
# PARITANTRA

## Journal of Systems Science and Engineering

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# Restoration/Rejuvenation of Water in the River Yamuna, Agra

A SPECIAL ISSUE

**Foreword by Revered Prof. P.S. Satsangi Sahab**
Chairman, Advisory Committee on Education,
Dayalbagh Educational Institutions

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## EDITORIAL COORDINATOR


**Prof. D. Bhagwan Das**
Professor, Department of Electrical Engineering
Dayalbagh Educational Institute (Deemed to be University)
Dayalbagh, Agra 282005, INDIA
(email: systems.society@gmail.com)


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# PARITANTRA

Journal of Systems Science and Engineering

## Aims and Scope

This journal publishes original research and advancement in the field of theory and applications of systems science and engineering. The journal is primarily devoted to unification of themes, cross fertilization of ideas, identification and characterization of underlying quantitative and qualitative features of problem formulation and general solution; and solution of multi-level interdisciplinary socio-economic, engineering-economic and real-world problems in the context of national/global development. The journal has a very wide scope which includes applied systems research, systems modelling methodology, socio-economic and environmental systems, operational research and management, informatics, artificial intelligence and soft systems including literary systems and theology ("Better Worldliness").

## Manuscript Preparation

Authors are requested to prepare their manuscripts using a standard manuscript format template provided on the SSI website: www.sysi.org in MS word.

## Submission

Papers may be submitted electronically to the Editorial Coordinator.
(email: systems.society@gmail.com)

PARITANTRA Journal of Systems Science and Engineering has a priority access to papers presented at meetings organized or sponsored by SSI. These papers may need an extension and further review before they are ready for publication. In addition, the journal may bring a special issue with papers which obtain the best paper awards during the presentations in a (Inter) National Systems Conference. The journal also encourages special issues on emerging themes in systems science and engineering, a proposal for which should be submitted to the Chief Editor through the Editorial Coordinator.

## Copyright

This Special Issue on

**“Restoration/Rejuvenation of Water in the River Yamuna, Agra”**

is

Most Humbly Dedicated to

## Param GURU HUZUR Dr M B Lal Sahab

The Seventh Acclaimed Spiritual Head of the **Ra Dha Sva Aa Mi** Faith, Dayalbagh, Agra

&

The Founder Director of the Dayalbagh Educational Institute (Deemed to be University), Dayalbagh, Agra

On His Birth Anniversary, January 31, 2024

Celebrated as the **Founder’s Day**

by the DEI Fraternity across the globe.

# FOREWORD

January 31 is a momentous day, a day of offering our tribute, a day of celebrations as it is the auspicious birth date of Param Guru Huzur Dr. M. B. Lal Sahab, the Founder Director of Dayalbagh Educational Institute (Deemed to be University).

All the living beings are the creation of the Supreme Lord God of the Universe. Our lofty goal of serving the "***the Last, the Least, the Lowest and the Lost***" amongst the gender-free humankind moving towards the asexual beings and then towards all living beings for better worldliness showcases the Dayalbagh way of life. This covers the whole spectrum from ***ab initio*** to ***ad infinitum*** through ***quintessentiality*** via Infinite Frugal Time (Kaal) and cohorts Maya***,*** to fulfill the balance task ahead***.*** This is not a grand finale but a process that will continue till the emancipation of all living beings with no denizens being left at the Nether Pole. Camels are now a part of our family. Dayalbagh and the Dayalbagh Educational Institute (Deemed to be University) have already taken initiatives in this regard. This was before the UN declared 2024 to be the International Year of Camelids.

It is a matter of great pleasure that the Special Issue on the "Restoration/Rejuvenation of water in the river Yamuna, Agra" is being released today, together with enduring already referred to Trinity arising from the one of the rarest celebrations of Holy Birthday of Param Purush Puran Dhani Huzur Dr. Makund Behari Lal Sahab on 31st January 2024 and the proposed release of the Book by Springer Nature, Titled "Consciousness Studies in Sciences and Humanities" (facilitated by its Managing Director Mr. Venkatesh Sarvasiddhi).

Prof. Prem Saran Satsangi
Chairman, Advisory Committee on Education
Dayalbagh Educational Institutions

# Editorial

## ”Restoration/Rejuvenation of Water in the River Yamuna, Agra”

### A SPECIAL ISSUE

We offer our humblest and utmost tribute in the Lotus Feet of Revered Param Guru Huzur Dr M.B. Lal Sahab, on His birth anniversary, January 31, celebrated as the Founder's Day by the DEI fraternity. HE is the seventh Spiritual Leader of the Radhasoami Faith and also the Founder Director of the institute.

This Special Issue is dedicated to Him. We are highly indebted to our Founder Director to have blessed us with an institution par excellence, in the service of humankind. The divine impartation of His ideology has nurtured and cultivated a unique educational system in the form of DEI. The Vice Chancellor of the Lucknow University and a pioneer zoologist, He had envisioned the relationship that binds all the living beings, including the elements of nature. It is here in the 'Garden of the Merciful', that all these elements of nature are taken care of.

E.O. Wilson has said, "Nature holds the key to our aesthetic, intellectual, cognitive and even spiritual satisfaction." We all are highly indebted to nature for its enriched bounties that it has bestowed on mankind. One of these is the rivers. The Yamuna river, a lifeline of northern India, has long served as a symbol of cultural and ecological heritage. However, unbridled urban development, industrialization, and unregulated human activities have inflicted severe degradation upon this once a mighty watercourse. The Yamuna river is facing severe problems such as increasing pollution, reducing water levels, and ecological imbalances in the contemporary times. It has been said that, "We depend on the gifts of nature, but these gifts must be received with gratitude and not exploited or abused."

We need to hear the river's clarion call for an immediate rejuvenation, restoration, resuscitation and revival. Amidst these challenges, a beacon of hope emerges from the initiative and relentless endeavours of the Dayalbagh Educational Institute and the Dayalbagh community in Agra. This issue adjures for a clarion call to action for the rejuvenation, restoration, and resuscitation of the Yamuna river System. It underlines the urgency of addressing the challenges holistically, with a collaborative approach among the stakeholders. By adopting sustainable practices, innovative technologies, and informed policies, we can pave the way for the revival of Yamuna river that would sustain ecological balance, provide clean water for all, and retain its cultural and spiritual significance for the generations to come.

Rigorous efforts are being carried out by the Dayalbagh community and the Dayalbagh Educational Institute (Deemed to be University) for conserving all the natural resources and for creating sustainable and viable methods for the progress and development to combat climate change and sustainability of the living and non-living beings. Following the maxim, "Take the initiative to make a difference, no matter how small." It is with this idea the Dayalbagh community and DEI are jointly striving to preserve and conserve the surroundings of the river Yamuna including its banks at Poiya Ghat to the highest standards. DEI has carried out a water conservation project under the sponsorship of the Department of Science and Technology where a filtration plant is helping in the distribution of potable water to the villages in the neighboring vicinity. The Institute is committed to preserve and conserve the Air, Water, and Soil quality. The quantity of the water flowing in the river Yamuna is influenced by the catchment area, number of streams discharging water into the river and treated water from the STPs etc.

With the advent of 21st century, the humankind attempted to master the entire planet posing a threat to our ecosystem. Today, these Homo sapiens stand on the verge of becoming God, poised to acquire not only eternal youth, but also divine abilities of creation and destruction. Having mastered our surroundings, increasing food production, building smart cities, establishing empires, and creating networks, the humankind have lost the track of the miseries and sufferings in this world. We may have become more powerful than ever before, but ironically have very little idea what to do with all that power. They are none other than some miscreants and builders lobby with evil intentions causing hindrance in the progress of the work.

This special issue is a paradigm of the ideas that were ratiocinated in the workshop on "Restoration/Rejuvenation of Water in the River Yamuna, Agra" organized in the Dayalbagh Educational Institute (Deemed to be University) Dayalbagh, Agra on May 04, 2023.The research topic showcases the innovative approach for reviving the Yamuna river.

The volume comprises seventeen papers dealing with a range of challenging issues related to increasing pollution, reducing water level, and ecological imbalances etc. that were disseminated in the event. All these papers are a significant contribution towards the restoration and rejuvenation of the river Yamuna. In his enlightening presentation,

Dr. Rajendra Singh, the 'Waterman of India' has asserted the significance of 'water' as one of the Panch Tatva (air, water, earth, sky and fire) in time and space. He has reminded all that the rivers have been considered as Narayan in India. We have also been enriched by the solutions that could be implemented for the cause. Mr Ahuja has examined the river rejuvenation of Yamuna vis a vis Rhine and Thames rivers and enumerated the geological/geomorphological activities which can augment the flow in Yamuna. Prof. Satya Prakash has focused on the Dayalbagh healthcare habitat model having a holistic approach towards eco-friendly management of all the natural and man-made resources. He stresses on the inter-linking river network. Prof Prem Vrat has not only identified an enumerated the causes of pollution in the river Yamuna, but also suggested the significance of coordinated efforts of the people, policies; technology and processes to revive the river.

The disastrous and adverse effect on the environment, as analyzed by Prof. Sanjeev Kumar and Prof. Karmeshu, is quite scientific. According to them, a nonlinear system in the environment has created the entire imbalance. It is difficult but possible to improve the ecosystem. An in-depth analysis of the present situation and its best possible solution has been offered by Prof. Pami Dua. The interdependence between sustainable practices and flood mitigation alone does not suffice the measures to check the problem. She recommends the Dayalbagh model with a holistic and community-centric approach to avert the disasters. A computer scientist at IIT Delhi, Prof. P. K. Kalra has explained the application of digital technology and tools that could help in the scientific research and solutions in restoration of rivers in general. Internet of Things, Remote Sensing Technology, AI-based hydromorphological can be used for the assessment of river restoration using UAV-remote sensing and of course the drones.

Prof. Bhojwani and Shri P.D. Satsangi have very systematically given us an account of how Dayalbagh has taken the initiative to develop and maintain the Anupam Upvan Biodiversity Park at Poiya Ghat. The contribution of the Dayalbagh community and DEI in providing a clean and green environment for the healthy life and also improving the quality of Yamuna river has been reported. Around 2750 plants of 35 species have been planted in 6.5 Acres of its fertile land.

Pioneering research by Prof. Gosain has enriched this workshop with his detailed analysis of the causes of the agony of the river Yamuna and the measures that can be implemented for bringing back its hydrological as well as environmental health. These are efficient irrigation methods such as drip and sprinklers, changing cropping patterns to adopt less water intensive crops, and reuse of treated water for irrigation.

The galaxy of the learned speakers has many more stars like Dr. K. Usha, and Dr. Bhupinder Singh (Senior Scientists). They have emphasized the alteration in Agricultural practices to utilize optimum and warranted use of pesticides and fertilizers development of eco-tourism, and eco-parks and above all the commitment of the society and the individuals to work for afforestation on river bank that would face lift the present condition of the river.

