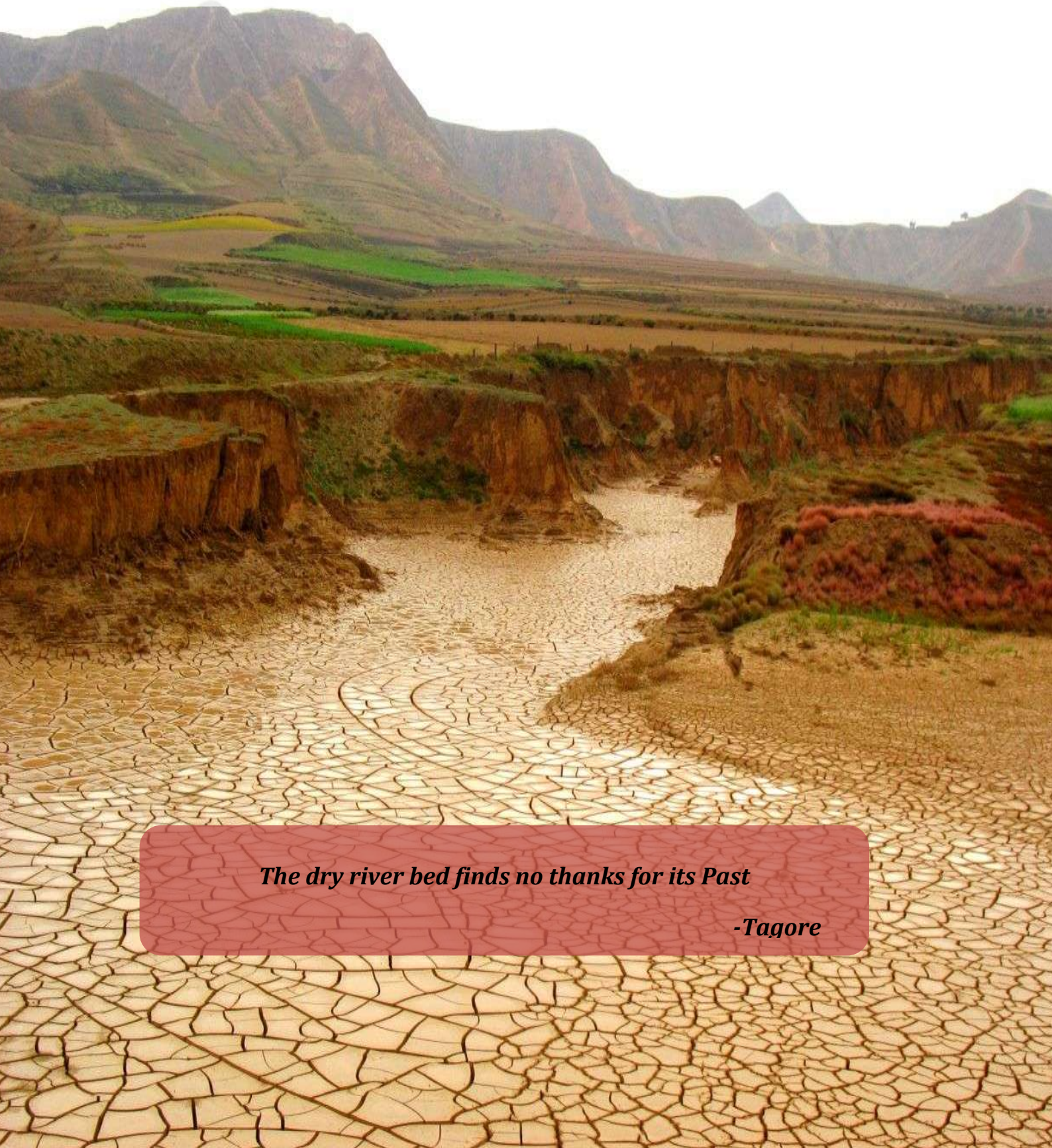


LIFE STREAM

ANNUAL ISSUE- 2018-OUR DYING RIVERS



The dry river bed finds no thanks for its Past

-Tagore

THEME: OUR DYING RIVERS

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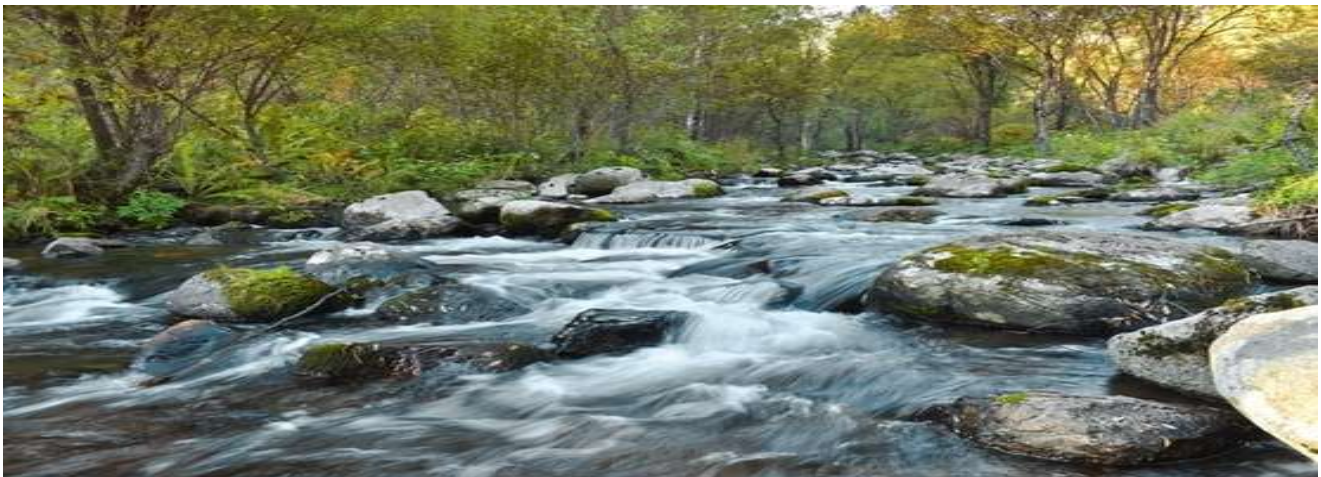
COVER: DRY RIVER

Image copyright: <https://sometimesawriter.wordpress.com/2012/11/06/the-case-of-the-dying-rivers-philippines/>

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No man ever steps in the same water twice, for its not the same river and he is not the same man - Heraclitus

WE PRESENT



(Credit: Stock Photos)

Rivers, lakes and streams sustain life on earth and they have played a central role in all aspects of human life, including literature, science, religion, art architecture and city planning. Today a majority of the rivers and other water bodies in the world are heavily polluted, dying or dead. It is distressing to see that the vast expanse of the sacred River Ganga (Ganges) that once was the cradle of great civilizations and empires, full of life and vigour, today stands desecrated and reduced to a thin lifeless, filthy stream in summer. We have, therefore, selected the theme 'Our Dying Rivers' for this issue of Life Stream.

Most people are indifferent to the plight of rivers, as they generally believe that technology or somebody would take care of the problems. Our limited objective, therefore, is to create awareness through this issue among the readers about the plight of our rivers. The related issue of the contamination of oceans, rivers and waterbodies by microplastics is also covered here. Also discussed are some of the attempts to clean up major rivers, as also some low cost solutions. The pioneering efforts to rejuvenate rivers by 'The Waterman of India' may interest you. The conception and execution of the Three Gorges Dam in China, the marvel of modern technology raise several questions. The poem by Sudha reaffirms our spiritual connect with rivers. Finally on what we do see up in the heavens- a magical river of stars or Akash Ganga.

As usual we have compiled a range of information on the theme from electronic and print media, reports, books, speeches and other sources so as to make it available all at one place, for your consideration. We invite suggestions, improvements and criticisms from the readers.

*We present here the **Annual Issue of Life Stream, 2018 on Our Dying Rivers.***

Life Science Team

*Water is the driving force of all nature-
Leonardo DaVinci*

NATURE:

DYING RIVERS: LIVING BEINGS

It has been happening for quite some time -the shrinking of rivers and lakes, their death and disappearance . But the only difference now is that it is happening at a faster pace in recent times than before. We have not been conscious of their decline, or else we have simply not cared. **It is distressing to see reports that world's major rivers are dying--one third are gone or going and that groundwater wells for 3 billion people are drying up.** The impact of this on life on earth can only be guessed.

The global scenario We know that river basins and surrounding wetlands support vast ecosystems on the earth and that any disturbance in one part of this fragile system can cause disruption to life in other parts of the system.

According to the World Water Commission the top ten river systems in the world are dying. Five of the ten rivers listed in the report are in Asia alone- the Yangtze, Mekong, Salween, Ganges and Indus. Danube in Europe, La Plata and Rio Grande/Rio Bravo in the Americas, Nile and Lake Victoria in Africas and Murray-Darling river in Australia are also included in the list.

Now let's look at the status of important rivers and lakes in different parts of the world in some detail.

Asia Among the major water systems affected in Asia are Helmand River in Afghanistan; the Indus River in Pakistan, Tonlé Sap in Cambodia, the largest freshwater lake in Southeast Asia, Ganges, the sacred river of India, Yangtze River in China (loss of 13,000 sq. km. of lakes in the River Basin, including 800 lakes that completely disappeared), disappearance of 852 rivers and 1160

The river cuts through the rock not due to its power, but due to its persistence-Jim Watkins

lakes in Mangolia and the Mekong River running through Chiangmai, Thailand.

India As pointed out by Isha Foundation, due to the pressure of population and development, perennial rivers in India are becoming seasonal; many of the smaller rivers have already vanished. Floods, as well as droughts are becoming increasingly frequent, as rivers turn unruly during the monsoon, and vanish once the rainy season is over. The rivers like the Ganges which originate in the Himalayas are drying due to melting of glaciers. *It is said that rivers of India are no more rivers but have been converted into filthy drains.* Three important river systems of the north, Indus, Ganga and Brahmaputra, besides shrinking, are also highly polluted.

In Southern India, Godavari, Cauvery, Krishna and Mahanadi are reported to be highly polluted. The polluted stretches of rivers include 49 in Maharashtra, 28 in Assam, 21 in Madhya Pradesh, 20 in Gujarat, 17 in West Bengal, 15 in Karnataka, 13 each in Kerala and Uttar Pradesh, 12 each in Manipur and Odisha, 10 in Meghalaya, 09 in Jammu and Kashmir, 08 each in Goa, Himachal Pradesh, Jharkhand and Rajasthan, 07 each in Tamil Nadu and Telangana, 06 in Andhra Pradesh, 05 in Bihar, Chhattisgarh, Sikkim and Uttarakhand, 03 in Nagaland and 02 each in Haryana, Punjab and Tripura.



River pollution, India
Source: (en.wikipedia.com)

Surveys undertaken by the Central Pollution Control Board (CPCB)

and the Centre for Science and Environment (CSE) have come up with some hard facts on river pollution in India. **Out of the 445 rivers surveyed, not even a quarter of them are fit for bathing.** Indian cities generate 10 billion gallons or 38 billion liters of municipal waste water every day, out of which only 29% is treated. According to the Central Pollution Control Board there were only 160 sewerage systems and sewage treatment plants in nearly 8,000 towns surveyed in 2011. Only 20% out of nearly 40,000 million liters of sewage produced daily in Indian cities is treated. The River Yamuna, the sole source of water for more than 60 million Indians today, has in the past decades become one of the filthiest rivers on the planet. In Delhi, people who live in illegal or unplanned settlements have their waste flowing directly into open sewers. Twenty-two drains carry industrial effluent into the river, while the streams and rivulets that feed on rainwater have been destroyed or choked off by garbage.

China According to recent reports the yellow river has been affected by pollution, hydroelectric dams and heavy extraction of water for industrial and agricultural uses. More than 150 million Chinese relies on the river for water, but the reduction in river level due to extensive water extraction has led to an increase in pollution concentration and water shortages. Today, only about a third of the river is stated to be drinkable and 30% the species in the river are said to be extinct.



A river in China Source: (en.wikimedia.org) Quoting the head of China's Ministry of Water Resources a news report published in 'The Guardian' dated February 21, 2013 mentions that up to 40 percent of the country's rivers are seriously polluted. Further, an

official report in 2012 found that up to 200 million rural Chinese have no access to clean drinking water. China's lakes are also affected by pollution. Reports also show that about one third of the industrial waste water and more than 90 percent of household sewage in China are released into rivers and lakes, without being treated. Nearly 80 percent of China's cities (278 of them) have no sewage treatment facilities and water supplies in 90 percent of the cities are contaminated. China has responded to the situation by building water infrastructure and better regulation, as well as opting for a number of technological solutions.

