for domestic and commercial uses. The best and most effective technique of filtering the water is a sequential or combined use of reverse osmosis (in the case of large-scale filtration) or mechanical filtering (in the case of small-scale filtration) and Activated carbon filtration. Any other effective technique can also be combined with these for ensuring complete purification of the flood water. During drought conditions, the main concern is the supply and transportation of safe water which can be done by inland transportation using trucks and other large vehicles.

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