Shri S. D. Satsangi and Dr. Gur Pyari Mehra have presented the essence of the rejuvenation of the river Yamuna that was absolutely nonpareil. The present site of the bank now known as the 'Swarg Dham', is just out of this world. The exuberant activities make everyone feel the bliss of the paradise. Any treatise about diverse aspects of India—culture or nature or people—is incomplete without the mention of its roots—the Vedas, Purans and Upanishads. Dr. Nishith Gaur has narrated the significance of the rivers in the Vedas. She has very captivatingly reminded us all not to forget our cultural heritage and the threat to the sources of water. An IITian, Prof. Huzur Saran, has enumerated some technology-based approaches to conserve the natural sources like the river Yamuna. The use of Internet of Things Sensors, Drones-Based Aerial Surveillance, User-friendly dashboards, Mobile Apps etc would help to revive the river.

Elucidating a very comprehensive analysis of the rejuvenation of the river Yamuna, Prof. A. M. Kayastha, has emphasized on the floodplain habitats with appropriate wetland vegetation that would help improve the water quality. He has also enlisted a holistic approach like creating off-river reservoirs upstream, introduction of the gradual switching over from water-intensive agronomic practices and the significance of wetlands in the floodplains to vitalize the river. Dr. Saran Kumar Satsangi, has thrown light on the historical relevance of the river Yamuna, when it was worshipped as a Goddess. How did it lose its relevance with the passage of time and became polluted has also been depicted by him. Dr. Satsangi has given the precautions to be taken for the revival of the river and delineated the effective measures that are taken up by DEI and Dayalbagh to maintain the same. An exemplary 'Dayalbagh Way of Life' ideal for the sustainable growth of the river Yamuna and its surroundings is the main focus of Shri Puneet Chaudhary. How one can be happy and healthy by leading this way of life in the vicinity of pure nature has been elaborated by him. In the words of Garrison Keillar, "A book is a gift you can open again and again." I am sure that this Special Issue would give credence to all the possible solutions to the future pillars of our nation in their ventures to safeguard the rivers.

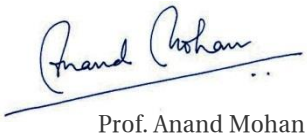
It has been truly said, "Rivers don't drink their own waters; trees don't eat their own fruits. The salt seasons the soup in order to have its purpose fulfilled. Live for others." This joint endeavour of the community and the institute is a stride to fulfill the mandates of the community to serve mankind and bring in better worldliness.

This would never have been possible without the benign blessings of our torch-bearer and Spiritual Master Revered Prof. P.S. Satsangi. I offer my utmost humble gratitude to Him for His ineffable Grace and initiative for such a noble cause. We are indeed very fortunate and blessed to have the Guidance of a Visionary with us. I also thank all the distinguished experts for sharing their ideologies for a challenging situation of our eco-system. I would like to quote Henry Ford and Edward Everett Hale here. They said,

"Coming together is a beginning, staying together is progress, and working together is success." We are sure that with such an enlightening beginning, we would practice and work upon the different strategies to bring back the glorious serenity of the river Yamuna once again. "Even a single lamp dispels the deepest darkness." Mahatma Gandhi. The lamp has been lit and by this one-of-a-kind workshop and this treasure of the ideologies of the renowned people would now inspire others to join in this noble endeavour. I also remember the words of Shri Majhrooh Sultanpuri that gives a hope that this would motivate and encourage others to revitalize the river Yamuna and make this earth a better place to live in.

**मैं अकेला ही चला था जानिब-ए-मंज़िल मगर**
**लोग साथ आते गए और कारवाँ बनता गया**

Let all of us join hands to accomplish this task. Winston Churchill has rightly said, "Success is Not Final, Failure is Not Fatal: it is the Courage to Continue that Counts".



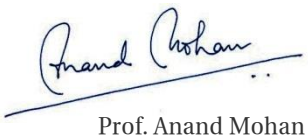
Prof. Anand Mohan
Guest Editor

# ACKNOWLEDGEMENTS

We bow our heads in our humble reverence and sincere gratitude to our Supreme Father, Revered Professor Prem Saran Satsangi Sahab, Chairman, Advisory Committee on Education, for Bestowing His Constant Grace and Guidelines. We also seek His Forgiveness for the errors that we make. His Initiative, Directions and Blessings have enabled us to carry out this task.

My sincere thanks to all the distinguished speakers for sparing their valuable time for joining us online and sharing their commendable expertise with us. The admirable efforts of the organizers of this workshop deserve a special recognition. We thank Dr. Shashi Srivastava and Dr. Namita Bhatia who have been kind enough to read and comment on the papers of this volume. Any remaining errors are of course entirely my own. The invaluable support from the office bearers of the Systems Society of India is deeply appreciated. I would like to thank my wife, Roopa and family members for their incredible support.

This would never have been possible without the benign blessings of our torch-bearer and Acclaimed Waqt/Present Sant Satguru Revered Professor P.S. Satsangi Sahab. I offer my utmost humble gratitude to Him for His ineffable Grace and initiative for such a noble cause. We are indeed very fortunate and blessed to have the Guidance of a Visionary with us. In the words of Garrison Keillar, “A book is a gift you can open again and again.” I am sure that this Special Issue would give credence to all the possible solutions to the future pillars of our nation in their ventures to safeguard the rivers.



Prof. Anand Mohan
Guest Editor

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## "Restoration/Rejuvenation of Water in the River Yamuna, Agra"

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## Contents

# यमुना नदी का कायाकल्प, पुनर्स्थापन और पुनर्जीवन

**डॉ. राजेंद्र सिंह, (जलपुरुष)**
भारतीय जल संरक्षणवादी तथा पर्यावरणविद्, अलवर, राजस्थान

दयालबाग़ द्वारा आयोजित इस यमुना कार्यशाला में मेरी भागीदारी निश्चिय ही मेरे लिये आनन्द का विषय है। इस कार्यशाला में परम् पूज्य ग्रेशियस हुजूर के दर्शन पाने का सौभाग्य, मेरे लिए विशिष्ट एवं हर्ष का विषय है।

परन्तु हर्ष के इस विशिष्ट अवसर पर जब मैं यमुना की बात करता हूँ, तो अनादिकाल से प्रकृति में विद्यमान अनगिनत प्राणियों की प्राणसलिला एवं कल–कल–निनादिनी यमुना की वर्तमान दयनीय स्थिति का स्मरण होने से अचानक मेरे आनन्द में कमी आ जाती है।

अपने उद्गम स्थल यमुनोत्री से निकलकर हथिनी कुंड तक यमुना जी की यात्रा जहाँ एक ओर बाल्यकाल में इठलाती, खेलती, कूदती, हुई निश्छल सुरकन्या के समान यात्रा करते हुए प्रतीत होती है, वहीं दूसरी ओर, यह एक विडम्बना है कि, हथिनी कुण्ड पुहुँचते ही मानो उस सुरकन्या के पाँवों में बेड़ियाँ पड़ जाती हैं। परतन्त्रता के अवसाद से अवसादित यमुनाजी अपने समस्त जल–प्रवाह के साथ कैनाल में चली जाती हैं।

12 मार्च 1992 में 5 राज्यों के बीच एक एग्रीमेंट हुआ था कि यमुना जी को लीन सीजन में भी 10 प्रतिशत पर्यावरणीय प्रवाह मिलेगा, लेकिन आज तक भी इतना पर्यावरणीय प्रवाह कभी नहीं मिला। जब बाढ़ आती है, तो सारा पानी आ जाता है, लेकिन लीन सीजन में जब यमुना बहनी चाहिए, तब उसका सारा पानी हथिनी कुण्ड बैराज में आकर कैनाल्स में चला जाता है। भौगोलिक दृष्टिकोण से यह नदी पुराने समय में 4 राज्यों की नदी थी; अब 5 राज्यों की हो गयी है। चूँकि उत्तराखण्ड और उत्तर प्रदेश अब अलग हैं, इस प्रकार से उत्तराखण्ड, उत्तर प्रदेश, हरियाणा, दिल्ली और पंजाब का भी इसमें हिस्सा है।

हम इस नदी को स्पिरिचुअल, कल्चरल और सिविलाईजेशनल नदी मानते हैं। भारतीयों में नदियों को आध्यात्मिक आस्था से जोड़कर देखे जाने की परम्परा रही है, लेकिन यह आस्था भी अब नदियों की सेहत ठीक करने में पर्याप्त मदद नहीं कर पा रही है, क्योंकि जो देश नदियों को माँ कहते हैं उन्हीं की नदियाँ सबसे गन्दी हैं, जो माँ नहीं कहते, उन्होंने तो फिर भी अपनी नदियों को वर्तमान में थोड़ा–बहुत ठीक किया है। अतः मेरा मानना है कि यमुना जो भारत की आध्यात्मिक, सांस्कृतिक और गंगा–जमुनी तहजीब की जन्म–दात्री रही है, उसको ज़रा उसी दृष्टि से देखने की आवश्यकता है। इस समय यदि यमुना नदी को ठीक करना है, तो यमुना के अध्यात्म और विज्ञान, इन दोनों के बारे में जानना पड़ेगा। इसके लिए तकनीक और इंजीनियरिंग की मदद की भी ज़रूरत है, लेकिन इस तकनीक और इंजीनियरिंग की मदद से यमुना के किनारे जो विकास हुआ है, वह बहुत भयानक है।

यमुना के दोनों तटों पर सीमेंट और कंक्रीट से विशाल भवन बनते जा रहे हैं। मैं जब यमुना के लिए, यमुना की ज़मीन पर सत्याग्रह कर रहा था, तब एक कविता लिखी थी, उसे पढ़ कर सुनाता हूँ–

*"सीमेंट कंकर पत्थर में मत बाँधो, कदम करील बड़ पीपल गूलर से बाँध दो मुझे।*
*मोर पपीहा कोयल चिड़िया यमुना को सबकी ज़रूरत है भैया, गंदे नाले यमुना में मत डालो।*
*साबी जैसी अन्य सभी को पवित्र बना दो,*
*जल ग्रहण क्षेत्र में जोहड़ बनाएँ, पुरानी सभी धाराओं को सदानीरा बनाएँ।"*

***Corresponding author:** rajendra@tarunbharatsangh.org
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मैं कहना यह चाहता हूँ कि आज हम यमुना के किनारे, जिस तरह से रिवर–व्यू और फ्रंट–व्यू डेव्लपमेंट के नाम पर सीमेंट–कंक्रीट के जंगल खड़े कर रहे हैं, वे यमुना की सेहत को बिगाड़ते हैं। यमुना के किनारे पर पंचवटी चाहिए। कदम, करील, गूलर, बरगद और पीपल– ये यमुना की पंचवटी हैं। हम यमुना की पंचवटी को भूल गये हैं। यमुना के किनारे पर यदि ये पेड़ होते, तो बहुत सारे जल के प्रदूषण को इन पेड़ों की जड़ें डाइजेस्ट कर सकती थीं। लेकिन हमने यमुना की विलक्षण प्रदूषण–नाशिनी शक्ति, जो यमुना के अन्दर खुद थी, यमुना के जल में थी, उसकी अनदेखी की है।