Middle East According to recent reports the Hamoun Wetlands, which once connected Afghanistan, Iran, Pakistan, is now said to be a dustbowl forcing people to move out; Iraq's famous marshes (believed to be the Garden of Eden) are drying up and River Jordan too is in danger of disappearing.

Africa Some of the major rivers and lakes in Africa which originate from Mt. Kenya, most lakes in Kenya, Lake Victoria, Lake Chad, the Nile River, Niger river, rivers and streams in Kaoma, Zambia, Lake Natron and Lake Manyara of Tanzania are said to be facing serious threats.

Europe Many rivers, lakes estuaries and aquifers in England and Wales, Elbe River and Rhine River of Germany, Lake Balaton (Europe's largest freshwater lake) of Hungary, Cyprus' Kourris Reservoir (gone), Lake Koroneia of Northern Greece, over 1,000 large lakes in Siberia, Russia (dried up), Lake Tuz, 2nd largest lake in Turkey (now a desert), lakes and wetlands in Konya Basin of Turkey (dried up), many of Turkey's large lakes including Lake Kozanlı, Lake Cavuscu, Lake Meke and River Kızılırmak, the largest river in Turkey are facing decline and pollution. Due to pollution, Rhine was known as "Europe's Sewage Ditch". Since 1980s, but countries surrounding the Rhine river worked together to form the International Commission

for the Protection of the Rhine (ICPR), which manages and

The general population doesn't know what's happening and it doesn't even know that it doesn't know.

-Noam Chomsky

monitor activities along the river, ensuring that the pollution in the Rhine's river is well regulated. A quarter of rivers in England are said to be at the risk of running dry. River Seine of France is polluted with dead fish and sewage. Po river in Italy, rivers of Scandinavian region are also highly polluted.

Americas According to the Environmental Protection Agency of the United States of America (EPA) the majority of rivers and streams in the US cannot support healthy aquatic life. North American freshwater species face a five times higher risk of extinction rates than land-based animals. The report labels 55 percent of the nation's water ways as being in "poor" condition and another 23 percent as just "fair." Only 21 percent of rivers are considered "good" and "healthy biological communities." The number of rivers and streams that qualify as "good" went down seven percent between 2004 and 2009. The Lower Colorado River, which provides drinking water for more than 30 million Americans, including those in major cities like L.A., Las Vegas, and Phoenix, tops the list as the most endangered river this year. Second most endangered is the Bear River in California, according to the report. The pollution is reportedly due to phosphorus and nitrogen effluents that come from fertilizer and wastewater run-off. Those chemicals, which come from farms and industrial sites, choke off healthy plant growth, which in turn leads to more soil erosion, more flooding, and run off.

Rivers and lakes affected in North America are Great Lakes of USA and Canada: Lakes Michigan-Huron, Superior-St.Clair, San Gabriel River, California, Canyon Lake, Texas, 10,000 plus lakes in Alaska, Colorado River, Largest US reservoir, Lake Mead, James River, Virginia, Elephant Butte and Caballo Reservoirs, Upper Colorado River Basin, Thurmond Lake, South Carolina Rivers in Wisconsin, Mexico's Lerma-Chapala-

Santiago River Basin and Rio Grande (Rio Norte) River.

Rivers and lakes in Central and South America



Source: www.downtoearth.org

The Lerma Santiago river, the second largest in Mexico, is reported to be under threat from pollution and decreased water flow. Some of the water sources affected are Glacial Lake Tempano in Chile and Cachet Lake, Iguazu Falls, UNESCO heritage site in Argentina and Brazil, Lake Poopó in Bolivia, aquifers in Peru and four main reservoirs in Uruguay.

According to news.nationalgeographic.com the Pilcomayo River in Paraguay is highly polluted and was also said to be suffering through its worst drought in almost two decades.

Rivers in Australia



Darling River- Source: en.wikipedia.org

*A planet being pushed to the edge will
eventually turn on us--*

Marco Lambertini

Murray River in Australia is reportedly suffering from the high demands placed upon its finite flows and a decade of drought. Construction of dams in the Murray–Darling division has affected the wetland systems in its basin.

The total flow at the Murray mouth has reportedly been reduced by 61 per cent due to human interventions. Further, saline water in the Murray–Darling Basin filters down into underground aquifers that in turn has adversely affected agriculture, regional communities and infrastructure.

Rivers in Antarctica The main water sources of Antarctica are the Adams Stream, Aiken Creek, Lawson Creek, Priscu Stream, Rezovski Creek, Surko Stream, Jemmi Creek, Onyx river and Alph river. They are technically all melt water streams.

According to a report by BBC hundreds of lakes lie beneath the frozen wastes of Antarctica and that the buried lakes are connected by a network of rivers of moving water far beneath the surface. Until now Antarctica was considered to be 'a pristine and untouched wilderness with relatively little pollution'.

Rivers in the Arctic There are five major rivers that flow into the Arctic, the Mackenzie and Yukon in North America, the Ob, Yenisey and Lena in Asia. According to a new study climate change is causing thick ice deposits that form along Arctic rivers to melt nearly a month earlier than they did 15 years ago.



Antarctic melt stream- Source: wikipedia

The need for conservation

Recent reports show that, at present, 50 per cent population of the world resides in 250 river basins. Maximum economic activities concentrate around rivers.

According to Ismail Serageldin, Chairman of the Commission **“The land and water crisis in river basins contributed to the total of 25 million environmental refugees last year, which for the first time exceeded the number of war-related refugees. By 2025, the number of environmental refugees could quadruple.”**

Many rivers are being depleted because global demand for water is rising sharply. The problem will be further aggravated by 2025. The report calls on governments to better protect river flows and water allocations, in order to safeguard habitats and people’s livelihoods.



Rhine River-(Source: Wikimedia Commons)

The Rhine and Danube experience The River Rhine is Western Europe's most important waterway. Rising in the Alps, the river connects the economies of some of the richest countries- Switzerland, Germany, France and Holland, before flowing into the North Sea. It was highly polluted from the 1950s to the 1970s, as for decades, industrial and domestic waste flowed untreated into the river. In an accident that occurred in Sandoz in 1986 highly toxic pesticides got mixed with the water and flowed into the Rhine. The International Commission for the Protection of the Rhine (ICPR), which was set up in 1950, but was not so active till then, launched the Rhine

Don't wish for it ; work for it.

- Anonymous

Action Programme (RAP) the following year, after the disaster. Since then, the water quality in the Rhine and its tributaries has reportedly improved significantly. Switzerland, Germany and France now work together in Basel to keep the river clean. This showed that rivers do not have borders. Industries that pollute are tracked and fined. *The water is extracted and checked every six minutes, 24 hours a day. It took almost 30 years to clean the river, that too at a cost of 45 billion euros, which shows that time, money and right approach are needed in cleaning up rivers.* All stakeholders, including government authorities, local bodies, representatives of industry, agriculture and individual households need to be involved. **Danube** is also an international river, which flows almost 1,800 miles through 10 countries and four capitals. Successful cleaning of River Danube after having heavy pollution by industries is also a significant achievement. *The ecological status of the Danube river has dramatically improved after its cleaning.*

The Thames River flows through London from Hampton in the west to the confluence of the River Darent near Erith in the east. Sixty years ago nothing could survive in it. In 1957, the Natural History Museum declared the Thames was biologically dead. But London's sewage system gradually improved along with the country's wider post-war recovery and the river began to breathe again. In the 1970s and 1980s, as part of a general increase in environmental awareness and concerns over the pesticides and fertilisers that were washed into Britain's rivers resulted in stricter regulations. The Cleaner Thames campaign was launched in September 2015 to combat plastic waste. *Today the Thames is ranked as the cleanest river in the world.*



Thames River London -The cleanest river in the world ,
Source: WIKIMEDIA COMMONS

Speaking at the World Economic Forum on 22-3-2018, Sadhguru, founder, ISHA Foundation, India made five practical solutions regarding cleaning up of rivers which are noteworthy.

1. Agricultural runoff harmful to rivers due to the use of chemicals for cultivation, can be rectified **if farmers are supported to move to organic cultivation.** It can also ensure the well-being of hundreds of millions of farmers.
2. Just as electricity, water and gas are metered, sewage should be too, with households and industries paying according to the meter readings.
3. **To make the treatment process effective, effluent treatment itself be made into a lucrative business proposition.** Sewage generated in cities end up in the sea but if this is treated and used for micro-irrigation it can



Budapest-River Danube (Source-wikipedia.org)

If there is magic on this planet, it is contained in water-Loren Eisely

water thousands of hectares of agriculture. Treatment of water only to the point needed for industrial and agricultural purposes can lower the cost of treatment.

4. Useful products can be obtained from waste in industry and agriculture while also remediating contaminated soil, water and air. Researchers are developing processes which can capture carbon dioxide and convert it into useful chemicals. Researchers also use microorganisms to break down toxic organic contaminants which are found in wastewater and generate electricity from them.

5. Having trees on river banks and government owned lands will not only revitalize rivers but also replenish the soil. In private lands support should be provided to farmers to shift from traditional crops to tree-based agriculture. It can also increase a farmer's income by three to eight times.

The way forward As Mr. U K Sinha in his article on restoring rivers (The Pioneer dated 27th September, 2017) pointed out-- "*Rivers are not a lost cause. Nature has the regenerative quality to it and we need to rejuvenate our thoughts. Actions need to come together and very quickly implemented through water efficiency mechanisms, scientific research platform, widespread education and training, and high-levels of institutional and administrative knowledge and public awakening*".

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On Cleaning up Rivers: Some of the most dramatic environmental battles in Europe have been over water engineering projects.

From Britain to the Czech Republic, European nations have been restoring rivers to their natural state — taking down dams, removing levies, and reviving floodplains. Restoring rivers requires recreating old channels and meanders and revegetating banks

For a continent that long viewed rivers as little more than shipping canals and sewers, it is a striking change.

(Courtesy: Yale School of Forestry)

The thing to remember is that everything you do affects the world in some way.

- Martin Dorey

CAN THE GANGES BE SAVED?

"From her source to the sea, from old times to new, the Ganga is the story of India's civilization"- Jawaharlal Nehru. Saving Ganga is not only to save the great river, but also this great civilization-WWF



The Ganga is one of the most sacred rivers in the world and is deeply revered by the people of India. If the river is sacred and revered by all, then why is it dying? Here we briefly examine the present status of the river and the efforts being made to save it. We also try to find out whether these efforts are sufficient to save the river.



Gomukh-Origin of Ganga Wikimedia commons

The Ganga rises in the Garhwal Himalaya from the Gangotri Glacier, about 4100 meters above the sea level as Bhagirathi River. The river flows through the Himalayas till another two

streams, the Mandakani and the Alakhnanda join at Devprayag. It is after this confluence that the river is known as the Ganga.

The Ganga Basin which is the largest river basin of the country houses about 40% population of India. The river after traversing a distance of 2525 kms. from its source, meets the Bay of Bengal at Ganga Sagar in West Bengal. During the course of its journey from the hills to the sea, municipal sewage from large urban centres, effluents from industries and polluting waste from several other sources are discharged into the river, resulting in its pollution.

Today, the Ganges is reported to be the fifth most polluted river in the world. The river flows through 29 cities with population over 100,000; 23 cities with population between 50,000 and 100,000, and about 48 towns with population below 50,000. A large number of industrial cities on the bank of the river in Kanpur, Allahabad, Varanasi and Patna, countless tanneries, chemical plants, textile mills, distilleries, slaughterhouses, and hospitals prosper and contribute to its pollution by discharging untreated waste into it. According to *en.wikipedia.org* one coal-based power plant on the banks of the Pandu River, a tributary of Ganges near the city of Kanpur, burns 600,000 tons of coal each year and produces 210,000 tons of fly ash. Waste materials are released into the Pandu River.

The chief contributory factor for river pollution in India (www.mapsofindia.com) is the dumping of approximately 1 billion liters of raw, untreated sewage in the river regularly. Apart from sewage, decomposing

human/animal bodies, food waste, plastic waste and industrial effluents are being thrown

Everyone thinks of changing the world but no one thinks of changing himself.

-Leo Tolstoy

into the river without a thought. Further, it contains 60,000 fecal coli form bacteria per 100 ml, which is a threat to human health. During festival seasons, over 70 million people reportedly bathe in the river.

A news report in swachhindia.ndtv.com dated 14th July, 2017 pointed out that **despite decades of having government schemes and millions of rupees spent to clean it up, the river is getting more and more polluted and that River Ganga is dying with each passing day.** According to the same news report, the pollution level in Ganga is almost 3000 times over the limit specified by the World Health Organization as safe. Further, **Ganga is ranked as number 2 river in the world that dumps maximum amount of plastics into the sea.**



Gangadevi Temple, Gangotri, where Ganga is worshipped as a goddess (Source: en.wikipedia.org)

The Ganga Action Plan was taken up on the basis of a survey on Ganga basin carried out by the Central Pollution Control Board in 1984, with the main objectives of pollution control, improving the water quality by interception, diversion and treatment of domestic sewage, toxic and industrial chemical wastes from identified polluting units entering in to the river. Indian governments have been trying to clean the Ganga River since 1986. The budget for five years is Rs. 20,000 crores (about \$ 3 billion). The

Love is in the air, but the air is highly polluted.

longer-term budget is Rs. 51,000 crores (about \$ 7 billion.)

Ganga Action Plan-Phase-1&11

Former Prime Minister of India Rajiv Gandhi launched Phase I of Ganga Action Plan in 1985, covering 25 Ganga towns in three states; Rs 862.59 crore were spent.

Phase II covered 59 towns in five states; Rs 505.31 cr were spent. Rivers such as Yamuna, Gomti, Damodar, Mahananda had separate action plans. According to authorities only about 20% of the Rs 3,700-crore funds allocated in the first two years of the program was utilized. "Mission Clean Ganga" project was launched on 31 December 2009 with the objective that by 2020, no industrial waste would be released in the river, without its treatment. The total budget provision was around Rs.15,000 crore. However, GAP reportedly achieved only 39% success in its proposed objectives. In 2011, with support from the World Bank, the government launched yet another clean-up program—the National Ganga River Basin Project (NGRBP).

Namami Gange Programme, is an Integrated Conservation Mission, approved as a Flagship Program by the Union Government in June 2014 with a budget outlay of Rs.20,000 crore to achieve the twin objectives of effective abatement of pollution, conservation and rejuvenation of the National River Ganga. Main components of the Program are provision for Sewerage Treatment Infrastructure, River-Front Development, River-Surface Cleaning, Bio-Diversity, Afforestation, Creation of Public Awareness, Industrial Effluent Monitoring and Ganga Gram. Under the program, the National Ganga River Basin Authority (NGRBA) was assigned the task of overall planning, implementation and monitoring. The project was transferred from the Ministry of Environment and Forests to the

Ministry of Water Resources, renamed as the Ministry of Water Resources, River Development and Ganga Rejuvenation). The NGRBA was replaced by the National Council for River Ganga (Rejuvenation, Protection and Management) or the NCRG. An estimated Rs 2,958 crores have been spent till July 2016 in various efforts in cleaning up of the river. Incidentally, Germany supports the Namami Gange project, earmarked 120 million euros of interest subsidised loan and 1.5 million euros towards technical assistance. Its implementation has been divided into Entry-Level Activities (for immediate visible impact), Medium-Term Activities (to be implemented within 5 years of time frame) and Long-Term Activities (to be implemented within 10 years).

Progress so far (as reported by the project authorities)

1. Creating Sewerage Treatment Capacity:- 63 sewerage management projects are under implementation in the States of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. 12 new sewerage management Projects have been launched in these states. Work is under construction for creating sewerage capacity of 1187.33 (MLD).

2. Creating River-Front Development:- 28 River-Front Development projects and 33 Entry Level Projects for construction, modernization and renovation of 182 Ghats and 118 crematoria have been initiated.

3. River Surface Cleaning:- River Surface cleaning for collection of floating solid wastes from the surface of the ghats and river and their disposal has been started in 11 locations.

4. Bio-Diversity Conservation:- Several Bio-Diversity Conservation projects namely, Biodiversity Conservation and Ganga Rejuvenation, Fish and Fishery Conservation in Ganga River, Ganges River Dolphin Conservation & Education Program have been initiated.

5. Bio-Diversity Centres at Dehradun, Narora, Allahabad, Varanasi and Barrackpore have

been developed for restoration of identified priority species. (The Ganges River Dolphin (scientific name: *Platanista Gangetica*) is a sub-species of freshwater or river dolphins found in Bangladesh, India, Nepal and Pakistan. The Union Government has declared it as the national aquatic animal on October 5, 2009).

5. Afforestation:- Forestry programs have been prepared with the help of Forest Research Institute, Dehradun for a period of 5 years (2016-2021) at project cost of Rs.2300 Rs.crores. Work has commenced in 7 districts of Uttarakhand for cultivation of medicinal plants.

6. Public Awareness:- A series of activities such as events, workshops, seminars and conferences and numerous IEC activities were organized to ensure public awareness and community participation in the program.

7. Industrial Effluent Monitoring:- Real Time Effluent Monitoring Stations (EMS) have been installed in 572 out of 760 Grossly Polluting Industries (GPIs). Closure notice has been issued to 135 GPIs so far and others have been given deadlines for compliance to stipulated norms and for installations of online EMS.

8. Ganga Gram:- Ministry of Drinking Water and Sanitation (MoDWS) identified 1674 Gram Panchayats situated on the bank of River Ganga in 5 States (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, West Bengal). Rs. 578 crores has been released to the Ministry of Drinking Water and Sanitation (MoDWS) for construction of toilets in 1674 Gram Panchayats of 5 Ganga Basin States. Out of the targeted 15,27,105 units, MoDWS has completed construction of 8,53,397 toilets.

A Consortium of 7 IITs has been engaged in the preparation of Ganga River basin Plan and 65 villages have been adopted by 13 IITs to develop as model villages.

Going back to a simpler life is not a step backward.

- *Yvon Chouinard*

Are the efforts enough?

A number of initiatives have been undertaken by successive governments to clean the river but they have failed to deliver the desired results. Only one out of 39 locations through

maintenance to make the mission sustainable. Creation of awareness amongst all stakeholders, especially those at the bottom level and making them an integral part of the project alone can lead to successful implementation.

“When a community takes ownership of their resources and shows the drive to protect their water bodies, such actions are far more effective than any top-down approach led officially. Mass mobilisation is the only sustainable way to revive and maintain water bodies that have long been neglected by their communities,” said Prashanth Nair, former Collector of Kozhikode, who has led several initiatives in the district to revive degraded water bodies.

which the Ganga river flows had clean water in the post-monsoon period last year, according to the Central Pollution Control Board (CPCB) after its latest study. As many as 37 of the 41 locations through which the Ganga river flows reported moderate to severe water pollution in the pre-monsoon period last year.

Apart from providing the entire funding for the Mission, the Central Government is implementing the program mostly through its agencies. Critics point out that lack of large scale community involvement is a serious draw back. Another criticism is that a part of the funding ought to have been provided through corporate houses, each sponsoring cleaning and development of stretches assigned which could have, besides saving government expenditure, would induce much needed completion in its implementation.

Another important challenge is to carefully balance economic interests of the people and environmental protection. After completion of the project leaving everything to the state Government or its agencies or Municipal/local bodies will not be sufficient. Agencies with proven record ought to take care of

Some believe that the present pollution control plan is fundamentally flawed. If the current plan is implemented, it will still not be effective even over the medium term, let alone the long term. By 2050, India will have 1.76 billion people and much larger industrial activities, none of which are seriously considered in the current plan. Consequently, the Ganga as a river will be more polluted than it is now, even after expenditure of over \$41 billion up to 2020. It is interesting to note that the Uttarakhand High Court in India issued a landmark judgment on March 20, 2017 declaring the Yamuna and the Ganga rivers as “living entities” but was soon reversed by the Supreme Court. Whether this declaration by the court is legally valid or not, implementing the spirit of the judgement will depend on the success of the Clean Ganga project.

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you can't stop the waves, but you can learn to swim

-John kabat Zan

SCIENCE: THE SCOURGE OF MICROPLASTICS

Have you ever heard of microplastics? Just look around you. They are everywhere. Today microplastics are considered as a global environmental problem. Microplastic pollution in our oceans and rivers is a major threat to environmental and human health. In this article we explain what are microplastics, where they can be found and how they pollute our environment. We have also included some suggested solutions to the problem posed by their presence.



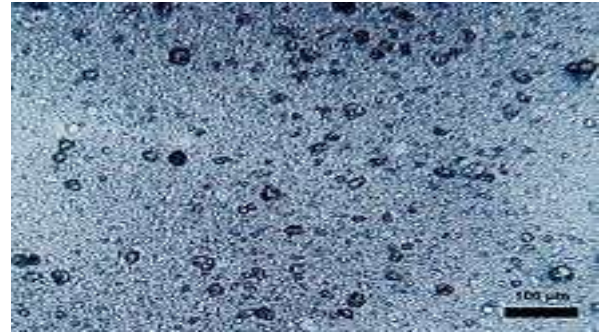
Microbeads (Source: Wikimedia Commons)

What are Microplastics? According to U.S. National Oceanic and Atmospheric Administration (NOAA), microplastics are any type of plastic fragment that is less than five millimeters in length. Plastics used in automotive industry, in cosmetics and cleaning agents, packaging, agricultural and pharmaceutical items enter natural ecosystems and pollute the environment. **Microplastic pollution has now reached epidemic levels.** Larger pieces of plastic break down over time into smaller ones and get released into the environment. Polymer fibers used in textiles break down into smaller fibers when they are washed in washing machines and end up in aquatic systems. Even the remote habitats of the Antarctic are not free from micro plastics. **Analysis carried out by the Greenpeace Research Laboratories at the University of Exeter revealed that even the most remote and pristine**

Use it up, wear it out, make it do, or do without.

-New England Proverb

wilderness of the Antarctic are contaminated with micro plastic waste and persistent hazardous chemicals.



Microplastics (Source: en.wikipedia.org)

Classification Microplastics are classified as primary or secondary, depending on the nature of their origin. Primary microplastics are those that are made to size. They are manufactured as microbeads, capsules, fibers or pellets. One study found that between 15% and 31% of plastics found around us are primary microplastics. Of this, the most (two-thirds) came from synthetic fibers of clothings that came off during washings or synthetic rubber in tyres that degrade over time.

Secondary microplastics are formed by degradation of larger plastic products. They enter the environment through natural weathering processes. These come from the human use of an object that gives off microplastics. Sources of secondary microplastics include water and soda bottles, fishing nets, and plastic bags. 40% of them make it past waste water treatment and out into water systems. Both primary and secondary forms of microplastics are present in the environment at high levels, particularly in aquatic and marine ecosystems. In some areas, the amount of microfibrers in the water

far exceeds the number of microbeads, as reported in Ottawa River, wherein 95% of microplastics were actually micro fibers.



(Ref: Wikimedia Commons)

A third category of microplastics is somewhere between primary and secondary microplastics. They are not specifically made to size, but originate directly from human use. There is a view that they should be classified as primary microplastics only.

Microbeads Microbeads are small plastic spheres used in face washes, cosmetics, toothpastes, shampoos, sunburn lotions, moisturizers and make-up as exfoliate or scrub. They are usually made out of polyethylene (or polypropylene, polyethylene tere-phthalate or nylon). Most of them are used as bulking agent in cosmetics, helping to increase the volume of the product or to aid in formation of film, controlling viscosity, adding aesthetics and lending adhesive properties. They are also used in hair fixing. Traditionally, natural items like ground almonds, salt, or oatmeal were used, but they were reportedly started getting replaced by micro plastics about 50 years ago. The negative consequences of microplastics came to be known to the world only in the past few years.

The Problem It was estimated in 2014 that there are between 15 and 51 trillion individual pieces of microplastics in the world's oceans, weighing between

93,000 and 236,000 metric tons. Microplastics could contribute up to 30% of the Great Pacific Garbage Patch polluting the world's oceans.



(Ref: Wikimedia Commons)

According to a 2017 IUCN report they are a bigger source of marine plastic pollution than the visible larger pieces of marine litter in many developed countries.

Microplastics are so small that they cannot be removed by water filtration and make it out into rivers and oceans. They enter our food chain through contaminated food and water. They contain plastic additives, which can reportedly cause early puberty in females, obesity, alter function of reproductive organs and reduce sperm counts due to their hormone disruptive ability. They are said to be harmful not only to human beings but to aquatic life as well. They are ingested by fish and other aquatic animals that they die or have health problems. Ingestion of micro plastics can lead to starvation of the organism due to blockage in their digestive tract, stomach lining getting damaged. Humans consume fish and sea food therefore, ultimately, the plastic particles.