हमने इसकी कैरिंग कैपेसिटी अर्थात् जल प्रवाह की शक्ति से भी ज़्यादा, उसमें प्रदूषण डाल दिया और यमुना के पर्यावरणीय प्रवाह को बिलकुल खत्म कर दिया। अब यमुनाजी में उत्तरकाशी से चलने वाला जल आगरा तक भी नहीं पहुँचता। उत्तरकाशी से चलने वाला जल अब हथिनी कुण्ड में ही रुक जाता है, बंद हो जाता है। इसलिए यमुना को शुद्ध करने के लिए इसका इकोलॉजिकल एनवायर्नमेंटल फ्लो एन्स्योर करना और रिवर और सिवर के सेपरेशन की महती आवश्यकता है। इसके अतिरिक्त हमें यह भी ध्यान रखने की आवश्यकता है कि, इण्डस्ट्री के उत्सर्जित जल को सेपरेट ट्रीटमेंट के बाद भी यमुना में नहीं आने दिया जाय। ट्रीटमेंट के बाद हम उस जल को बाग़वानी, खेती, उद्योग व इण्डस्ट्री में रि–ट्रीट, रि–सायकल ऑर रि–यूज करने के सिद्धान्त को अपनाएँगे तो यमुना फिर से एक दिन जवान हो कर, स्वस्थ होकर हमारे स्वास्थ्य को ठीक रखने लगेगी। यमुना जी के स्वास्थ्य की चिन्ता हमें नहीं है, इसीलिए हम यमुना को सीमेंट, कंक्रीट, पत्थर में बांध रहे हैं। यमुना को अविरलता और निर्मलता चाहिए। आज हमने यमुना की अविरलता और निर्मलता को सम्पूर्ण तरह से समाप्त कर दिया है। हथिनी कुण्ड के नीचे यमुना जी अपनी अविरलता से नहीं बहती, हमें यमुना माँ की सेहत ठीक करनी है, तो हथिनी कुण्ड से नीचे की तरफ जो यमुना जी का निर्मल जल है, उसे 1992 के एग्रीमेट के तहत् आगरा तक अविरल प्रवाहित होने देना चाहिए। इन दो लेवल पर काम करने की आवश्यकता है। पहला लेवल यह है कि राज्य तथा समाज, न सिर्फ़ यमुना जी, बल्कि समस्त नदियों के बारे में, अपने रोल और रेस्पॉन्सिबिलिटी को समझे। जब राज्य तथा समाज अपनी रेस्पॉन्सिबिलिटी को नहीं समझते, तब हमारे हुजूर सत्संगी जी जैसे संत की महती भूमिका हो जाती है, जनता को खड़ा करके यह समझाने के लिए, कि तुम्हारी सेहत तभी तक ही ठीक रहेगी, जब तक यमुना की सेहत ठीक है। इसलिए हम जब आजकल के युवा, जो हैल्थ कॉन्सियस हैं, की हैल्थ कॉन्सियसनेस को यमुना की हैल्थ कॉन्सियसनेस के साथ जोडेंगे, तो यूथ इस काम में हमारे साथ आयेंगे। हमें यह जानकर प्रसन्नता है कि दयालबाग़ में बहुत यूथ हैं और वे सभी कल्चर्ड और डिसिप्लिन्ड स्टूडेंट्स हैं। हमें हमारी माँ यमुना की हैल्थ और हमारे यूथ की हैल्थ तथा हमारी हैल्थ के रिलेशन से अपने स्टूडेंट्स को सिखाने की आवश्यकता है। जिस दिन उनको ये रियलाईजेशन होगा, जिस दिन उनको ये महसूस होगा, कि हमारी हैल्थ यमुना की हैल्थ के बिना ठीक नहीं रह सकती, तो वे कुछ इनोवेटिव और क्रिएटिव एक्शन लेंगे और जो दयालबाग़ का एक्शन है, उस एक्शन में भी बढ़–चढ़ कर आगे आयेंगे। मुझे लगता है कि हम भारत के लोग नीर, नारी, नदी को नारायण मानते थे।

नीर माने लाइफ, नारी क्रिएटर (जननी) अर्थात् जन्म देने वाली और नदी प्रवाह (गति) देने वाले थे। ऑल फ्लो, सिविलाईजशनल, कल्चरल, स्पिरिचुअल, इकोनॉमिकल ऑल द फ्लो आर रिलेटेड विद् रिवर। अतः हम यह कह सकते हैं कि जीवन को जो प्रवाह देती है वह नदी होती है। यमुना के प्रवाह से एक बड़ी सिविलाइजेशन गंगा–यमुना तहजीब, गंगा–यमुना संस्कृति, गंगा यमुना सभ्यता का जन्म हुआ है। मुझे लगता है कि हम अपनी लाइफ लाइन यमुना को अपने सिविलाइजेशन के कल्चरल, अपनी स्पिरिचुअल अपने इकोनोमिकल ऑल फ्लो विथ ऑवर रिवर यमुना से जोड़कर देखें, यदि हम इस नदी के साथ, यानी यमुना के साथ अपने जीवन के फ्लो को जोडकर देखें, तो हमारा रियलाईजेशन, इंटर रिअलाईजेशन निश्चित ही यमुना के लिए केवल सोचने की ही नहीं, कुछ करने की ताकत देगा तथा हमें कुछ करने का कमिटमेंट, कुछ करने का डेडिकेशन और कुछ करने का एक्शन देगा। इसलिए हम अपनी यमुना नदी के साथ जो इण्डियन थॉट ऑफ स्कूल में था, कभी नीर, नारी, नदी, नारायण हैं, ऐसे मानते हुए, जब भारत के लोग नीर, नारी, नदी को नारायण जैसा सम्मान देते थे; तब उनके मत में विद्या जगी और वह विद्या, जिससे सबका सुख हुआ, सबका भला हुआ। भला करने वाली विद्या अब दुबारा पुनर्जीवित करने की आवश्यकता है। सबका सुख और भला करने की आवश्यकता है। हमारी शिक्षा हमें केवल मेन्टल एक्सरसाइज कराती है और हम शिक्षा में मेन्टल एक्सरसाइज करके अपने पैकेज, अपनी सर्विस, अपने कैरियर इत्यादि की खोज में लग जाते हैं। जब हमें विद्या मिलती है, तो हम अपने जीवन को विरति भाव से, मुक्ति के भाव से देखने लगते हैं। यमुना हमें सबके शुभ के रास्ते पर आगे बढ़ायेगी, इसीलिए पूज्य हुजूर ने हमारा ध्यान यमुना जी की तरफ बढ़ाया है।

यमुना नदी के अविरल–निर्मल प्रवाह हेतु हमें 11 सूत्रीय कार्य करने की आवश्यकता है–

1. यमुना के किनारे के जितने भी शिक्षण संस्थान हैं, वे अपनी टेरिटोरियल रेस्पौन्सिबिलिटी डिसाइड करें। एक ज़माना था, जब यमुना के किनारे के मंदिर और घाट पर रहने वाले पुजारी और सन्त, यमुना में गन्दगी होने से रोका करते थे; आजकल वे नहीं रोकते। मुझे लगता है, जब शिक्षण संस्थान इसको रोकने में आगे आयेंगे, तब सरकारों को थोड़ी शर्म आएगी और सरकार अपनी रेस्पौन्सिबिलिटी को, अपनी ड्यूटी को निभाने के लिए आगे आयेगी। यही है यमुना की साक्षरता।

2. यमुना में बहने वाले जितने भी गंदे नाले हैं, उनका काम हमें ज्ञात है। दयालबाग़ ने बहुत अच्छे से मॉनिटरिंग करके, पॉइटं मॉनिटरिंग करके, इन्हें चिह्नित किया था और बताया था कि, किस तरह से पॉलुशन आता है। दयालबाग़ द्वारा बनाये गये पॉलुशन डाटा के आधार पर आगरा के अलावा अन्य शहरों के शिक्षण संस्थान भी इसका रिसोर्स मैपिंग करें और बतायें कि कहाँ पर किस तरह का गन्दा पानी, किस तरह का पॉलुटेड वाटर यमुना में आ रहा है।

3. यमुना में वर्षा–जल के जो नाले या जल स्रोत मिलते हैं, वर्षा जल के उन स्रोतों को ठीक से पुनर्जीवित करने, उनको रेजुविनेट करने तथा यमुना के फ्लो को बढ़ाने, इन तीनों कार्यों को, हमारी ये कार्यशाला अपने इम्पोर्टेन्ट काम की तरह हाथ में ले।

4. चौथा काम जो सरकार से करवाने का है, वह यह है कि यमुना की ज़मीन का आईडेंटिफिकेशन और डिमार्केशन करवाया जाए। यमुना के जो पुराने ब्लू जोन, रेड जोन और ग्रीन जोन, तीन तरह के जोन (लैंड) हैं, उनकी आईडेंटिफिकेशन और डिमार्केशन सरकार के इरीगेशन डिपार्टमेंट और म्युनिसिपल कॉरपोरेशन के ज्वॉइंट एक्शन से करवाने की ज़िम्मेदारी हमारी इस कार्यशाला में से कुछ लोगों को लेनी चाहिए। ऐसा करके यमुना को आज़ादी से बहने का अवसर दें।

   मैं जानता हूँ कि दयालबाग़ ने अपने सामने की यमुना जी को बहुत अच्छे से बनाया है, लेकिन जैसी कोशिश दयालबाग़ में हुई है, वैसी दूसरी जगह पर नहीं हुई है। दूसरी जगह पर भी वैसी ही कोशिश करवाने हेतु, हमारी इस कार्यशाला में डिस्कशन करके, विचार–विमर्श करके, किसी निष्कर्ष पर पहुँचने की आवश्यकता है। उस विमर्श का निष्कर्ष बनाके, उसकी संस्तुति रिपोर्ट बना कर, इस काम में लगाने के लिए हमें अलग–अलग तरह के ग्रुप बनाने चाहिएँ। लेकिन यह चार नम्बर का काम तो सरकार से करवाना पड़ेगा।

5. पाँचवाँ काम यह है कि यमुना जी के दोनों तरफ जो सिविल सोसाइटी हैं, उनको इस तरह से जागरूक किया जाये कि वे अपना गन्दा जल, निर्मल यमुना में न मिलने दें। ये जो छोटे–छोटे, नये तरह के बॉयो–ट्रीटमेंट प्लांट्स आये हैं और जो पानी के शोधन के लिए अब नवीन प्रयास हो रहे हैं, उन्हें हमारी सिविल सोसाइटी तक पहुँचाना और उनके बारे में समझाना, ये भी एक आवश्यक कार्य है।

6. यमुनाजी के कैचमेंट एरिया में जो पुराने ताल, तलैया, पोखर हैं, उन सब को रिजुविनेट और रिचार्ज करके नदी के फ्लो को बढ़ाने की आवश्यकता है। इससे हमारा ग्राउण्ड वाटर का लेवल ऊपर आयेगा तथा ग्राउण्ड वाटर भी ऊपर आयेगा, तब हमारी नदी यमुना जी का बहाव बढ़ेगा। क्योंकि डिस्चार्ज बहुत है और रिचार्ज घट गया है, इसलिए आज यमुना में जो नेचुरल फ्लो, सब–सरफेस वाटर फ्लो आते हैं तथा जो अण्डर गाउण्ड वाटर फ्लो है, वह फ्लो यमुना को नहीं मिल रहा है। समाज, सरकार और शिक्षण संस्थानों, तीनों की ज्वाइंट भागीदारी से हम ये काम कर सकते हैं। संयुक्त ज़िम्मेदारी से ही काम हो सकते हैं।