It is not yet certain whether micro plastics are actually harmful to living organisms although scientists remain concerned about the human-health impacts of marine plastics because, they eventually will degrade and fragment into nanoplastics, which measure less than

100 billionths of a meter. These tiny plastics can penetrate cells

We can't always choose the music life plays for us, but we can choose how we dance to it.-Unknown

and move into tissues and organs. An article in National Geographic pointed out that since researchers lack analytical methods to identify nanoplastics in food, they do not have any data on their occurrence or absorption by humans. **Currently, research on this topic is still very early. Not all studies conclusively found that microplastics were harmful to humans.**



(Ref: Wikimedia Commons)

Microplastics do not dissolve in water, but they constantly break down into smaller pieces. **Micro plastic are not biodegradable because they are newly introduced into the environment and no bacteria have evolved so far which can break down the carbon-carbon links found in plastic.**

Global Studies



A plastic microfiber seen under a microscope (Wikimedia Commons)

In studies conducted, the River Thames in London was found to have about 80 microplastic particles per liter, as was the River Cegin in North Wales. **Micro plastics were**

found inside every marine mammal studied in a recent UK survey. The Guardian newspaper dated January, 31 2019 reported that microplastics are being widely ingested by Britain's marine mammals in a study conducted by the University of Exeter and Plymouth Marine Laboratory (PML). The research on 50 stranded creatures including porpoises, dolphins, grey seals and a pygmy sperm whale showed that that **every animal had ingested micro plastics.** The March, 7, 2019 edition of the newspaper also reported contamination found across UK lakes and rivers; **microplastic pollution was reported in all 10 lakes, rivers and reservoirs sampled in UK .** More than 1,000 small pieces of plastic per liter were found in the River Thames, near Manchester, which was revealed last year as the most contaminated place yet tested worldwide. They were also found in groundwater in US, as also along the Yangtze river and Spanish coast, and harboring dangerous bacteria in Singapore. They were revealed in a study in 2017 to be in tap water around the world and consumed by people in Europe, Japan and Russia.

Research by the National University of Singapore found more than 400 types of bacteria on 275 pieces of microplastics collected from local beaches.

The study, titled "Microplastic Ingestion by Riverine Macro Invertebrates," led by School of Biosciences, Cardiff University revealed that presence of microplastics is widespread in insects sampled from South Wales rivers. **Microplastic fragments were found to have been ingested by one in every two insects in all the sites sampled.**

A study conducted in september, 2018 in UK found microplastics materials in three different kinds of May Fly and Caddis Larve investigated, irrespective of their feeding habits.

The River Danube is seeing a rise in plastic waste, pesticide run off and pharmaceutical waste. The last Joint Danube Survey report by International

Live simply so others may simply live.

- Mother Theresa

Commission for the Protection of the Danube River (ICPDR) lists the top 20 hazardous substances to the entire river and found that just seven of them are officially reported on.

A study in Austria last year discovered that 40 tones of micro plastics, pieces of plastic 5 mm or smaller in diameter are being transported each year through the country's stretch of the river alone.

As South Africa is a water-scarce country, the researchers reported that contamination of water with plastic could have a much greater effect on human and environmental health.

High levels of plastic pollution were found in almost all samples as per a study conducted by North-West University as reported in Morning star (Saturday Star) dated 7th July 2018.

Global initiatives Globally, several efforts have been made to assess the extent and types of micro plastic pollution. According to the joint report from the UN Environment Programme (UNEP) and the World Resource Institute (WRI), *127 countries have adopted some form of legislation to regulate plastic bags so far* (ref: Green News dated Dec 8, 2018). To date, however, just eight countries across the world – including Canada, France, and the UK have imposed a ban on microbeads through national laws and regulation. The US banned the manufacture of products containing micro plastics in 2017. The import or manufacture of toiletries containing microbeads was banned on 1 January 2018 and sales were banned from 1 July 2018. Microbeads in natural health products and non-prescription drugs will be banned in 2019. The California rules include a prohibition against biodegradable microbeads, which other states with similar legislation allow. At least six other states have passed laws restricting microbeads, including Colorado, Illinois, Indiana, Maine, Maryland and New Jersey in 2015. The Canadian government also prohibited production of toiletries containing

micro plastics from January 2018. The UK imposed a more limited ban on plastic microbeads in cosmetics and personal care products last year, focused on items such as shaving foam, tooth paste and shower gel. Countries such as Sweden, Finland, France, Iceland and Ireland have planned national ban on rinse-off cosmetic products containing micro beads. In Austria Federal Ministry of Agriculture, Forestry, Environment and Water Management, is working with plastics manufacturers, trying to reduce their plastic output into the Danube down to zero. Ireland is a world leader in this area, bringing in a successful plastic bag levy in 2002 that led to a rapid and major reduction in consumer use of single-use plastic bags.

The Guardian newspaper dated January 30, 2019 reported that a wide-ranging ban on microplastics covering about 90% of pollutants has been proposed by the European Union in an attempt to cut 400,000 tones of plastic pollution in 20 years.

India There is a dearth of studies conducted on microplastics in India. Earlier this year, a study by New Delhi-based non-profit Toxics Link had, for the first time, reportedly confirmed the presence of microplastics in cosmetic products available in India as well. During the course of the study, the researchers tested six varieties of face washes, three of body washes, three of face scrubs, one face mask and five leave-on lotions of national and international brands as also the 'herbal' products. *Their lab results showed that 50 per cent of the face wash products and 67 per cent of the facial scrubs contained micro plastics.*

A first-of-its-kind study for the country by the Indian Institute of Technology-Bombay (IIT-B) revealed that *most table salts sold in India are likely to contain microplastics from polluted sea water.* The Hindu Newspaper (www.thehindu.com) dated Nov 17, 2018) quoted a study reported in SCIENCE in 2015, wherein researchers estimated that **India had**

dumped 0.6 million tones of plastic into the ocean in 2010.

We've seen albatrosses come back with their belly full of food for their young. You think it's going to be squid, but it's plastic. –David Attenborough

China was the top dumper, while India ranked 12th and the US ranked 20th. This was despite the fact that Indians generated only around 0.34 kg of waste per person per day (ppd), while Americans threw away 2.58 kg ppd. **The problem was that India was mismanaging over 80% of its waste, while in the U.S. it was only 2%.**

It was reported in the media that the scientists at the CMFRI (Central Marine Research Institute), Kochi have recovered plastics from the gut of a dozens of species: mackerel near Mangalore, yellow fish tuna near Kochi and anchovies off the coast of Alappuzha, among them. In 2014, researchers from the Forest Department of Gujarat after conducting a post-mortem on the 1-ton carcass of a Longman's Beaked Whale on a beach in the Sutrapada municipality found four large plastic bags in its stomach blocking the whale's digestive system. Micro plastics have been reportedly detected in the Sabarmati River in Gujarat. Plastic particles now threaten to pollute drinking water sources in Gujarat.

On the directions given by National Green Tribunal (NGT) for analysis of micro beads in cosmetics, the Bureau of Indian Standards did a study and classified microbead products in India as 'not fit for use' in May 2017. However, after that there has been no notification or instruction from the government banning the use of micro beads in cosmetics in India . ***India is considered years behind in contemplating any legislation to ban the use of microbeads.***

The way forward Modern industrial products containing microplastics have brought about unprecedented changes in our lifestyles. The use of cosmetics and other modern products containing

microplastics is not confined to the upper crust of society alone; **it has penetrated all sections of the society as articles containing micro plastics are attractive, convenient to use and easy to dispose of.** Due to their easy availability, these products are no longer considered a luxury. People have become so habituated to their use that it is indeed difficult for them to stay away from them. Microplastics are now an essential part of our daily life. Littering and ineffective waste management are key contributors micro plastic pollution. **Unfortunately, the public has not been concerned about their ill effects or deliberately ignored the consequences of their use.**



Micro plastic pollution Credit: Hermes Rivera

How do we then handle the menace of microplastic pollution all around us? Here are a few thoughts.

- **Creation of public awareness** Public awareness is the most important step for minimizing/ regulating the use of microplastics. For this, efforts by Governments alone are not enough. Environmentalists, voluntary organizations, educational and social institutions, hospitals, municipalities/ counties/ peoples' groups and individuals have to play a leading role.

We need to free ourselves from the tyranny of convenience.- Martin Dorey

- **Our actions as individuals can make a difference**, such as no use of bottled water, using a water filter to cut down on bottled water, buying unpackaged fruit and vegetables etc.



Plastic Lily in Bogor Botanical Gardens
(Ref. Wikimedia Commons)

- **Making ethical choices** As consumers, we seldom exercise the right to choose a product. Once we are aware of the harm a product can cause, we should exercise this right with caution and care. The use of this right by a large collection of individual consumers could force manufacturers to replace the harmful products. In countries which are yet to ban/ regulate the use of microplastics, the consumers should look for the ingredients of a product in order to make a conscious choice.
- **There is a need for a fuller assessment of the sources, movements and effects of microplastics in each country**, as they are transported between the land and sea along rivers.
- **Enactment of laws for banning the use of microbeads in industrial products, and initiating other major policy changes ought to be a priority by Governments.** It is true that many a time the laws are not implemented; but they nevertheless serve as a basis for taking action against the violators. These

The thing to remember is that everything you do affects the world in some way.

- Martin Dorey

laws should cover manufacturers of cosmetic products, plastics and packaging industries, textiles and tyre making industries, clearly stating the role of environmental regulators, and ordinary people concerned about the environment. For proper implementation of laws, all concerned including administration, courts, media, public and private institutions environmentalists, and of course, the citizens need to be sensitized.

- The growing plastics industry is required to take urgent steps to **clean-up and recycle microplastics** to create a viable plastics sector in order to reduce their negative impact on the environment. **Continued efforts are needed to reduce the cost of recycling.** Well funded and focused research studies by reputed institutions will be the key to creating sustainable reduction and recycling efforts.
- **Manufacturers of plastic could be forced to take responsibility for the damage wrought on the environment, especially through Extender Producer Responsibility (EPR) laws**, which require plastic producers to fund and manage recycling and disposal of their products. EPR laws are already being used in the USA for electronic products such as phones, televisions and batteries that contain lead, mercury, and cadmium; many states now require manufacturers of these products to support their recycling and disposal at the end of the product's lifespan.
- Many environmental activists are calling for a ban on plastics. However, the very properties that make plastic so dangerous - its durability and long lifespan - also make it a great asset. **A material that will not die or be destroyed for five hundred years is valuable. We can reuse it almost**

endlessly. The problem is not plastic itself. The problem is using it irresponsibly.

- A material that can be constantly recycled is a great help to ecology and the economy, especially when the human population is growing rapidly and our lifestyle demands are increasing exponentially. **The solution is not to ban plastic, but to ensure that it is used responsibly and recycled properly.**

Plastic recycling is a complicated issue. There are so many different grades of plastic, each requiring their own recycling process. Some of these plastic types are not even recyclable in a commercially viable manner. The process of collecting and sorting these different categories has many challenges, including technological capacity, and social awareness around disposal. **A blue print to transform "filth into wealth" is the need of the hour.** A comprehensive legal and policy framework to streamline and commercialize the process of plastic recycling must be created. It is the plastic industry's responsibility to raise the necessary social awareness about responsible use and recycling. **If we can show people that plastic is precious, you will not find a piece of plastic waste anywhere.**

Waste management is key to containing microplastic pollution, as usually, they mostly originate from waste that is not managed properly. Therefore, **having adequate waste disposal infrastructure and protocols, especially in informal/illegal settlements, ought to be a priority.**

Effective/efficient treatment of effluences is important in segregating micoplactic pollutants. **Future treatment plants should have an additional processing phase, specifically for micro-pollutants**

Alternatives:- Sustained efforts need to be made by international companies to develop alternatives to microplastics like bees wax and jojoba waxes starched from corn and other natural compounds, which can be used in place of micro plastics to get similar results. This may not be easy as this is dependent on multiple factors. Nevertheless seeking other options has now become mandatory.

What can you do?

- Use less water.
- Keep your car repaired.
- Use organic gardening techniques.
- Compost and contain yard waste.
- Deal with household chemicals and medicines properly.
- Go sustainable.
- Do not litter

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3.www.downtoearth.org.in 4. gmet-green-now.com



A mountain of garbage (Credit: Antoine Giret)

Be a part of the solution: not pollution.

- Unknown

ECONOMICS: SAVING RIVERS- LOW COST SOLUTIONS

(In this write up we include some of the innovations in trying to find low cost solutions to cleaning up/rejuvenating polluted rivers. Some of these are taken up by young people who are concerned about their environment or are interested in earning an income with a larger vision of cleaning up rivers. Readers may be inspired to follow their examples)



(Ref: Wikimedia Commons)

We have, in this issue of Life Stream, provided details on the status of important rivers in different parts of the world. The cost and time needed to clean up/ rejuvenate dying rivers being high, the authorities are reluctant to take up large projects. For example, we mentioned that attempts are being made to clean the Ganges, one of the large rivers in India. Under the Ganga Action Plan, so far, 261 projects have been sanctioned at an estimated cost of Rs 255.63 billion (Rs. 25,563.48 crore), out of which only 76 projects have been completed and made operational, while rest of the projects are still at various stages of implementation. It is, therefore, heartening to note that attempts are being made by several entrepreneurs/ and decentralised groups to offer solutions to the problem of river pollution. A few

Man is a complex being, he makes the deserts bloom and lakes die.- Gil Stern

instances are detailed below.

The INTACH Project A pilot project taken up by INTACH (The Indian National Trust for Art and Cultural Heritage) is a good example of low cost and simple solution to reduce water pollution. The South Asia Network on Dams, Rivers and People in an article (Ref The Wire dated 11-9-2017), reported that an INTACH pilot project to clean 3.5 km long Assi river in Varanasi (which flows into the Ganga at the Assi Ghat in Varanasi) has yielded good results, using low-cost unconventional methods. **The process of bacterial bio-remediation for removing pollutants from water was employed using biological products.** This was based on their success in other areas, including the Palam nallah (drain) in Dwarka in 2012, the Kushak nallah in Chankyapuri in 2010 and the east Taj drain which crosses the eastern entrance of the Taj Mahal.



(courtesy: INTACH)

The Assi River runs through densely-populated areas that discharge their waste directly into the water. According to the article, the team introduced bacteria concentrates into the water (100 litres of concentrate a day) at six river locations.

As the bacteria degrade organic pollutants, they enhance dissolved oxygen levels in the water and removes odours. The team installed

soil bag weirs and coir log bundles as media for bacteria to live, grow, multiply and treat the pollutants, and also to reduce water flow. Floating waste was removed manually. Installing these interventions were completed by the end of December 2016. Within four weeks, the foul smell emanating from the river had reduced. A significant improvement was visible when the water was tested two months after the treatment began. The team reported that biochemical oxygen demand levels had reduced by 83.7% and chemical oxygen demand levels by 50%.

The cost of this project, according to INTACH, was only Rs 4.34 crore in the first year and Rs 3.75 crores in subsequent years at constant prices. Conventional methods, including sewage treatment plants, would require Rs 75 crore in capital equipment cost, with land costs, maintenance costs etc.



Researchers in IIT Bombay identify a bacterial strain that prefers aromatic pollutants over sugar as food (Ref: Wikimedia Commons)

Start ups While large campaigns for cleaning up rivers have received everyone's attention, no one knows that there are small yet significant attempts made by inspired individuals. Three such instances have been reported by one of the websites (www. the betterindia.com).

Anyone who believes in indefinite growth on a physically finite planet is either mad or an economist. – Sir David Attenborough

1. Omnipresent Robot Tech Pvt. Ltd. First of the three innovations is a Ro-Boat that can work on its own, with minimal human intervention. Fitted with fog lights and zoom camera it capable of 24×7 operations in all weather conditions. It also has solar panels and twin propeller engines that enable navigation using less power.



The device can completely submerge in water to pull out the pollutants. It is reportedly capable of conducting operations for 12 hours per day, cleaning up 600 kg of waste per day. It can clean up nearly 200 tons of waste per year. It was also reported that the company is developing drones by collecting videos on pollution to enhance the Ro-Boats efficiency in cleaning. Massachusettes Institute of Technology (MIT) reportedly gave its recognition for Ro-Boat technology as one of the top 20 innovations in India in 2013. US-AID had also recognized it as one of the top 5 innovations in the area of water and sanitation.

2. HelpUsGreen- Making products from floral wastes.

In India, apart from chemicals, fertilizers and industrial wastes, rivers are also polluted by floral wastes thrown into their waters from places of worship located along the rivers.

Two young entrepreneurs – Ankit Agrawal and Karan Rastogi developed a technique in 2015 for converting floral wastes collected

from temples/mosques/gurudwaras along the Ganges into natural and chemical-free

lifestyle products like incense sticks and scents. The startup set up by them collects around 1.5 tons of floral waste from Kanpur and 8 tons from Varanasi.

Around 80% of the flowers collected are used in making vermi-composts. For this the flowers are mixed with organic cow dung and treated with other natural components for increasing their nitrogen content. Later earth worms are also added to convert the mix into vermi-compost. The compost gets ready in two month's time. The rest of the flowers are crushed and made into incense sticks and other items used in prayers.



(Ref: HelpUsgreen)

The web site reported that they have provided employment to 80 women from different self-help groups in the nearby villages. Beggars have also been assigned the work of bringing flowers collected from the river. The startup also used recycled packing from discarded cartons. Their innovative work not only reduces pollution of river waters, but provides employment opportunities to the needy. The group advises the devotees who visit religious places along the rivers to pray and give their offerings, not to throw puja offerings into the river. Instead only biodegradable materials should be used while making offerings in the river water; used plastic bags should be recycled and the rivers should not be used as toilets.



(Ref: HelpUsGreen)

3. **Detect Technologies**-The third innovation reported is the development of a system designed to detect pipeline leakages by Daniel Raj David, a final year student of mechanical engineering and his team from IIT, Madras. The start-up is named Detect Technologies. The Guided Ultrasonic Monitoring Pipe Systems (GUMPS) can detect oil leakages from oil pipelines which run on the river bed of the Ganges. The biggest challenge they faced was converting the technique developed into a viable commercial enterprise. By constantly monitoring net works of pipelines the start up is able to alert the authorities of any impending leaks, thus prevent pollution due to oil leakages. It also helps prevention of loss of marine life.



IITM-start-up Detect Technologies (youtube.com)

Apart from individual efforts there are reports of group efforts reported on cleaning and revival of rivers and water bodies. One such example is that of a panchayat (local body) in Kerala reviving a stretch of river passing through the area (see box).

Only we humans make waste that nature can't digest.- Charles Moore

A MODEL TO FOLLOW

A panchayat in the state of Kerala in India has shown the way. Having no resources of its own, the panchayat utilized funds it received from the government under employment guarantee scheme to rejuvenate a stretch of river flowing through it.



Kuttamperoor River, a tributary of Pampa and Achenkoil rivers in Alleppey district of Kerala got a new lease of life recently. Waste materials such as plastic bottles, containers and food refuse dumped by unscrupulous hotels and eateries had ruined the flora and fauna. Polluted water reportedly infiltrated into drinking water, water resources including wells along the river. Wells dried up in many adjoining areas.

The Budhanoor panchayat took up cleaning up a 5 km stretch of the river flowing along panchayat . The project was implemented under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS). Thick layers of water weeds and waste dumped into the waterway for over a decade were removed. About 200 workers were engaged for the work during a two-month period, generating 30,000 man days. A sum of Rs.72 lakh was spent on the project. www.thehindu.com



The cleaned up kuttamperoor river in Kerala (Wikimedia Commons)

The Way Forward

Studies indicate that cities which bring their downtown rivers 'back to life' have many benefits, transforming their urban areas into 'vibrant, healthy, economic engines for businesses, recreation, and neighborhood vitality'. Rejuvenation of rivers by leveraging technology and eco-friendly methodologies, while also planning for sustainable infrastructure and improving the socio-economic lives of the people entwined with the water bodies is a viable option.

“At the grassroots levels, the focus is to create awareness about reviving rivers, cleaning the water bodies and mobilising volunteers for the project. From the above mentioned instances it is clear that efforts made by individuals and groups demonstrate that rivers indeed can be cleaned up by local efforts to a significant level. Of course, preventive action is more important than treatment afterwards. Nevertheless, inspired by these examples many more individuals and groups could take up similar cost effective, innovative and easy to execute projects at local levels within a given time frame, involving the communities.. This will go a long way in cleaning up rivers in a speedy and sustainable manner.

Ref: en.wikipedia.org/ www.thehindu.com/ www.thebetterindia.com/

A river is more than an amenity; it is a treasure-Oliver Wendell Holmes



(The Ganga at Varanasi- Image IWP Flickr)



Pilgrims at Kumbh Mela-Varanasi (Ref: First Post)



Mandakini River (Wikipedia.)

For many of us, clean water is so plentiful and readily available that we rarely, if ever, pause to consider what life would be like without it. - Marcus Samuelson



A small shrine at Gomukh, Gangotri glacier (Ref; Wikipedia)



Bhagirathi River (Ref: Wikipedia)

When we destroy something created by man we call it vandalism, but we destroy something by nature we call it progress.- Ed Begeley Jr.

PERSONALITY: THE WATERMAN OF INDIA



"Water is my life, my happiness and my teacher" --Rajendra Singh

We have seen that rivers are dead or are dying not only in India, but in different parts of the world. The number of rivers defined as polluted in India has more than doubled in the last five years, from 121 to 275, The Central Pollution Control Board, India which examined the water quality of 445 rivers across the country in 2015 found that 275 rivers have 302 polluted stretches. Rejuvenation of dying rivers being a complex task, any success in their revival brings relief and hope to all of us.

In this article we discuss the inspiring example of Dr.Rajendra Singh.

As a water- conservationist he is well known for his pioneering work in community-based efforts in water harvesting and water management. *By involving the community he brought back to life rivers that had dried up long ago, using simple techniques and rudimentary tools.* His exceptional work and dedication have earned him the nickname the 'Waterman of India'.

"One takes what the river offers, both good and the bad. The joy of living by running water far outweighs the sorrow."

-Matthew Goldman

Profile of Dr.Singh

Dr. Rajendra Singh, was born on 6 August 1959 in village Daula in Bagpat district in UttarPradesh .His father was a farmer who owned 60 acres of land in the village. Singh did early schooling in his village.

When he was in high school, a visit by Shri Ramesh Sharma, a member of the Gandhi Peace Foundation to his village left a lasting impression on his mind. Shri Sharma involved him in a program for eradicating alcoholism in his village, when he was only 14 years old. His English language teacher in school, Pratap Singh,also influenced him. Shri Singh used to discuss political and social issues with students after classes.

Dr.Singh enrolled for post graduation in Hindi literature, at a college in Baraut, affiliated with Allahabad University. He was inspired by Jayprakash Narayan's call for 'total revolution', when Emergency was declared in India in 1975. He then formed the Chhatra Yuva Sangharsh Vahini (Student Youth Struggle Battalion). He had already joined the Tarun Bharat Sangh (TBS) by then, an NGO founded in 1975 by a group of students and professors from the University of Rajasthan. According to him, during that period, he learnt to respect communities, uphold democratic values, and care for the poor.



He started his career as a National Service Volunteer for education in Jaipur, from where was appointed to oversee adult education schools in Dausa district in Rajasthan.

He acquired a degree in Ayurveda

medicine and joined government service in 1980. He left his job in 1984. "You have only one heart and one mind," he said, "When you work in government service, you use neither." In 1985 he sold all his household goods and boarded a bus going into interior of Rajasthan, along with four friends from Tarun Bharat Sangha. He reached Alwar district and settled in village Bhikampura and started practice of Ayurvedic medicine in Gopalpura, a nearby village, while his colleagues worked for promoting education in the villages.



(Ref: fridaymagazine.ae)

Alwar district was at the time largely dry and barren due to deforestation and mining. Its water table had dwindled. Moreover, the villagers had slowly abandoned traditional water conservation techniques, like building check dams, or johad, instead were relying on bore wells. Due to continued use of pumping out water, water table was pushed further down each time, till they went completely dry. The area was declared a dark zone, due to non availability of ground water. A village elder, Mangu Lal Meena, advised him that water was a bigger issue to address in rural Rajasthan rather than education. Further, he ought to work manually insted of behaving like city folks who came only on visits to the villages.

Rajendra Singh decided to work on *johads*, or earthen check dams, which have been traditionally used to store rainwater and recharge groundwater, a technique which had been abandoned in by villagers . He therefore, decided to learn the techniques from local farmers; his friends were

unwilling to work manually and went back to the city. He took up desilting the Gopalpura johad, lying in disuse for a long time, with the help of local youth. **During the monsoon that year, the johad filled up with water. Soon wells which had been dry for years in the area had water.** With the help of villagers the johad was further deepened in the next three years. This helped in lifting the water table in the nearby areas.

Encouraged by his sucess in Gopalpura he started moving on foot (*padayatra*) through the villages of the area in 1986, to educate the villages on the need to build check dams. In 1986 with the help of people of Bhanota-Kolyala village, 20 km away from Gopalpura he constructed a johad at the source of a dried up Arvar River. Villages that lay in its catchment area, and along it also built earthen dams. 375 such earthen dams were built . **The river started to flow again in 1990, after remaining dry for over 60 years.** According to him it was hard work; he and his team labored for 10-14 hours a day. When the rains came, the water bodies filled up. **By 1995, the Avari became a perennial river again.**

He started operating from Tarun Ashram in Kishori-Bhikampura in Thanagazi tehsil bordering the Sariska sanctuaryin Rajasthan. His NGO took an active part in the park's management by assisting the Forest Department. Over the next 20 years, Singh and his colleagues kept working. **They built more than 8600 johads and brought water back to 1000 villages throughout Rajasthan.**

During those years, rivers like Ruparel, Sarsa, Bhagani and Jahajwali were revived after remaining dry for decades. As a result, forests began to re-generate and wildlife returned. Abandoned villages in the areas got populated and farming activities could be resumed once

again, in hundreds of drought-prone villages in neighbouring districts of Jaipur, Dausa, Sawai

Mother earth is so generous. If only we give her the chance, she will restore everything in absolute abundance and beauty- Sadguru

Madhopur, Bharatpur and Karauli, where work of TBS gradually spread. It had built 4,500 earthen check dams, or *johads*, to collect rainwater in 850 villages in 11 districts of Rajasthan.