7. हम यह ध्यान रखें कि अब हमारी यमुना नदी की ज़मीन में, अर्थात् यमुना की जो ग्रीन जोन है, उसमें कंस्ट्रक्शन न हो और इस प्रकार के कंस्ट्रक्शन को रुकवाया जाय।

8. यह भी प्रयास करना कि, हमारी माँ यमुना को हथिनी कुण्ड से 1992 के एग्रीमेंट के अनुसार फ्लो मिले। यदि यह फ्लो मिलेगा तभी यमुना जी ठीक से बहेंगी।

9. हमारा अगला कार्य इन राज्य सरकारों को, जो यमुना का सारा पानी उठाती हैं, यह सिखाना है कि हमारी एग्रीकल्चर लैण्ड में सबसे ज़्यादा पानी का फ्लो आ रहा है। इसलिए हमारे क्रॉप पैटर्न का रेन पैटर्न के साथ लिंक हों, जिससे हमें यमुना से और ग्राउण्ड वाटर से ज़्यादा पानी न लेना पड़े। कम पानी में हमारी फ़सलें हो सकें।

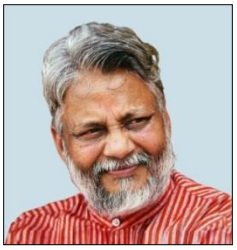
10. 10 वाँ कार्य यह है कि हमें अब यमुनोत्री से लेकर प्रयाग (इलाहाबाद) तक, यमुना की एक यात्रा प्लान करनी चाहिए; जिससे एक बार पुनः उन पाँच राज्यों को अपनी–अपनी ज़िम्मेदारी का बोध हो सके।

11. 11 वाँ कार्य यह है कि ये वर्कशॉप और डिस्कशन जो आज सम्पन्न हो रहे हैं, जो विमर्श हो रहा है, इसको ठीक से निष्कर्ष में, कन्क्लूजन में लेकर एक रिपोर्ट बनाकर एक संस्तुति के रूप में सरकार के साथ जल्द से ज़ल्द डायलॉग बढ़ाना चाहिए।

अन्त में एक स्लोगन 'पूज्य हुजूर' की इजाजत से ''नीर, नारी, नदी; नारायण हैं, नारायण हैं, नारायण हैं।''

यमुना की सेहत ठीक करने के लिए, हम अपनी–अपनी ज़िम्मेदारी, अपनी–अपनी हक़दारी, का अहसास करें और उसके साथ काम करने में जुट जायें। यह भाव हमारे अन्दर से आना चाहिए।

## About the Author



**Dr. Rajendra Singh** is a water conservationist and environmentalist from Alwar district, Rajasthan in India. Also known as "Waterman of India", he won the Magsaysay Award in 2001 and Stockholm Water Prize in 2015. He runs an NGO called 'Tarun Bharat Sangh', which was founded in 1975.

# Need for an Integrated Systems Approach in Rejuvenating the River Yamuna

**Prof. Prem Vrat**
AICTE – Distinguished Chair Professor
Pro-Chancellor; Professor of Eminence and Chief Mentor,
The North Cap University, Gurugram, Haryana, India

***Abstract:*** *This paper calls for identifying the root causes of increased pollution of the river Yamuna, particularly in the 22 Km. stretch in Delhi and pleads for an integrated systems approach – both preventive and corrective measures to find holistic solutions to coordinate efforts of various stake holders in public as well as private domains. A suggestion to model the problem in a system dynamic modelling framework is made to develop a set of scenarios and policy options in order to choose the preferred solution for achieving a cleaner river Yamuna sustainably.*

***Keywords:*** *Yamuna, Rejuvenation, Waste Disposal, System Dynamics, Behavioural Practice*

## INTRODUCTION/BACKGROUND TO THE PROBLEM:

River Yamuna is a sacred river of India and is the largest tributary of Ganga River; which joins it at Prayagraj while flowing through seven states of India – Uttarakhand; Haryana; Delhi – NCR; U.P; Rajasthan and Himachal Pradesh. It is worshipped by the devotees and is a source for irrigation; drinking; industries; bathing; immersion of idols and ashes after the cremation of the dead bodies. The fertile banks of the river are also availed for the agricultural activities like growing vegetables and cultivating crops.

However; this sacred river is now one of the most polluted rivers in India with its water contaminated at an alarmingly high level which is not even fit to bath or for drinking purposes. Its contaminated water is a health hazard even in terms of contaminated vegetables, food and fruits grown in its basin. This alarming pollution/contamination of the river Yamuna has led to initiatives such as Yamuna Action Plan (YAP) by the Government of India with the Japanese support. However it appears reasonable to infer that the problem of pollution not only prevails but has also reached an alarming plight. Despite a huge amount of money spent on solving the problem; it still remains a challenge. It is opined in this article that unless an integrated systems approach is adopted in a coordinated manner involving all the stake-holders to coordinate efforts of people; policies; processes and technology; there will be no permanent solution to rejuvenate the river Yamuna. We need to address the root cause of the problem instead of only addressing the symptoms of the problem.

## THE MAJOR SOURCE OF POLLUTION OF YAMUNA:

The river Yamuna enters Delhi from Haryana at Wazirabad and flows through Delhi in 22 Kms. stretch up to Okhla barrage which constitutes only 02% of its total length but this 02% length accounts for nearly 76% of the total pollution load. It supports 70% of Delhi's water supply. Thus the areas after Okhla barrage till it joins in confluence with the Ganga are mainly affected by the changes that it undergoes during its 22 km. journey. Some of the major sources of pollution and contamination of the river are:

**a)** Domestic waste water supplies: 90% of the domestic waste water of the city flows into the Yamuna. It contains detergent, laundry waste water, chemical, phosphate compounds causing toxic froth in the river.

**b)** Industrial effluent: Heavy metal contamination due to industrial effluents; large catchment area in a densely populated area well connected to several drains-Najafgarh drain and Shahadra drain being the two major drains entering the Yamuna water. The rapid growth of the population of Delhi, industrialization and contamination of water bodies is a health hazard affecting the nervous system, organ failures etc.

**c)** Untreated sewage around 800 million litres/day is pumped into the river and 44 million litres of industrial effluents are discharged into the river Yamuna every day. Only 35% of sewage is treated before releasing into the river. Many STP's operate at the non-optimal level and having maintenance issues.

**Corresponding author: premvrat@gmail.com*
ISSN 0972-5032 (P); 

**d)** Immersion of idols during festive seasons and other spiritual events and during various puja functions or religious ceremonies.

**e)** Cremation and immersion of ashes in the river as per religious rites and rituals.

**f)** Encroachment of land in the river bed region; having human settlements; cultivation of vegetables and engaging in various business activities like dairy farming etc.

## Need for an Integrated Systems Approach in Handling the Problem:

The disjointed and non-coordinated efforts have not been successful in the past; nor are these likely to succeed in future. Hence, we need to sensitize people through education and training to have value system so that the utmost concern for self and a lower concern for the others in this case river Yamuna is discouraged. It calls for genuine respect and reverence for the sacred river and any form of man-made pollution and water contamination to be perceived as a sinful activity by the entire population instead of believing that one can wash off one's sins by throwing residual solids or liquid or any form in the river Yamuna. Thus attitudinal change in addition to seeking technical solutions to the problem is a pre-requisite; otherwise no sustainable solution is possible.

Thus we need to sensitize general population to have a preventive mindset; eliminate waste of all kinds; conserve water, develop technologies which prevent them from throwing waste-both solid and liquid into the river Yamuna. Steps/measures like -- improving STP's, inter-linking water bodies; using bio-degradable materials for idols and creating artificial lakes and water bodies to enable people to immerse idols or take bath on religious occasions in those artificial water bodies and ensuring that the water from such water bodies is released to the drains only after treating it—need to be taken up. There is a need for inter-state cooperation; for instance Haryana with Delhi, there has always been a perpetual problem about the the release of water from the Barrage to river Yamuna with respect to Hathni Kund Barrage in Haryana. The excess release of water during the monsoon season is, at times attributed to cause floods in Yamuna in Delhi. There are multiple stake holders who need to work in a coordinated manner.

The Major causes are the polluted water from two major drains that are released into the Yamuna. This calls to ensure that only the treated water is released into Yamuna, certainly after the through statutory policy interventions.

One could also explore options of recycling the water from drains after treatments for greening of parks/horticulture purpose etc.

We also need to improve sewage system; regular cleaning and dredging of drains, develop Yamuna banks into recreation parks and plantation of the right type of trees across the flow trajectory throughout its way to Prayagraj. A rigorous water quality monitoring using state of art technology must be put in place to the prevent river from being polluted or contaminated.

Encroachments; slums across the line of river flow must be prevented. A preventive focus should be the top priority rather than a corrective approach to keep cleaning without preventive polluting sources from being released to Yamuna. Development of picnic spots; entertainment parks and regular dredging of the river from silt formation may facilitate an increase in the flow velocity. The river may also be used for water sports and water-way transportation purpose with terms of contract requiring to keep the Yamuna clean.

Taking flood as an opportunity to cleanse the river from the present pollution and ensuring that in future no pollutant is allowed after that flood subsides, can also be an effective strategy to convert a difficulty into an opportunity. After the flood water level subsides; one can assume that the dirty water has been flushed forward. Hence maximum preventive efforts must be put in place to ensure that after the monsoon season monitoring alertness and control mechanism must be stepped up. There is also a need to have a single authority mandated with this task rather than multiple agencies for a coordinated effort in this direction.

## CONCLUDING REMARKS:

The Rejuvenation of the river Yamuna is vital but it is a very complex task because the causes are multifarious and unless we address removing the root causes of the problem; symptomatic solutions provided will not be sustainable. The major focus should be preventive; sensitizing behavior of people not to throw waste into the river. A system dynamics based policy modelling approach may help in developing various scenarios and select a desirable policy option which would provide a better way of rejuvenating the river through coordinated efforts of people, policies; technology and processes. Changing human behavior is crucial in this endeavor; otherwise the problem will remain despite isolated efforts in controlling pollution in the river Yamuna.

## About the Author

**Prof. Prem Vrat,** Pro-Chancellor at North Campus University Gurugram Professor of Eminence, Management Development Institute, Gurugram Former Vice Chancellor, Uttar Pradesh Technical University, Lucknow and Founder-Director, IIT Roorkee has had an outstanding academic record and is a product of IIT system throughout. He had obtained B.Tech. (Hons.) in Mechanical Engineering in 1966 from IIT Kharagpur and M.Tech. (Industrial Engineering & Operations Research) from the same institute in 1968. He received PhD Degree in Industrial Engineering & Operations Research from IIT, Delhi in 1974. He was Honorary Research Fellow at the Department of Engineering Production, University of Birmingham (U.K.) during 1975-76.

Prof. Prem Vrat has more than 41 years of experience in teaching, research, and consultancy and management development across the globe at Mechanical Engineering Department at IIT Delhi, AIT Bangkok and IIT **Roorkee**.

# River as Self-Organizing System with Critical Transitions: A Case Study of the Yamuna River

**Prof. Sanjeev Kumar and Prof. Karmeshu***
University of Petroleum and Energy Studies, Dehradun

## 1. INTRODUCTION

A river is a nonlinear complex system involving both biotic and abiotic interactions. This leads to the emergence of biodiversity supporting a variety of life forms. The effect of vegetation and its impact on the hydrodynamics condition in stream ecosystem has been an area of intense research investigations [1, 2]. Meandering rivers exhibit self-organization process affecting the morphology of the river platform governed by fractal geometry [3]. Montgomery [4] notes that the meandering river is a weakly chaotic dynamical system characterized by small Lyapunov exponents. The functioning of the stream as an ecosystem can be better understood as an interaction between water flow and plant growth Cornacchia etal [5] have developed a mathematical model which captures biophysical feedback between plant growth and flow leading to spatial self – organization.

The flat area along the river, called the flood plain, needs to be protected. Bhaduri [6] observes that damages to flood plains cause harm to the river ecosystems while lessening general water recharge capacity, thus posing threats to flash floods. Soni and Singh [7] forcefully argue in the context of Yamuna River, that flood plains are increasingly natural storage of water with remarkable characteristics of self - recharging and self – sustainable aquifer for the city water. Accordingly, in the context of river ecosystems both the river and the flood plain are equally important. However, flood plains are being increasingly utilized for the construction of commercial buildings and tourist resorts, and consequently adversely affecting the river ecosystems.

For the purpose of illustration large scale construction has been done on the riverbed which makes the availability of good quality water irretrievable. This has been characterized as rogue development because it deprives the population of water resources. Another disturbing feature, as noted by Prof. Jain [8] is that the quality of water has considerably deteriorated. Jain [**8**] further points out that the rivers have been polluted on account of heavy untreated sewage flux, domestic waste, industrial effluents, and agricultural residuals. Accordingly, the study of water quality parameters such as dissolved oxygen concentrations and electric conductivity etc are measured based on water quality time series. [9]

The degradation of the river systems is facing threats on account of critical transition which may occur as the river ecosystem reaches tipping points. Such transitions entail the risk of unwanted collapse [10]. Accordingly, the science of river restoration has taken center stage worldwide by rejuvenating river ecosystem by deliberate policy intervention as one can prevent the system reaching the tipping point of phase transformation. It is pertinent to point out that regime shifts with qualitatively different characteristics are ubiquitous. Martin etal [11] elaborate that catastrophic shifts occur in real circumstances and the recovery from state/regime to another is exceedingly difficult. They elaborate the mechanisms to smooth the abrupt transitions enabling them to make transitions easier to revert. [11]

## 2. MODELING WATER POLLUTION

The effect of global water pollution is significant and poses a major challenge for humanity. With a view to control pollutant levels, the understanding of spatio–temporal dynamics of pollutants will require stochastic framework. Recently, there has been a growing realization that the pollution levels exhibit long tail non-Gaussian distributions. The rationale for non-gaussian heavy tail distribution is provided by the super statistical framework in a long time series with long time scale [12, 13]. The complicated probability distribution with heavy tail may arise on account of aggregation of many short time series, each with simple, non-heavy tail distribution [9]. The pdf of heavy tail q-Gaussian distribution is

$$p(x \mid q, b, \mu) = \frac{\sqrt{b}}{c_q}[1 + (1-q)(-b(x-\mu)^2)]^{\frac{1}{1-q}},$$

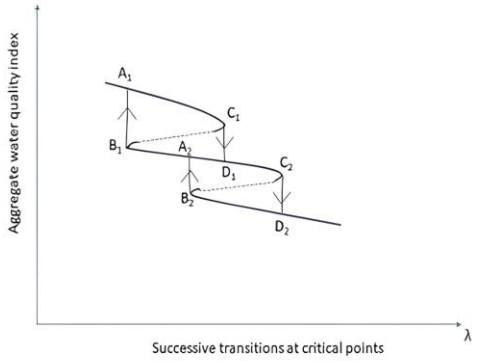
where $c_q$ is the normalization constant, b and $\mu$ are scale and shift parameters, respectively.

*Corresponding author: karmeshu@gmail.com
ISSN 0972-5032 (P); 

The parameter q represents the entropic index which is the limit $q \rightarrow 1$ transforms q-Gaussian to Gaussian distribution with variance $\frac{1}{2b}$. It is worth noting that q-Gaussian distribution may arise from Gaussian process with time-dependent variance, displaying superposition of many simple Gaussian distribution in the long term. The underlying idea is that the governing stochastic process changes on a long-time scale, while on a shorter time scale $<< T$, the system relaxes toward its local equilibrium [9]. Within the superstatistical framework, the statistical fluctuations of the pollutants in any river, say Yamuna may be worth investigating. A human activity on account of urbanization has had an adverse effect on the quality of water for the ecosystem of urbanized rivers. Researchers have collected a vast amount of data pertaining to high-frequency electrical conductivity and temperature etc., both in urban as well as rural streams. $Schäfer$ etal [14] have concluded from their study that combination of point and diffuse pollution sources e g common electrolytes, like chloride, sulphate, sodium, potassium in waste water and their impact on health is a challenging problem, $Schäfer$ etal [14] have adopted machine learning approach to identify key parameters of water quality dynamics.

## 3. CRITICAL TRANSITIONS, REGIME SHIFTS AND TIPPING POINTS

The phenomenon of catastrophic shifts in the form of critical transitions at tipping points (threshold points) is ubiquitous. There are signatures in the form of early warning signals before reaching threshold points where critical transition to a contrasting state occurs as shown in Figure 1.




For the purpose of illustration, the transition occurs at the tipping point $C_1$ and the river system shifts to the lower contrasting state $B_1$ $C_2$. It may be pointed out that the fluctuations on the account of both internal as well as environmental stochasticity in the river systems are greatly enhanced as one approaches the critical points (tipping points). It would thus be helpful if early warning signals associated with critical transitions can be identified. Small perturbations at critical points may cause sudden transitions resulting in great environmental damage. Retrieving the previous state may not be possible as it entails enormous cost. Attempts are being made to develop appropriate nonlinear stochastic does not seem to be appropriate, Stochastic approaches to help anticipate critical transition.[15]. Thus, a river ecosystem may be resilient up to a certain level of human intervention by way of exploitation of river resources including floodplains. Such interventions beyond critical points may lead to disastrous consequences. Accordingly, human activities have posed big threats to the rivers by over harvesting, pollutant loading, addition of drainage water, converting flood planes into Urban use. An alarming consequence is likely to appear on account of successive bifurcation in the form of catastrophes.

## 4. RIVER RESTORATION: YAMUNA RIVER

A major concern relates to monitoring of the water bodies for assessing the water quality. The Central Pollution Board [16] is involved in the study of river stretches for the restoration of water quality. The distribution of pollutants in the river may depict heavy tails corresponding power law distribution and thus implying preponderance of high level pollutants. This investigation would be useful for understanding and controlling the pollutants. Iyer [17] points out that the river conservation in the broader context is not only concerned with rescuing the river from pollutants and contamination but is much more.

In the context of the river management, the need for protecting floodplain from unplanned construction and encroachment on the riverbed is of paramount importance in averting floods. Bahaduri [6] points out that the lack of

flood plain regulation despite disastrous floods in the recent times is a matter of serious concern. For the purpose of illustration, the flood plain on the Yamuna River is of good quality drinking water. Soni [18] notes in his book "that the floodplain is an extensive and exceptional aquifer that runs the whole length of the river – even thousands of kilometers". The river restoration is essentially interplay of scientific knowledge and the role of restoration as a social process, besides the identified objectives [19].

## 5. CONCLUSIONS

The deepening environmental crisis over the last few decades, particularly on account of the greed of human beings, has caused irreparable damage to the environment. The continued over exploitation of the natural resources has led to a situation where the environmental impact has not only been disastrous, but irreversible. Such a situation has aroused partly due to lack of understanding of the environment as a nonlinear system with a multitude of linkages, being continuously affected. The nonlinearity in the environment may give rise to multiple equilibria where the perturbations may shift the system from one equilibrium to the other. This connects to the notion of resilience of the ecosystem.

It is to be realized that the environmental resources cannot continue to be exploited with impunity as it will create a wide range of problems. These problems fall within the framework of sustainability. Osten and Miller [20] discuss the sustainable use of common pool resources, exploring the nexus between profitability/greed and sustainability. They note "If individual agents are solely driven by profit, the shared resources is depleted in the long run – sustainability is possible despite some greed, but too much will lead to the over – exploitation."

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## About the Author

Dr. Sanjeev Kumar is working as a Professor, in the School of Computer Science and Coordinator, Centre for Stochastic Modelling and Simulation at the University of Petroleum and Energy Studies, Dehradun since February, 2022. Earlier he had been working as a Professor in Department of Computer Science & Engineering and Head of Institutional Innovation Centre at KIET Group of Institutions, Ghaziabad. Professor Sanjeev Kumar is Ph.D. from School of Computer & System Sciences, Jawaharlal Nehru University, New Delhi, in the area of Stochastic Modelling and Monte Carlo Simulation of Spiking Patterns in an Ensemble of Neurons. He obtained his BSc (Engg) in Electrical Engineering and M.Tech. (Engineering Systems) from Dayalbagh Educational Institute (Deemed to be University), Agra. Prof. Sanjeev is having teaching and research experience in the area of Computer Science and Engineering for more than twenty years. Prof. Sanjeev has research interest in Computational Neuroscience, Cognitive Analytics, and Artificial Intelligence. He has worked as a co-editor of IEEE Conference proceedings, and Reviewer for SCI journal. Prof. Sanjeev has more than forty publications including IEEE Transactions/BioSystems and seven patents (national and international) to his credit.

## About the Author

Prof Karmeshu is a Distinguished Professor in the School of Computer Science and Director, Center of Stochastic Modeling and Simulation at University of Petroleum and Energy Studies, Dehradun. He is Concurrently the Chairman, Scientific Computing Panel (Naval Research Board), DRDO and Professor (Honorary) at the Shiv Nadar University, Greater Noida.

His main research interest is in the area of Mathematical Modelling and Computer Simulation. Prof Karmeshu is the Recipient of Shanti Swarup Bhatnagar Award in Mathematical Science. He was Awarded the Doctor of Science (Honoris Causa) at the Thirty-ninth Convocation, by the Dayalbagh Educational Institute (Deemed be to University) Agra.

# Sustainable Approaches to Mitigating Flood Disasters in the River Yamuna

**Prof. Pami Dua**
Delhi School of Economics,
University of Delhi, Delhi 110007

***Abstract:*** *In the face of climate change, this article aims to address the immediate and recurrent threat of flash floods triggered by intense rainfall. As global warming intensifies, the urgency for effective flood mitigation strategies has become apparent. Early flood warning systems play a pivotal role in alleviating adverse impacts; however, their effectiveness depends on community preparedness. This paper attempts to offer insights into the interplay between sustainable practices and for flood mitigation, highlighting the importance of community engagement (involvement/responsibility of the community) alongside technological and infrastructural measures. The Dayalbagh model provides a roadmap for the other communities, underscoring the need for a holistic and community-centric approach to climatic change-induced disasters.*

## 1. INTRODUCTION

Amid the challenges posed by climate change, the threat of flash floods looms significantly, demanding unwavering attention and sustainable solutions. These sudden and devastating deluges, triggered by intense bouts of rainfall, have the potential to wreak havoc on communities and landscapes with little warning. While climate change undoubtedly casts a long shadow over our environmental challenges, this article shifts its focus to a specific and pressing concern: flash floods. In many regions, these events are an immediate and recurrent threat, calling for targeted strategies to enhance resilience against their swift and unpredictable onslaught.