Reforestation has been taken up by numerous village communities, and Gram Sabhas have been set up especially to look after community resources. A notable example is the *Bhairondev Lok Vanyajeev Abhyaranya* (people's sanctuary), spread over 12 km² near Bhanota-Kolyala village at the head of Arvari. He has also been organizing *Pani Pachayat* or Water Parliament in distant villages in Rajasthan to make people aware of the traditional water conservation wisdom, the urgency of groundwater recharge for maintaining underground aquifers and advocating community control over natural resources. By 2001, TBS had spread over an area of 6,500 km², also including parts of Madhya Pradesh, Gujarat and Andhra Pradesh.

Honors and recognitions



(Ref: thenewminute.com)

- The river was awarded the 'International River Prize',
- In March 2000, the "Down to Earth — Joseph. C. John Award" was presented to the villagers by the then president of India.
- He was awarded the Magsaysay Award for Community

Leadership in the same year.

- In 2005, he was awarded the Jamnalal Bajaj Award. In 2008,
- ***The Guardian named him amongst its list of "50 people who could save the planet"***.
- In 2015, he won the Stockholm Water Prize, an award known as "the Nobel Prize for water".
- In 2016, he was bestowed with Ahimsa Award by Institute of Jainology based in UK.

Issues Despite the pioneering work by Shri Singh and others on water conservation, mining of groundwater, especially for crop irrigation continues unabated. Large dams have brought both more droughts and flooding. "In the 70 years since independence, more than 10 times more land is under drought and eight times more land is under flood. I have seen people in some of these villages being displaced three, four, eight times. This is not really development. These dams are damned", observed Rajendra Singh. The solution lies in the traditional water harvesting techniques promoted by Dr. Singh and his team.

Ref:en.wikipedia.org



(credit:BBC)
Ref:en.wikipedia.com/

When our lives are connected with nature, we draw from indigenous knowledge, which is also science, but with common sense- Rajendra Singh

POEM: AND THE FAITH LIVES ON**- Sudha Shrotria**

(Courtesy: liveindia.com)

*Many a childhood days were spent
 Joyful and content
 By the river front
 Watching
 In the morning glow
 The mighty Ganges flow
 With the sound of temple bells
 Resonating in the backdrop
 And the roar of gushing water
 Reverberating
 Giving a message of hope and life.
 A timeless symbol of faith
 Inspiring seekers to take the holy dip
 Blessings for eternal bliss
 Of purity
 And nectar of immortality
 Of spiritual solace*

*And salvation for the soul; and the followers
 In gratitude to the mother
 Worship the waters divine
 The memory fades away
 As I stand before the river front now
 The mighty river
 Somewhat sad and mild,
 Narrows down
 Stressed with the load of the town
 Black muddy waters
 Wastes and plastic afloat
 Choking in parts low
 It struggles to flow
 But in the distance I see
 Millions take the holy dip
 Amidst splashes and sprays
 The devotees stand in the water to pray,
 For deliverance
 Holding to belief
 That the mighty river will make way
 To wash their sins away.*

(Source: indiawaterportal.com)

Faith does not need to push the river because the faith is able to trust that there is a river. The river is flowing. We are in it.

ART & ARCHITECTURE: GORGES DAM-- MARVEL OR MONSTROCIETY?



(Source: en wikipedia.org)

(In this section we have included a write-up on the Three Gorges Dam in China which is considered a masterpiece of Chinese engineering. Unlike a piece of art, the dam, like the Roman aqueducts, is a utilitarian structure and a unique architectural feat. The readers may be interested in knowing how the idea was conceived and how it was executed and at what costs to the people and the environment)

Three Gorges Dam on the Yangtze River in China is the largest hydroelectric power plant in the world, and is one of the most controversial public works in modern times. It is said to be the largest structure constructed by the Chinese since the Great Wall of China. The Chinese government and the people of China are extremely proud of its success. It cost the Chinese government 203 billion Yuan (US\$31.765 billion) to make. It is said to be even visible from the moon, making it a global tourist attraction.

Basic Features

The dam is named as Three Gorges because its reservoir region is a mountainous stretch along China's Yangtze River, between Chongqing and Yichang cities and that three gorges namely Qutang, Wu

We build too many walls and not enough bridges.- Sir Issac Newton

and Xiling are carved between three cliffs.

The **dam** spans the Yangtze River by the town of Sandouping, in Yiling District, Yichang, Hubei province, China. According to Encyclopedia Britanica the Dam, a concrete gravity structure, is 2,335 metres (7,660 feet) long with a maximum height of 185 metres (607 feet). 28 million cubic metres (37 million cubic yards) of concrete and 463,000 metric tons of steel are incorporated into its design. It has the installed capacity to generate 22,500 megawatts of electricity, making it the largest hydroelectric dam in the world. After completion, the dam was expected to generate 18,000 megawatts of power, eight times that of the Hoover Dam in USA on the Colorado River.

History It was Sun Yat-sen who had originally developed the idea of a large dam across the Yangtze River in 1919. The preliminary work on its plans was started by the Nationalist government, led by Chiang Kai-shek in 1932.



(NASA-The Three Gorges Dam- satellite image)

A survey of the area was conducted in 1944 by John L. Savage, head design engineer of the United States Bureau of Reclamation. He drew up a proposal for a dam named the 'Yangtze River Project'.

After training around 54 Chinese engineers in the U.S, further exploration, survey, studies on economic feasibility, and

design work were carried out. But due to the Chinese Civil War in 1947, the work had to be stopped.

After the Communist takeover of China in 1949 Mao Zedong supported the project. However, the nearby Gezhouba Dam project was taken up first on priority. The project was affected by financial problems, due to the Great Leap Forward and the Cultural Revolution. The project was again taken up in 1980. However, it was approved by The National People's Congress only in 1992. Although the construction started on December 14, 1994, it could become operational only in May 2012. The ship lift for the dam was completed in 2015.

Costs According to Wikipedia, the original estimated cost of the Three Gorges Dam project was 180 billion Yuan (US\$22.5 billion). By the end of 2008, the expenditure reportedly reached 148.365 billion Yuan, of which 64.613 billion Yuan was spent on construction, 68.557 billion Yuan on relocating affected residents, and 15.195 billion Yuan on financing. The construction cost was to be recovered as and when the dam generated 1,000 terawatt-hours (3,600 PJ) of electricity, yielding 250 billion Yuan. Full cost recovery was thus expected to occur after ten years when the dam was fully operational. The full cost of the Three Gorges Dam was reportedly recovered by December 20, 2013.

The funding sources for construction were the Three Gorges Dam Construction Fund, profits from the Gezhouba Dam, loans from the China Development Bank, loans from domestic and foreign commercial banks, corporate bonds, and revenue from both before and after the dam is fully operational.



The Three Gorges dam (ref: Wikimedia Commons)

Advantages

The Three Gorges Dam was expected to have many positive effects.

- The dam was intended to protect millions of people from the periodic flooding that plagues the Yangtze basin. In 1998 there was a major flood that cost £500 million yuan to rebuild. It had demolished factories, displaced 14 million, destroyed 5 million houses and affected 25 million hectares of farmland. **Therefore, one of the chief objectives was to stop flooding of 11 major cities and towns on the rivers flood plain.**
- **It was planned as a major source of renewable energy and to provide power for China's industrial boom.** The dam's HEP (hydro-electric power) would provide 14% of China's future electric-power. **The HEP that will generate is the same as 18 nuclear power stations.**
- **HEP (hydro-electric power) will make power much more affordable to people.** This energy would help people living in poverty.

Never give up; for even rivers some day wash dams away.

- Arthur Golden



The Three Gorges dam site (Ref: Wikimedia Commons)

- With HEP there is no generation of CO₂ (global warming gas) , hence there is no atmospheric or environmental pollution.
- The HEP will reduce 50 million tons of coal burning, carbon dioxide and emissions will reduce by a 100 million ton.
- The displaced people would move to new cities which will be more advanced and modern with entirely new infrastructure, better sewage, transport, electricity, schools, colleges, housing and telephone communication.
- Ships of carrying capacity with 10,000 ton worth goods could be accommodated.
- The dam has created an enormous 600 km lake that would generate income by providing jobs for people in areas like tourism and fishing.
- It gave a boost to Chinese standing in the world .

Negative impacts

The construction of the Three Gorges Dam has many negative effects .From the start the dam has been controversial, both domestically and abroad. It was taken up and completed despite opposition from people. According to critics, the project had been plagued by corruption, spiraling costs, environment

al impacts, human rights violations and resettlement problems. More than 100 workers were killed during the construction of the Dam. It altered the appearance of the Three Gorges as the water level rose over 91 m (300 ft). **As of June 2008, China relocated 1.24 million residents as 13 cities, 140 towns and 1350 villages either flooded or were partially flooded by the reservoir.** Relocation was completed on July 22, 2008.

- The Three Gorges Dam is a steel-concrete gravity dam. The water is held back by the innate mass of the individual dam sections. The reservoir-induced seismicity due to the weight of the reservoir's water is a major concern.
- Damming up too much water in the reservoir carries a heightened risk of landslides, earthquakes and prolonged damage to the river's ecology.
- The flooding of the dam will wash away fertile soil making it harder to grow crops. The Yangtze River grows 70% of the country's rice harvest and 50% of China's food production.
- 60,000 hectares of fertile farmlands were affected by the 600 km (370 mi) long reservoir.
- Around 1,300 archaeological sites and Buddhist temples were reportedly flooded. Cultural and historical relics had to be moved to higher ground as they are discovered, but undiscovered relics were lost in the flooding.
- The submergence of hundreds of factories, mines and waste dumps, and the presence of massive industrial units up stream created a mass of effluent, silt, industrial pollutants and rubbish in the reservoir.
- The government has acknowledged that filling the reservoir has increased the frequency of earthquakes.

A dam tears at all the interconnected webs of river valley life.- Patrick McCully

The Government paid those displaced compensation for the loss of their homes and farmland, but the new houses and flats are very expensive. Corruption and crime have reportedly made the new houses too expensive and poorly built.

On eco-system

Experts point out that the environmental impacts of the project are profound, and are likely to get worse as time goes on. The world's worst dam disaster was a mega-catastrophe that struck central China in 1975 when two large dams burst, as many as 230,000 people died.

Concerns have been expressed about the survival forests around the dam site. Area of forests in the region surrounding the Dam has dwindled from twenty percent in 1950 to less than ten percent as of 2002.

This region has long been known for its rich biodiversity. It is home to 6,388 species of plants, which belong to 238 families and 1508 genera. These rare species are also used as ingredients in traditional Chinese medicines. Of these plant species, 57 percent are endangered.

The region also abundant in hundreds of fresh water and terrestrial animal species. Wet lands used by Siberian crane, a critically endangered species, have been destroyed. It is learned that only 3,000 to 4,000 Siberian cranes are now left.

Erosion of the reservoir and downstream riverbanks is causing landslides, and threatening one of the world's biggest fisheries in the East China Sea. Yangtze River basin is said to be the home to 361 different fish species and accounts for twenty-seven percent of all endangered freshwater fish species in China. Freshwater fish are especially affected by dams due to changes in the water temperature and flow regime. Other aquatic species have also been endangered by the dam.

Baiji or Chinese river dolphin, is

reported to be extinct now.

Overall impact

The people of China takes pride in the fact that the Three Gorges Dam is the largest concrete structure in the world. But has construction of the Dam fulfilled all its objectives? Could the Chinese government account for all human/environment costs involved? Have all those been displaced fully rehabilitated? Has any interim assessment about its safety been made? Has any disaster taken place? We do not have, at present, answers to any of these questions, as very little information is made available by the Chinese side.

The way forward

As mentioned in an article published in The Guardian newspaper dated 12th January, 2015 'Dams illustrate the brilliance and arrogance of human ingenuity'. Dams generate one-sixth of the world's electricity and irrigate one-seventh of our food crops. But experts have advised against construction of dams across rivers. Only a third of the world's great rivers reportedly remain free flowing, due



The Three Gorges dam (Source: en wikipedia.org)

to the impact of dams. Sixty per cent of the length of the world's large river systems are at least moderately or severely fragmented by dams and other ways of drawing water for irrigation.

According to the World Commission on Dams, large dams have forced some 40-80 million people from their lands in the past six decades and in the great majority of cases, the refugees have been economically,

Never give up for even rivers someday wash dams away- Arthur Golden

culturally and psychologically devastated. Apart from those displaced by reservoirs **there are millions of others who have lost their land and homes** to the canals, irrigation schemes, roads, power lines and industrial developments that accompany dams.