In the pursuit of a more resilient future, this article explores the critical relationship between sustainable community practices and flash flood mitigation. This contends that fostering sustainable lifestyles within communities can significantly diminish the risk of flash floods by reducing human-induced environmental impacts. The journey into this realm will shed light on an exceptional example set by the Dayalbagh community in India. Their commitment to sustainable living not only serves as a beacon of hope but also exemplifies how it can effectively contribute to the conservation and rejuvenation of natural ecosystems, ultimately fortifying their resilience in the face of flash floods.

As global warming intensifies, the prevalence and severity of floods are anticipated to escalate, highlighting the urgency for effective mitigation strategies. Given this emerging reality, the necessity for disaster preparedness and response systems cannot be overstated. Particularly, early flood warning systems, which anticipate and predict the onset of floods, play a pivotal role in alleviating adverse impacts, conserving resources, and bolstering disaster resilience. However, the effectiveness of these systems is significantly dependent on the preparedness and responsiveness of the communities at risk.

Against this backdrop, this study delves into the interplay between sustainable lifestyle practices and flood mitigation, arguing that community-led sustainable living can reduce the risk of flooding by minimising human-induced environmental hazards. Notably, this paper highlights the model of the Dayalbagh community in India, emphasizing both its sustainable living practices and community engagement towards preparing for disasters, demonstrating how these efforts have facilitated the conservation and restoration of natural ecosystems, thereby strengthening its flood resilience.

Through this exploration, the paper contributes a nuanced perspective to the discourse on flood mitigation and adaptation, underscoring the crucial role of community engagement and sustainable practices alongside technological and infrastructural measures. The insights from the Dayalbagh model provide a roadmap for other communities grappling with similar challenges, underlining the imperative for a holistic and community-centric approach in navigating the complexities of climate change-induced disasters.

**Corresponding author:* pami.dua@gmail.com
ISSN 0972-5032 (P); 

### *Floods: Classifications, Consequences and Causes*

Floods, defined as the inundation of land and human settlements by rising water in channels, can cause extensive damage. Unlike other natural disasters, floods have well-established causes and often occur in predictable regions and timeframes. Floods can be classified on the basis of duration and location.

#### *Duration*

a) Slow-Onset Flooding: This type of flooding occurs gradually over a period of days or weeks due to prolonged rainfall or snowmelt

b) Rapid-Onset Flooding: This type of flooding occurs suddenly and with little warning, usually within six hours of heavy rainfall or snowmelt

c) Flash Flooding: This type of flooding is a rapid-onset flood that occurs within minutes or a few hours of excessive rainfall, characterized by raging torrents that rip through river beds, urban streets, or mountain canyons. Unlike other types of flooding, which can be gradual or location-specific, flash floods are unique for their speed and unpredictability. They pose acute risks in urban areas with impermeable surfaces and arid regions with narrow water channels. Their sudden and severe impact underscores the need for immediate preparedness.

#### *Location*

a) Coastal Flooding: This type of flooding occurs when a large storm or tsunami causes the sea to rush inland

b) Arroyos Flooding: This type of flooding occurs in arid regions where water flows in a narrow channel, usually after heavy rainfall

c) River Flooding: This type of flooding occurs when water levels rise over the top of river banks due to excessive rain, snowmelt, or an ice jam.

South, Southeast, and East Asian countries, particularly China, India, and Bangladesh, frequently bear the brunt of these catastrophes. In India, of the total geographical area of 329 million hectares, more than 40 million hectares of land are vulnerable to floods, roughly one-eighth of the country's total area (www.ndma.gov.in). The basins of the Brahmaputra, Ganga, and Indus rivers represent the most flood-prone regions, with Uttar Pradesh, Bihar, West Bengal, and Odisha suffering the most.

The recent floods in the Yamuna River have inflicted significant human and economic distress, marking an unprecedented surge in water levels that triggered large-scale evacuations and resulted in loss of life. With a population of three million residing along its banks—600,000 of whom live in areas categorized as slums—the full extent of the human impact remains uncertain. On the economic front, the damage to agriculture and infrastructure has been substantial (Biswas, 2023).

Climate change significantly amplifies the risk of flooding through intensified rainfall events and shifts in the monsoon season, which is crucial for India's rainfall. Melting Himalayan glaciers further contribute to elevated river flows, heightening the potential for downstream flooding. Concurrently, rising sea levels escalate the severity of coastal floods. Rapid urbanization and inadequate infrastructure disrupt natural drainage systems, worsening the urban flooding.

As the planet continues to warm, the need for robust flood management strategies becomes paramount. These should include early warning systems, flood-resistant infrastructure, and sustainable land-use planning. Building resilience against these threats involves a multifaceted approach that includes both mitigation and adaptation measures. For example, ecosystem conservation, such as protecting forests and wetlands, serves as a natural buffer against floods. Balanced water availability can be achieved through efficient water management practices like improved irrigation systems, rainwater harvesting, and watershed management.

Understanding the implications of climate change and adopting sustainable practices will be instrumental in safeguarding invaluable natural resources like the Yamuna River and the communities dependent on them.

This paper is structured to provide a comprehensive understanding of sustainable approaches to mitigating and adapting flood disasters in the River Yamuna. Section 2 delves into the Early Warning Systems currently implemented in India to prepare for floods. In Section 3, the paper focuses on creating resilience towards floods, exploring both structural and non-structural measures, as well as government policies aimed at flood management. Section 4 discusses

Dayalbagh's ongoing initiatives to restore and rejuvenate the River Yamuna, shedding light on community-led efforts and their reverberations. The article concludes in Section 5, where the actionable insights for future resilience building against flood-related disasters have been summarised.

## 2. EARLY WARNING SYSTEMS IN INDIA TO PREPARE FOR FLOODS

Early warning systems are essential for getting ready for natural disasters. They help us know in advance when a disaster might happen. This early notice is crucial because it gives us time to get ready, protect our communities, and reduce the degree of harm. These systems also help the emergency teams respond quickly and provide information to the public so that people can stay safe. So, early warning systems are like safety nets that help us to be prepared when nature's fury strikes.

The newly constituted Disaster Risk Reduction Working Group (DRRWG) under India's G20 Presidency has identified Universal Coverage of Early Warning Systems as one of its five key priorities (Mishra, 2023). The DRRWG aims to promote pre-arranged finances to take early action, thereby ensuring that Early Warning Systems truly work as systems that serve the needs of communities at risk. The DRRWG recognizes the importance of Nature-based Solutions and Ecosystem-based Approaches for Disaster Risk Reduction and aims to generate and collate a robust evidence base (including cost-benefit analyses) for the effective implementation of these approaches.

The Sendai Framework, established in 2015 at the Third United Nations World Conference on Disaster Risk Reduction, (UNDRR, 2015) sets out seven targets and four key priorities to reduce disaster risks. These include understanding disaster risk, strengthening disaster risk governance, investing in disaster reduction for resilience, and enhancing disaster preparedness to "Build Back Better" in the face of disasters. The framework's primary goal is to significantly decrease disaster risk and minimize losses in various aspects of life, livelihoods, and assets over the next 15 years.

Table 1 summarizes various early warning systems and technologies used to mitigate flood disasters in India, emphasizing the importance of technology and community involvement in enhancing overall flood resilience. Details follow.

TABLE 1
EARLY WARNING SYSTEMS AND TECHNOLOGIES TO MITIGATE FLOOD DISASTERS IN INDIA

| Early Warning System | Description |
|---|---|
| Central Water Commission (CWC) | • Issues timely flood forecasts and warnings from May to December annually.<br>• Forecasts enable authorities to initiate appropriate responses, reducing vulnerabilities and flood risks. |
| Indian Meteorological Department (IMD) | • It issues the Flash Flood Guidance Bulletin, offering detailed rainfall forecasts for 6 and 24 hours.<br>• CWC supplements these with a 5-day Advisory Flood Forecast, incorporating real-time water level and inflow data. |
| National Disaster Management Authority (NDMA) | • NDMA, leads efforts in policy formulation, coordination, and response to reduce flood impacts in India.<br>• This includes working with states, districts, and communities to enhance preparedness through early warning systems and technology integration. |
| Remote Sensing | • National Remote Sensing Centre, ISRO employs satellite remote sensing and aerial data for flood forecasting. (for forecasting flood) |
| Regional Flood Early Warning Systems | **Examples:**<br>Collaborative efforts, including the Community-Based Flood Early-Warning System project, strengthen flood preparedness, while participation in glacial flood warning system initiatives extends beyond Uttar Pradesh.<br>• Guwahati's TERI and NDMA Flood Early Warning System utilizes advanced analytics and machine learning for precise flood predictions, offering alerts up to 72 hours in advance, significantly bolstering resilience. |
| Community-Based Flood Early-Warning System (CBFEWS) | • CBFEWS is Information and Communication Technology (ICT) based solution designed to involve local communities in flood risk management.<br>• These systems empower communities to proactively respond to the flood threats. |

### *Central Water Commission*

The practice of flood forecasting and issuing warnings in India has been operational since 1958, beginning with the Yamuna River. Over the years, the program has extended its reach to encompass the majority of flood-prone inter-state river basins.

As of 2021, the Central Water Commission (CWC) scaled up its flood forecasting services to 331 stations, catering to 22 states and three union territories. Annually, from May to December, the CWC's 36 Field Divisions undertake flood forecasting activities. They issue flood forecasts and warnings to both central and state authorities, reducing vulnerabilities and flood risks. This initiative is instrumental in offering timely alerts about potential flood events, enabling authorities to initiate appropriate responses and lessen flood-related damage.

### *Indian Meteorological Department*

The Indian Meteorological Department's (IMD) National Weather Forecasting Centre regularly releases the All-India Weather Warning Bulletin, providing a comprehensive 5-day prediction of rainfall and general weather conditions. Additionally, it publishes the Flash Flood Guidance Bulletin, offering a detailed forecast of rainfall for the upcoming 6 and 24 hours. Complementing these forecasts, the CWC disseminates a 5-day Advisory Flood Forecast. Incorporating real-time water level and inflow predictions for rivers and reservoirs, this forecast provides valuable data for all flood forecasting stations across the country.

### *National Disaster Management Authority (NDMA)*

The National Disaster Management Authority (NDMA) holds a key role in the early warning flood forecast system in India. The NDMA's review of early warning systems across various Indian cities offers valuable insights and guidance for developing effective systems at the city and urban local body levels. The development of flood forecasting and warning systems is an integral part of regional and national flood preparedness strategies, and the NDMA places a high priority on this aspect. These concerted efforts by the NDMA, including the formulation of guidelines and the review of early warning systems, are critical advancements in enhancing India's readiness and response capabilities in the face of flood disasters.

### *Remote Sensing and Advanced Technologies*

In addition to the traditional flood mitigation strategies, the potential of advanced technologies like Geographic Information Systems (GIS), satellite technologies, and machine learning is recognized (Sankaranarayanan et al.,2020). GIS assists in creating hazard maps to guide future planning and decision-making processes. Simultaneously, satellite technologies monitor weather patterns, river levels, and flood extents, providing crucial early warnings (Sneha et al. (2018)).

Deep learning and machine learning have revolutionized the flood mitigation strategies by analysing extensive datasets, including satellite imagery and radar data, to predict and track flood events with remarkable precision. These technologies, coupled with real-time weather and water level data, enhance flood forecasting accuracy, empowering decision-makers with actionable insights for efficient flood management (Mosavi, 2018).

Another noteworthy player in the nation's disaster management endeavours is the National Remote Sensing Centre of the Indian Space Research Organisation. It utilizes satellite remote sensing and aerial data, enabling better-informed decision-making and preparedness efforts.

The value of these advance warnings and forecasts lies in their ability to prompt continuous action to prepare for impending disasters.

### *Regional Flood Early Warning Systems*

A study by the Council on Energy, Environment, and Water (CEEW, 2023) recognizes Uttar Pradesh as one of the leading states in adopting Flood Early Warning Systems. To mitigate flood impacts, Uttar Pradesh has 39 Flood Early Warning Forecasting Stations (PIB, 2023). The state government has launched the "Aapda Prahari" app, which incorporates an Integrated Early Warning System for floods, providing crucial alerts to the citizens. Collaborative efforts, including the Community-Based Flood Early-Warning System project, are also working to strengthen flood preparedness. Additionally, the region is included in the initiatives being taken to develop early warning systems for glacial floods, with plans to expand these efforts beyond Uttar Pradesh (Reuters, 2023).

A noteworthy partnership between TERI (The Energy and Resources Institute) and NDMA (National Disaster Management Authority) has led to the launch of the Flood Early Warning System (FEWS) in Guwahati. This state-of-the-art system employs advanced analytics and machine learning algorithms to predict floods accurately. Capable of providing flood forecasts up to 72 hours in advance, the FEWS delivers timely alerts to both authorities and citizens, enabling proactive measures against potential floods. The implementation of this system showcases a significant leap in flood prediction and response capabilities, bolstering Guwahati's resilience to flooding.

***Community-Based Flood Early-Warning System***

Community flood resilience is defined as the outcome that enables a community to not only withstand flood risk but also thrive and advance despite it. In essence, if a flood-prone community embodies resilience, its progress remains unimpeded by flooding events. This definition is rooted in the broader concept of disaster resilience, which emphasizes a system, community, or society's capacity to simultaneously pursue social, ecological, and economic development while effectively managing disaster risk over time.

The Community-Based Flood Early-Warning System is an Information and Communication Technology (ICT) enabled mechanism designed to identify and address flood emergencies. It operates by engaging local communities in preparation and management. This wireless system effectively manages flood and flash flood risks by issuing early warnings to communities downstream and promoting collaboration between upstream and downstream areas in sharing flood-related information (UNFCCF (n.d.)).

The system comprises two main components: a transmitter and a receiver. The transmitter is positioned along the riverbank, while the receiver is located in a nearby riverfront house. A flood sensor connected to the transmitter monitors the rising water levels. Once the water reaches a critical threshold, a wireless signal is transmitted to the receiver. Subsequently, the flood warning is disseminated through mobile phones to relevant agencies and vulnerable downstream communities. Importantly, the determination of these critical flood levels is a collaborative effort, involving the local community's input and insights. For instance, in Uttarakhand's Chamoli district, a CBFEWS employs flood sensors linked to the transmitters to detect the level of the rising water, triggering alarms when water reaches critical levels. Meanwhile, in Assam's Dhemaji district, a CBFEWS combines rain gauges, river gauges, community-based observers, and a mobile app for early warning messages and alerts.

Communities can reduce flood severity by taking pre-emptive steps, such as reinforcing riverbanks, preventing erosion, and maintaining an organized drainage network k. Afforestation, preserving floodplains, and constructing dams are the other measures that the communities can adopt to enhance their resilience and safeguard against floods.

All the above measures align with the National Disaster Management Authority of India's (NDMA) mission of fostering a culture of prevention, preparedness, and mitigation. By promoting public awareness, bolstering community resilience, and improving disaster response capacity nationwide, the NDMA underscores India's commitment to creating a safer environment for its citizens.

Embracing the technological advancements and fostering community involvement is crucial for improving overall flood resilience and safeguarding communities from the devastating aftermaths of flooding.

Given below in Section 3 are some structural and non-structural measures that can be adopted for flood mitigation and adaptation, including the policies introduced by the government for flood management. +

## 3. CREATING RESILIENCE TOWARDS FLOODS

This section outlines a comprehensive framework for building resilience against flood disasters, focusing on both structural and non-structural measures (Table 2). Under structural measures, it enumerates approaches like constructing storage dams, barrages, and channelizing rivers. Additionally, it also suggests strengthening drainage systems and creating raised road structures for better infrastructure resilience. On the non-structural side, nature-based solutions are emphasized, including afforestation, hydro seeding, and restoring wetlands. Specific floodplain management techniques like dike reallocation have also been proposed. In terms of policy, the section incorporates measures at the national, regional, and local levels, such as the National Water Policy and the Delhi Flood Control Plan, aimed at effective flood management.

TABLE 2
STRUCTURAL AND NON-STRUCTURAL MEASURES FOR FLOOD RESILIENCE

| Category | Sub-Category | Specific Measures |
|---|---|---|
| Structural Measures | Dams & Barrages | Construction of Storage Dams |
| | | Barrage |
| | | Coordinated Barrage Operation |
| | River Engineering | River Channelization |
| | | Diversion into Retention Basins |
| | | Embankments |
| | Infrastructure | Strengthen Drainage Systems |
| | | Sustainable Drainage Systems |
| | | Raised Structures for Roads |
| Non-Structural: Nature | Afforestation | Vetiver |
| | | Hydro Seeding |
| | | Bamboo Planting |
| | | Cross Slope Tree Planting |
| | | Planting and Managing Hedgerows |
| | | Grass Strips |
| | | Living Fences |
| | | Sedge Planting |
| Non-Structural: Nature | Floodplain Management | Flood Plain Widening |
| | | Full Restoration with Dike |
| | | Restoring Wetlands |
| Non-Structural: Policy | National | National Water Policy |
| | | Flood Management and Border Areas Programme |
| | Regional | Flood Plain Zoning |
| | Local | Delhi Flood Control Plan |
| | | Yamuna Floodplain Management Plan |

## 3.1. STRUCTURAL MEASURES

### 3.1.1. Dams and Barrages

***Construction of Storage Dams***

The strategic implementation of storage reservoirs along the Yamuna River holds great promise in mitigating downstream flood impacts. By storing excess water during heavy rainfall, these reservoirs effectively attenuate peak flows, resulting in a significant reduction in flood magnitudes downstream. This crucial flood control mechanism offers enhanced protection to vulnerable areas, reducing the severity of inundation and providing critical safety to communities in the path of flooding along the Yamuna River.

***Barrage***

Barrages are concrete structures comprising gates that control water flow, primarily used for managing irrigation and water systems. The Farakka Barrage, constructed in 1975, is a prominent example in India. It was built across the Ganga River to redirect a portion of its flow to the Hooghly River, a tributary.

The Hathnikund Barrage, a flood control structure on the Yamuna River plays a pivotal role in regulating the Yamuna river's water flow and is interconnected via three water channels – Western Yamuna Canal to Haryana, Eastern Yamuna

Canal going to Uttar Pradesh and the residuary (main river) flowing to Delhi. During the 2023 floods, an overflow at the Hathnikund Barrage resulted in flooding in various areas of Haryana, Uttar Pradesh and Delhi. This situation was so severe that the Delhi government was put on high alert due to the discharge of over two lakh cusecs of water from the Hathnikund Barrage into the Yamuna river.

Despite this overflow, it is important to acknowledge that the Hathnikund Barrage has historically played a vital role in regulating the water level of the Yamuna River. This regulation supports navigation and contributes to the preservation of the overall health of the river ecosystem. Furthermore, the barrage has been recognized for its life-saving capabilities during flood events, underlining its importance in disaster management and flood control.

***Coordinated Barrage Operation***

Based on the analysis of the historical flood data, it is evident that the discharge released from barrages can vary significantly. To ensure safe and synchronised management of floodwater, it is crucial to develop a comprehensive policy for coordinated release in regions. It is recommended that responsibility for the operation of barrages be assigned either to the local Flood Department or a committee led by the chief engineer of the relevant water management authority. By establishing a coordinated barrage operation strategy, regions can effectively manage floodwater and minimise the risks associated with uncontrolled releases. This approach can be applied in various regions, including Agra, to enhance the overall flood management system and protect vulnerable areas from the repercussions of floods.

### 3.1.2. River Engineering

***River Channelization***

Channelization is a method of river engineering that widens or deepens rivers to increase their flow capacity. It is used to improve the efficiency of water movement during floods and reduce damage to the river banks. Sedimentation at the river base is removed through dredging to increase water flow rates. Channelization also helps with erosion control and the rehabilitation of watercourses. It has been implemented in rivers like Gomti in Lucknow, Mithi in Mumbai, and Brahmaputra in Assam to control floods.

***Diversion of Flood Water into Retention Basins***

To divert floodwater into retention basins, the following steps can be taken:

1. Identify suitable retention basin sites capable of holding significant floodwater without endangering nearby communities.

2. Construct basins designed for maximum floodwater storage and controlled release to prevent downstream flooding.

3. Regularly dredge the basins to increase their capacity for floodwater storage.

4. Maintain and utilize nearby recreational areas or lakes to prevent them from becoming dumping grounds and mosquito breeding sites.

***Embankments***

Embankments are artificial banks built along riverbanks to protect adjacent land from flooding. They are typically made of compacted soil, sand, and stones, with additional structures like spurs, gabion boxes, and sandbags for reinforcement. Embankments confine flood flows and prevent water from spilling, reducing flood damage. They are a popular and widely used method of flood protection, often considered economical and quick to construct.

### 3.1.3. Infrastructure Resilience

***Strengthening of Drainage Systems***

The phenomenon of rapid urbanisation necessitates the enhancement of existing drainage systems to effectively manage floods caused by the overflow of rivers, such as the Yamuna. Current drainage systems, originally designed under outdated parameters, have become insufficient owing to the increased population and urban development. Therefore, it is essential to promptly upgrade drainage infrastructure by incorporating new design parameters that consider the impact of urbanisation and updated rainfall data spanning several decades. This entails remodelling trunk

drains, reinforcing embankments, and adapting to the evolving urban landscape to accommodate higher discharges resulting from urban growth.