The 'disease of gigantism' in dam building continues in countries across the world despite these issues. If large dams are bad then what are the alternatives?

- Conservationists point to the largest dam removal project in the U.S. as a success story. The ecosystem of Washington's Elwha River has been reportedly thriving since the removal of its hydroelectric dam system.
- The best form of water storage is in the ground, not in huge surface reservoirs created by damming rivers, as groundwater does neither flood homes and habitats nor evaporate as does water in reservoirs.
- A movement in India, as also in many other parts of the world, is now seeking to revive and update the age-old practice of reviving the natural recharge of groundwater by building embankments. People then have improved access to groundwater for household use, farm animals and crops. No family is displaced in this process.
- Rainwater harvesting can be taken up in urban areas, where rain can be caught on rooftops and channelled into tanks.
- More effective ways to manage floods through advance planning by trying to minimize the damage they cause need to be pursued.

Better watershed management, rainwater

harvesting, halting deforestation and restoring wetlands and urban planning, and early-warning systems are advocated.

- Renewable energy, including solar energy rather than mega dams and fossil fuels is the right choice for the 21st century.
- Feasibility studies for new dams have regularly underestimated their costs and exaggerated their benefits, possibly due to vested interest and corruption. It is said that if assessments of options for water and energy needs were made comprehensive, transparent and participatory, very few large dams would make the grade.

The human and environmental costs involved are too high to justify construction of dams. It is clear that the very existence of life on earth will depend on how we manage our natural resources.

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Water released from The Three Gorges Dam
Photo credit:STR/AFP/Getty images)

Men may dam it and say that they have made a lake, but it will still be a river. It will keep its nature and bide its time like a caged animal alert for the slightest opening. In time it will have its way, the dam, like the ancient cliffs will be carried away piecemeal in the currents- Wendall Berry

TRAVEL: THE GREAT LAKE OF CAMBODIA

-Where nature's affluence meets human poverty



The Great lake, Cambodia (en wikipedia.org)

Cambodia, also called Kampuchea (officially known as the Kingdom of Cambodia-Kampucie/ *Kampuchea* in Khmer) is a country situated in the southern part of the Indochina peninsula, with Phnom Penh as its capital. We (my sister and myself) visited Cambodia two years ago, to specially see *Angkor Wat*, the world famous temple complex which was once the seat of Khmer empire in Cambodia between 9th–15th centuries CE. It was amazing to know that India could exercise its cultural influence in a far away country like Cambodia, which has an altogether different ethnic and cultural identity. The temple complex is conceptualized and built in conformity with the Hindu cosmic view. Further, the written Khmer language, is considered to be a derivative of the *Pallava* script from southern India. The Archeological Survey of India (ASI) played a pivotal role in restoring and conserving the temple complex.



Angkor
(wikipedia)

Wat

Siem Reap.

The **Angkor Wat** temple complex is laid out in Siem Reap province in the north west corner of the country. Siem Reap could be reached from New Delhi by two separate routes- via Singapore or Bangkok. We took a flight to Singapore, and, from there, to Siem Reap.

The visit to *Angkor Wat* was indeed awe inspiring. When we returned to the hotel, we were told that we should also see **Tonl'e Sap** or the "Great Lake", the largest freshwater lake in Southeast Asia, which was only about 18 km away from Siem Reap town . Having come all the way to Siem Reap, we didn't want to miss it. In the mean time, we looked for detailed information on the Lake.



Satellite view of the lake (curtesy: NASA)

The Great Lake According to the Consortium of International Agricultural Research Center, Cambodia, the lake and the entire Lower Mekong Basin is the largest and the richest inland fishery in the world and is also one of the most unique and dynamic freshwater ecosystems in the world. The lake long provided enough bounty to sustain those living along its shores. As pointed out by a visitor, like Egyptians living on the banks of River Nile, the people of Cambodia were provided an abundance of food supply by the lake on a continued basis, so that they could utilize their free labor to create grand monuments and attain a high level of culture. In the wet season, they used the advancing waters along the river to carry quarried stones to build the great temples of Angkor. Some historians are of view that the

Life is like a lake which gives a perfect view when you watch it from far- Samik Garg

abundance provided by Tonle Sap, is one reason why the Angkor civilization was so great and was able to sustain itself for so long. It is amazing how man and nature lived in harmony for centuries together.



A Floating church in the Great lake (Ref: en wikipedia.org)

Boating in the lake

We were told that boat services were available for cruise around the lake. You could also make your journey from Siem Reap to Phnom Penh by express boat services. It was late afternoon when we started for the lake from Siem Reap. We, therefore, took a taxi which took us around forty minutes to reach the lake. We purchased the tickets from a man with unfriendly looks and hired a small boat. Initially the lake and its surroundings were unimpressive. The jetty and its premises were not seen maintained properly. But as the boat started moving forward the lake became a vast expanse of water, extending as far as the eye could see. **Never had I seen such a large mass of fresh water before. It appeared as though we were swimming in a huge cup of tea, for the lake waters were muddy.**

After covering some distance we could see floating villages. **we were told that thousands of people live on the lake in more than 170 floating villages.**



Houses on the bank of the lake (Ref:en.wikipedia.com)

It is said that one million Cambodians directly depend on the lake for their livelihood. 90% of those people have stilt houses constructed in the lake and 10% live in floating villages. About these houses as one traveler put it ---' *Rising up from the dusty ground, impossibly thin, spidery bamboo legs supported gravity-defying bodies. Houses on stilts (of) every design, different, but each a testament to stability and strength, providing shelter to whole families: grandparents, parents, children, a couple of chickens and a handful of dogs'--*. Besides, there were schools, churches and other structures floating on water. A boy of about 14 years who assisted our boatman said that he was studying in one of those schools. Our boatman told us that those living in floating villages move to the shore during dry seasons.

Those living in those make-shift houses generally do not have basic amenities. According to factsanddetails.com/southeast-asia/cambodia villagers have to pay nearly 30 cents for 8 gallons of well water brought in by vendors from other villages miles away on high ground for safe drinking water. **With no public sewage system, the lake is used as a toilet and garbage dump.** Migration is very widespread, especially among young women, affecting the livelihoods of households in positive and negative ways; Most living in those makeshift houses appeared to be poor.

The Pulsating river

We moved along the lake for some time. But for those floating villages the lake appeared to be somewhat drab, as one is unable to visualize what lie beneath. It then

A lake carries you into recesses of feeling otherwise impenetrable.-

William Wordsworth

occurred to me as to how the lake could support such a huge human population, in fact, a large ecosystem? Where does its bounty come from? On checking the facts about the lake we noted that the Tonle Sap River connects the lake with the Mekong River. **The river keeps changing its direction depending on the seasons. Usually it functions as the outlet of the Tonle Sap lake, but in June it flows in the opposite direction.** Melting of snow in the Himalayas and heavy monsoon rainfalls occur at the same time, increasing the water levels in Mekong River and then it causes the reverse flow of the 'Tonle' Sap River.

During raining season from June to October, the lake is filled by water flowing from the Mekong. Water flows *out* from the Lake to the Mekong River, in summer. **The unique annual reverse flow of the river called the 'return of the River' and is the main reason for the Lake's natural wealth.** This phenomenon supports the migration of Mekong fish which come to the lake for spawning.



wikipedia.org

Tonle Sap lake acts as a natural buffer of the Mekong river system, regulating floods in Cambodia's central plains. The water level of the lake reportedly rises to 7 meters during the annual rainy season; the minimum size of the lake then expands from 2,500 sq. km to reach up to 16,000 sq.kms. This annual event is celebrated in the capital Phnom Penh as water festival with boat races. Visitors reportedly flock to participate in the event. In dry season from November to May the lake is two meters in depth and its size shrinks to 3,000 square kilometers. **The**

Our destination is never a place, but a new way of seeing thing.

flow of water in Tonlé Sap expands and contracts with the seasons. Therefore, it has earned the name the **'beating heart of Asia'**. The 'annual flood pulse is followed by a livelihood pulse', with the livelihoods very closely connected with the annual hydrological cycle of the lake.

Fishing The lake is one of the most productive and large wetland ecosystems in the world. About 60% of Cambodian population is sustained by the lake as it provides, besides fish, fresh water as well as fertile soil for growing crops along the



Ref;wikitravel.org

Mekong, Tonle' Sap and Bassac rivers. Fish and rice form the back-bone of the traditional livelihood in the area.

The lake is famous for its abundance in fish. **The lake is said to be the source of 18 percent of the planet's freshwater fish catch** and is the fourth largest source of fresh water fish in the world. Fish is a part of the



Boats on the lake (Ref;wikitravel.org)

people's staple diet. It is learned that the **fish supply 81 percent of the protein to the people.** It is estimated that fishermen can catch up to 300,000 tons of fish annually. The lake has more than 150 species of fish. The lake nurtures over 300 species of fresh water fishes, as well as snakes, crocodiles, tortoises, turtles and otters. The catfish

species which can grow up to 250 kg is said to be almost extinct now. Prawns are also harvested from the lake and lake water is used in raising crocodiles.

According to CGIAR (formerly the Consultative Group for International Agricultural Research) **de-regulation of the fishing lot system was taken up recently by the Royal Government of Cambodia (RGC). It terminated the 100 year old fishing lot system in the lake and allowed open access to the whole lake.** The Tonle Sap Authority (TSA) was established to oversee the management of the lake. CGIAR pointed out that this sudden change was brought about without any clear plan or strategy; further, the poor, particularly those living in marginalized areas such as floating villages and floodplains, continue to have limited access to well-managed fishery resources. Use of new technologies, access to capital markets, good marketing and transport infrastructure and skill up gradation of those involved are very much needed to help the inhabitants of the area.

Forests

It is reported that when the water level in the lake recedes, a 20-30 km wide band of forest called underwater forest is exposed.



Lake forest: credit-bookmundi.com

Tree trunks and parts of the crowns and sometimes even whole trees are inundated by annual floods for a few months. The forest near the edge of the lake provides ideal shelter to all kinds of fishes for spawning and breeding. The egg laying egg season is from August to October. More than 100 varieties water birds

including storks, pelicans and other animal species, including monkeys, snakes, birds and turtle are stated to be supported by the lake forest. Forests also provide non timber forest products (NTFP) to those who depend on the forests for their livelihoods, and serve as natural barriers to speedy winds and cyclones. It is, therefore, unfortunate that Tonle Sap's fresh water swamp forest has been threatened by deforestation during recent decades. Critics pointed out that **National government granting of 99-year land leases since 2000 to foreign companies to grow sugarcane and rubber after logging has adversely affected the critical habitat.** While boating in the lake we could see the lake forests only at a distance. We could neither spot any bird or animal, for dusk had already settled in.

Agriculture



Paddy cultivation-Tonl'e Sap (Wikimedia Commons)

The silt deposited by the flooding of the Tonl'e Sap is extremely fertile which helps the local rice farmers cultivate paddy during the season. The farmers have reportedly developed a deepwater rice variety that is unique to this area. Water from the lake is utilized for irrigation of the fields during dry seasons. CGIAR-Research Program on Aquatic Agricultural Systems reported that livelihoods of the locals are organized around the cultivation of rice both during wet and dry seasons, fishing, fish processing, fish marketing, and the collection of forest products and firewood, aquatic animals and plants. However, **farming households, especially those highly dependent on lake resources, are entrenched in**

There are no foreign lands. It is the traveler only who is foreign. - RL Stevenson

poverty. Service delivery (extension, credit etc.) to poor households is patchy that had an adverse effect on productivity.

Challenges The Mekong is the ninth largest river in the world, a ranking based on run off. Six countries namely China, Myanmar, Thailand, Lao PDR, Cambodia and Vietnam share the Mekong Basin. The estimated population in the basin is nearly 70 million. According to a UNDP report around 40% of population live below the poverty line in Vietnam, Laos PDR and Cambodia.



Life on Tonle Sap Lake (Credit: flickr.com)

The lake eco-system is today is under threat due to

- Rapid environmental / climatic changes, poor environment management and weak regulation.
- Deforestation and the silting of the lake.
- Overfishing and conversion of traditional spawning areas to agricultural fields causing a significant decline in fish population
- Pollution of lake waters by fertilizer residues, chemicals and plastic wastes.
- Construction of new dams on the Mekong River, especially in China and Laos causing possible disruption in the entire Tonle Sap water cycle.
- Rise in illegal

A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature---Henry David Thoreau

fishing, especially by outsiders in Fish Conservation Areas (FCA), often blocking important fish migratory channels by engaging undesirable methods.

- Deliberate and accidental forest fires, adverse climate impacts, and, upstream hydropower development leading to loss of flooded forest, habitat loss and loss of biodiversity.
- Tighter government regulation of fishing, and environmental degradation adversely affecting livelihoods.
- Pollution affecting the health and lifestyle of people.

It is rightly pointed out that considering the scale of the challenges, the lake is living on borrowed time.

Efforts at conservation

The Great Lake was designated as a UNESCO biosphere in 1997. Scientists are studying dam and fish dynamics and pushing Mekong countries to consider the whole river basin when building dams. However, these efforts are very limited when compared to the huge need for conservation of the lake ecosystem.

The way forward In the end we asked ourselves what did we achieve by the visit? A visit to the Tonle Sap lake is not an experience that is the same as that one gets visiting more commercialized, well maintained and attractive tourist destinations. This experience may be rated as staid and subdued by an ordinary traveler in search of fun and frolic. On the other hand, it is something more deep for others for whom traveling is also a learning experience. This travel was about getting a glimpse of how thousands of people cope up with poverty in the midst of plenty in their daily lives and how all other beings dependent on the lake are equally affected.

Is there a way out? Yes, if all involved work together. Can we save the lake and its ecosystem? Here

are some action points;-

- 1) Create awareness among ordinary people
- 2) put in place an effective regulatory mechanism
- 3) ensure its enforcement
- 4) a quick assessment of damages
- 5) draft a plan/program balancing human needs vs protection of nature-protect natural rhythms of the lake
- 6) strengthen the existing coordination mechanism with local participation and engage reputed voluntary agencies
- 7) organize international funding by way of sponsorship of specific items in the plan
- 8) involve communities in implementation
- 9) Form women's groups for conservation
- 10) take up housing and sanitation using eco-friendly technology
- 11) ensure proper waste disposal
12. to enhance livelihood opportunities -connect agriculture to capital markets, provide good marketing and transport infrastructure and help in up gradation of skills
13. training of youth, both girls and boys, in various skills to help their employment in various sectors
- 14) provide alternate livelihoods
15. focus on education and health care
- 16) restrict/ban construction of dams along the river
- 17) promote harnessing solar energy
- 18) involvement of UN agencies like UNICEF/UNFPA/UNDP in poverty alleviation programs.

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A girl rowing in the lake (Credit: escape.com au)



A Scenic view of the lake (Credit: Getty Images)



- Bird sanctuary (Credit; tourismcambodia.com)

A mind that is stretched by a new experience can never go back to its old dimensions-Oliver W Holmes

FOOD: DRY WEATHER DIET

{When our rivers are not able to support ecosystems, we need to think deeply about the kind of crops we need to raise and the type of food we consume. It is unfortunate that people in many parts of the world cultivate plants in unsuitable lands and unfavourable climates, especially cereals like rice by wasting huge amount of precious water. Nevertheless, there are crops like millets which can grow in arid conditions that can provide us with nutritious and tasty food. Here we discuss the relative merits of millets from which some easy preparations could be made. This is the repeat of an article on the subject published in an earlier issue of Life Stream}

What are Millets? Millets (ref; en.wikipedia.com) are generally small-grained, annual, warm-weather cereals belonging to grass family, widely grown around the world as cereal crops or grains for fodder. They are highly tolerant of extreme weather conditions such as drought and are nutritious .

Millets are indigenous to many parts of the world and have been in cultivation in East Asia for the last 10,000 years. With 97% of millet production in developing countries they are important crops in the semi-arid tropics of Asia and Africa, especially in India, Mali, Nigeria, and Niger .



Finger millet (en.wikipedia.com)

Major millets are the most widely cultivated species. They include *Eleusine coracana* : Finger millet (also known as ragi), *Panicum miliaceum*: Proso millet (

Common millet, broom corn millet, hog millet or white millet). *Pennisetum glaucum*: Pearl millet (*bajra* in Hindi) - the most widely grown due to its productivity and short growing season under dry, high-temperature conditions. *Setaria italica*: Foxtail millet - (*kakum* in Hindi). *Sorghum bicolor*: Sorghum - usually not considered being a millet, but sometimes known as *Great millet* (*jowar* in Hindi).



Pearl Millet (en.wikipedia.com)

Millets as food Millets are smart carb with lots of fiber and low simple sugars. Because of this property, it



Sorghum (britannica.com)

has a relatively low glycemic index and has been shown to produce lower blood sugar levels than wheat or rice. Before the spread of cultivation of paddy and wheat, millets were the staple food in many communities, especially the tribal communities. In olden times even in our villages apart from rice, millets were used in making different food items like porridges, payasams and steamed balls.

Don't dig your grave with your own knife and fork- English Proverb



Ripe head of Proso millet (en.wikipedia.com)

Fried and powdered millets are made into a paste with heated milk and Ghee and fed to babies as their first solid food. Let us now try two of the popular millet recipes.

1. Millet Kichdi



(tickling palates.com)

A tasty *Kichdi* (mixed watery porridge) can be made out of millets. The millet kichdi is filling, nutritious and also makes a wholesome meal in itself. For a simple *kichdi* basically you need 1/2 cup millet (soaked in water for 30 minutes), 1/2 cup dal and 2 1/2 cups water (for thin kichdi you need to add more water), cut vegetables of your choice, green chillies, onion, add turmeric, cumin and red chillies for seasoning and salt with ghee for taste. After sautéing the vegetables, followed by the millet and dal pressure cook for 2-3 whistles. Heat cumin seeds and red chillies in oil and pour over the cooked *kichdi*. Add ghee for taste.

2. Millet and vegetable soup- A simple, nutritious and delicious millet soup can be prepared easily which would be suitable for eating in winter and rainy seasons. Based on a recipe which appeared in spruce.com a simple



curtsey www.thespruce.com .

millet kichdi can be prepared as follows:-

Total time -45 mins (Prep: 10 mins, cooking time: 35 mins) Yield: 4 to 6 servings

INGREDIENTS:- 1 CUP MILLET ; 1 CUP VEGETABLES CHOPPED (CARROT BEANS PEAS OR LOCAL VEGETABLES); 2 TABLESPOONS COOKING OIL; 1 ONION, CHOPPED; 1 BAY LEAF; 1-CUP VEGETABLE STOCK; 2 CUPS WATER; SALT AND FRESHLY GROUND PEPPER AND ONE BUNCH CORIANDER LEAVES CHOPPED
PREPARATION

1. Warm the cooking oil over medium heat in a pot. Add the chopped onion and cut vegetables and cook 5 minutes, until the onion is translucent.
2. Add potato, bay leaf, stock and water, and two pinches of salt. Bring to a boil, cover, reduce heat, and cook 15 minutes.
3. While the soup is cooking, heat a small skillet over medium heat. Add the millet to the pan and toast for 5 minutes, stirring frequently, until the millet is golden and gives off a nutty fragrance.
4. Add the millet to the soup and cook an additional 20 minutes, until the millet and vegetables are tender. Remove and discard the bay leaf . Adjust the seasoning to taste and serve, garnished with chopped coriander and a drizzle of oil.

Variations: Add a couple of cups of chopped tomatoes . You can also substitute chicken stock for the vegetable stock. . For added protein, add cooked beans or chickpeas .

ASTRONOMY: THE RIVER IN THE HEAVENS

(To a spectator on Earth the band of stars called the Milky Way appears like a river across the sky. Akashaganga is the Indian name for the Milky Way Galaxy).



The Milky Way galaxy (en. wikipedia.com)

What is the Milky way?

The **Milky Way** is a galaxy that contains our Solar System. It appears as a band of light across the sky formed from stars. But the stars are not individually distinguishable by the naked eye. The Milky Way appears as a band because its disk-shaped structure is viewed from within.

Mythology

In India, Milky Way has been referred to as **Aakash Ganga**, which literally translates into: “**Ganga of the heavens.**” The Chinese call it the Silver River.

The ancient Greeks called this galaxy The Milky Circle. As per Greek mythology, suckling Heracles was being fed by Hera. Accidentally, some milk spilled over, giving birth to the Milky Circle. The ancient Greeks had also believed that the galaxy was a road that led to Mount Olympus. Greeks also thought that Milky Way is the path of ruins left behind by the chariot of Sun God Helios.

The Milky Way reminded the Romans about milk and hence, they

There are more micro plastics in the ocean than there are stars in the sky- Pinterest quote

called it the Milky Road.

History

Democritus, a Greek philosopher who lived circa 460 BCE to 370 BCE was the first person in world to claim that the Milky Way was made up of stars.

Scientific explanation It was not until the 17th Century CE that Democritus’ claim was validated by **Galileo Galilei**. He showed that the light band was actually the light emitted by numerous individual stars. Galileo resolved the band of light into individual stars with the help of his telescope in 1610. **Until the early 1920s, most astronomers thought that the Milky Way contained all the stars in the Universe.** Lateron, observations by Edwin Hubble showed that the Milky Way is just one of the billion galaxies in the universe.



The milky Way www. space.com

Features: The Milky Way has many unique features. According to NASA

- The Milky Way is made up of approximately 100 billion stars. There are probably at least 100 billion planets in the Milky Way.
- It is a spiral galaxy with a diameter between 100,000 and 180,000 light-years.
- Shortly after the big bang the Milky Way began as a series of dense clusters in the early universe. The first stars to form were in globular clusters that still exist. They are among the oldest stars formed in the Milky Way region.
 - The oldest stars in the Milky Way are nearly as old as the universe itself

- The Milky Way has grown by merging with other galaxies through time.
- The stars in the Milky Way form a large disk whose diameter is about 100,000 light years.
- Our Solar System is located within the disk about 25,000 light years away from the center of our galaxy. **We live in the suburbs of the galaxy.**
- The stars in the inner $\approx 10,000$ light-years form a bulge and one or more bars that radiate from the bulge. The very center is marked by an intense radio source, named Sagittarius A*, which is likely to be a supermassive black hole.
- **Just as the Earth goes around the Sun, the Sun goes around the center of the Milky Way.** It takes 250 million years for our Sun and the solar system to go all the way around the center of the Milky Way.
- The Milky Way as a whole is moving at a velocity of approximately 600 km per second with respect to extragalactic frames of reference.
- The Milky Way has several satellite galaxies and is part of the Local Group of Galaxies,

Future predictions The Andromeda–Milky Way collision is



(credit: www.space.com)

a galactic collision predicted to occur in about 4

billion years between the two largest galaxies in the Local Group—the Milky Way (which contains the Solar System and Earth) and the Andromeda Galaxy (Ref.en.wikipedia.com)

Based on data from the Hubble Space Telescope, Milky Way galaxy and Andromeda galaxy are predicted to distort each other with tidal pull in 3.75 billion years, as shown in the picture above. The Andromeda Galaxy is approaching the Milky Way at about 110 kilometers per second. According to NASA, 'the Milky Way is destined to get a major makeover during the encounter, which is predicted to happen four billion years from now. It is likely the sun will be flung into a new region of our galaxy, but **our Earth and solar system are in no danger of being destroyed**'.



(credit: www.space.com)

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Behind every atom of this world hides an infinite universe- Rumi

LIFE STREAM is a quarterly magazine on holistic life published by a group of people who are committed to spreading the message of living in harmony with nature.

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LIFE SCIENCE FOUNDATION

SERVICE IN TRUSTEESHIP

ABOUT US

The Life Science Foundation is a Not- for- Profit Public Charitable Trust registered on 30th December, 2009. It is a unique initiative by two officers belonging to the Indian Administrative Service (Bihar cadre) namely S. Jalaja and A.N.P. Sinha (IAS-1974) who have retired as Secretaries to Government of India. Their long experience with Governments at the National and State levels have instilled in them the will to continue to serve people, although from a different platform. Service through the medium of a public charitable Trust is in keeping with the Gandhi's ideal of Trusteeship.

OUR VISION

The term Life Science encompasses all aspects of life from meaning and purpose of life, Right to life- an inalienable right of every human being- to the interconnectedness of the entire web of life. Our vision, therefore, is to promote holistic understanding of life and its purpose, and improvement of quality of life of all.

OUR MISSION

Our mission is to improve quality of life through policy development, applied research and real life action. The Gandhian ideals of Sarvodaya and Trusteeship will be the guiding spirits.

OUR AIMS AND OBJECTIVES

To accomplish the above Vision and Mission, the Foundation will initially have the following aims and objectives. In course of time, more could be included:

1. To promote strategic thinking and suggest policy interventions on holistic and sustainable development.
2. To promote holistic health care system based on simple living, preventive healthcare, and both modern and traditional health systems.
3. To undertake studies, research and action-oriented projects pertaining to holistic life.
4. To undertake pilot projects of good governance including e-governance and eventually support the governments in adopting and up scaling successful pilots.
5. To work towards promoting quality of life of vulnerable sections of population, including women and children.
6. To promote all- round human resource development.
7. To design self- sustaining livelihood projects which minimise subsidies and donor-dependency.
8. To undertake other activities which are conducive to pursuit and fulfilment of the vision, Mission and Objectives of the Foundation.
9. Network with institutions and agencies to achieve the above objectives.