***Sustainable Drainage Systems***

Significant urbanisation in the upper Yamuna catchment has worsened the flood risk downstream. To mitigate this impact, it is essential to establish sustainable drainage systems that can minimise the adverse effects of urbanisation on watercourses. By separating the sewerage system from the drains, we can enhance their functionality and aesthetic appeal. These drains can be further utilised to conserve water by implementing control structures that regulate surface runoff and encourage greater infiltration into the ground, thus reducing flood risks.

***Raised Structure on the Pillars for Roads between Embankments***

In urban regions such as Agra, it is important to reconsider the design of the bridges and roads that traverse the rivers such as Yamuna. Currently, there may be instances in which the existing bridges tightly enclose the river, impeding its natural flow during periods of high -water discharge. This can lead to congestion and increased upstream water level. To mitigate these issues, it is crucial to avoid constructing pseudo-bridges or elevated road cum embankments that further confine the river. Instead, if a new bridge is necessary, it should be supported by pillars spanning between embankments, allowing the river to flow freely beneath it. By adopting this approach, the construction of the raised structures on pillars for roads can prevent additional enclosures of the river and the subsequent rise in the water levels. This strategy can be applied in various regions, including Agra, to maintain the natural flow of rivers and minimise the impact of congestion on water levels during peak discharge periods (India Wris. 2021).

## 3.2. NON-STRUCTURAL MEASURES: NATURE-BASED SOLUTIONS

### 3.2.1. Afforestation and Watershed Management

Afforestation and watershed management strategies are central to environmental remediation in regions around the Yamuna River, particularly Agra. These not only include the planting of conventional trees but also encompass specialized riverine grasses and bamboos designed to fortify the floodplains. Collaborations between the local government and forestry departments are crucial for the successful revitalization of the floodplain areas. These actions serve multiple purposes: soil and water protection, groundwater replenishment, and increased resilience against the pollutants.

***Specialised Vegetation Techniques***

- **Planting Vetiver:** Vetiver, an adaptive and fast-growing plant, has been successful in stabilizing the soil along the riverbanks in Uttar Pradesh, reducing both soil erosion and water runoff considerably.
- **Hydro Seeding:** This accelerated grass planting technique is effective for stabilizing slopes and preventing soil erosion, particularly on steep terrain.
- **Cross-Slope Tree Planting:** Implementing cross-slope and riparian planting methods can increase water storage, stabilize riverbanks, and reduce soil erosion, serving as a supplementary measure to the conventional afforestation.
- **Bamboo Planting:** Given its extensive root system, bamboo is effective for soil stabilization and could be considered a targeted approach within an afforestation strategy.
- **Grass Strips:** Utilizing tall grasses can slow down the speed of flowing water, reducing soil erosion.
- **Living Fences:** Creating living fences using shrubs and trees like willows can absorb excess water while acting as windbreaks.
- **Sedge Planting:** For waterlogged areas, sedges can offer an effective solution for the absorption of water.
- **Planting and Managing Hedgerows:** Hedgerows act as natural barriers that slow down runoff and encourage water absorption, serving as a practical option in both agricultural and riverine settings.

By implementing these specialized vegetative measures along with the traditional afforestation and watershed management, the flood resilience of the areas surrounding the Yamuna River can be greatly enhanced. These methods serve to minimize downstream flood risks, increase groundwater levels, and offer habitats for diverse wildlife. This

multifaceted approach could offer robust solutions for flood mitigation and ecosystem revitalization (Hangzo and Samant, 2023).

#### 3.2.2. Floodplain Management

***Flood Plain Widening***

Expanding rivers' floodplains through restoration efforts plays a crucial role in enhancing flood resilience and safeguarding communities. An exemplary instance is the ongoing widening project of the Adyar River in Chennai, initiated after the destructive 2015 flood. The completed work on a 22-kilometer stretch is part of a broader initiative, with the authorities conducting a study to explore further widening of the Adyar River. Implementing a similar technique along the banks of the Yamuna River in North India can prove instrumental in mitigating flood risks and protecting the well-being of the local communities.

***Full Restoration with Dike Reallocation***

An ecological restoration strategy involving the reshaping or reallocation of dikes along the rivers can significantly enhance flood protection and ecosystem health. This approach restores natural water flow, reducing flood risks and increasing landscape resilience. The benefits include improved flood protection and healthier ecosystems. However, implementation may involve costs, infrastructure considerations, potential displacement, and technical complexities. In the context of the Yamuna River, such a strategy could be implemented by assessing the most vulnerable areas along the river's course, gradually reshaping or reallocating dikes to allow for natural water flow and ecosystem restoration, while considering the needs and concerns of local communities and ecosystems (Kumar et al, 2017).

***Restoring Wetlands***

The Wetlands act as natural buffers, storing floodwater and reducing the frequency and intensity of floods. The Wetlands in India cover an estimated one to five percent of the country's geographical area and are home to a significant portion of its biodiversity. The Indian Space Research Organisation (ISRO) has identified a total of 7,57,060 wetlands in India, spanning 15.26 million hectares or 4.63 percent of the country's geographic area (ISRO, 2011). Among these, 75 wetlands covering 13,266.77 square kilometres are designated as the Wetlands of International Importance known as Ramsar Sites (Ramsar Convention Secretariat, 2020). However, the encroachment of urban development has posed a serious threat to these vital ecosystems.

The preservation and restoration of wetlands are crucial not only for flood control but also for maintaining biodiversity, water quality, and overall ecological balance. Strategies for wetland restoration include re-establishing native vegetation, controlling invasive species, and implementing policies to protect existing wetlands from further degradation. Through coordinated efforts between governmental agencies, NGOs, and local communities, wetland restoration can play a key role in sustainable flood management and ecological conservation.

### 3.3. NON- STRUCTURAL MEASURES: POLICIES

#### 3.3.1. National Level

***National Water Policy***

The first National Water Policy was adopted in September 1987, and it underwent subsequent reviews and updates in 2002 and 2012. The key aspects include the conservation of rivers, water bodies, and associated infrastructure, as well as the integrated management of storage capacities, wetlands, and floodplains. The policy emphasised the prevention of encroachment and diversion of water bodies and drainage channels, with restoration and maintenance efforts wherever feasible. By adhering to this well-crafted policy, authorities can facilitate sustainable water management practices for the Yamuna River, ultimately contributing to the region's ecological health, ensuring adequate water resources, and enhancing the overall well-being of communities that depend on this vital waterway.

#### 3.3.2. Regional Level

***Flood Plain Zoning***

Floodplain zoning is a vital strategy for identifying and designating areas prone to different levels of flooding, allowing appropriate development regulations to minimise damage when the floods occur. The Indian government had circulated a draft bill called the "Model Bill for Flood Plain Zoning, 1975", but only a few states have enacted this

legislation, with many yet to delineate and demarcate floodplains. The experts have warned of dire consequences if floodplain zoning is not undertaken because of the rise in the frequency and intensity of floods due to climate change.

#### 3.3.3. Local Level

***Delhi Flood Control Plan (DFCP)***

The Delhi Flood Control Plan (DFCP) is a comprehensive strategy designed to effectively manage and mitigate flooding in Delhi, India. It focuses on enhancing drainage infrastructure, including canals and storm water drains, to ensure efficient water runoff during heavy rainfall and prevent water logging. The plan also regulates the Yamuna River's flow, prevents erosion, and minimizes flood risks through embankments and flood control structures. Advanced technologies, such as weather monitoring and river level sensors, enable accurate flood forecasting and timely early warning alerts. The DFCP emphasizes reservoirs and dams upstream to regulate water flow, considering climate change, population growth, and urban development for adaptive management.

***Yamuna Floodplain Management Plan (YFMP)***

The Yamuna Flood Management Plan (YFMP) incorporates the demarcation of floodplain zones and implements land use regulations to reduce flood risks in vulnerable regions. The plan focuses on managing the river channel with the construction of embankments, revetments, and flood control structures, effectively regulating water flow and preventing bank erosion. Conservation and restoration of natural floodplain features, such as wetlands and vegetation, are emphasized to enhance ecological functions and minimize flood impacts. Additionally, community participation, awareness, and capacity building are promoted to bolster the resilience of residents in flood-prone areas and enable effective responses to flood risks.

## 4. DAYALBAGH'S ONGOING EFFORTS TO RESTORE/REJUVENATE THE RIVER YAMUNA

Building resilience towards flood risks can be initiated at the community level using a systems-based approach that considers various interdependencies. This approach is crucial to handle disaster-ridden situations.

One of the notable initiatives by Dayalbagh is the extensive cleanliness drive along the Yamuna. The community has been actively involved in cleaning the riverbank and organizing regular cleanup campaigns. These efforts are instrumental in preventing further degradation of the river's ecosystem and its impact on downstream areas. Flood mitigation is another critical area where Dayalbagh has made significant strides. The region around the Yamuna river is prone to flooding during the monsoon season, causing immense damage to property and livelihoods. Dayalbagh has implemented several innovative strategies to mitigate flood risks.

One of the primary measures taken by Dayalbagh is afforestation and wetland conservation. The community has planted a vast number of trees along the riverbank, which not only act as a natural buffer to absorb excess water during floods but also improve the overall ecological health of the area. Furthermore, wetlands have been conserved to act as natural sponges that can absorb excess water, preventing downstream flooding.

Dayalbagh's endeavours to clean the Yamuna and mitigate flooding are commendable examples of community-driven environmental conservation and sustainable development. Through a combination of river cleaning, afforestation, infrastructure development, and educational initiatives, Dayalbagh has made a positive has exerted a striking influence on the environment and the lives of the people living along the Yamuna.

It is notable that there is a link between a sustainable lifestyle and flooding, as sustainable living practices can help reduce the risk of flooding by minimizing the ramification of human activities on the environment, promoting the conservation and restoration of natural ecosystems and reducing the impact of climate change. The Dayalbagh Way of Life helps to achieve sustainable living and provides a long-term resilient solution to the problem of flooding.

In this context the recent efforts by Dayalbagh to preserve and conserve the surroundings of the river Yamuna including its banks to the highest standards are noteworthy. In the Ambrosial Words of Revered Professor P.S. Satsangi Sahab, Chairman, Advisory Committee on Education, Dayalbagh Educational Institutions:

“A major purpose is to enhance the smooth flow of the river and carry out cleanliness all around as accountable and responsible community activities….”

Further, Dayalbagh Educational Institute has taken up river bed upgrading activity as its social responsibility to conserve and protect the mineral-rich soil of the river bed which also becomes an avenue of active research for sustaining and substantiating the agro-ecological initiatives taken up by DEI and Dayalbagh.

Thus, the activities of Dayalbagh towards protecting the climate and environment by creating natural harmony in the prevailing surroundings, promotes the restoration of the Yamuna river's natural characteristics and dynamics, and also increases flood resilience in a more sustainable way than the traditional solutions.

## 5. CONCLUSION

This paper explores the current flood forecasting and warning systems in India, tracing their evolution and expanded coverage over the years. The Central Water Commission (CWC) has played a pivotal role in extending these systems to encompass the majority of flood-prone inter-state river basins, operating 331 stations that cater to 22 states and three union territories. This enhancement in forecasting capabilities has significantly reduced vulnerabilities and flood risks by issuing timely forecasts and warnings to both: the central and state authorities. Recognizing the potential of advanced technologies such as Geographic Information Systems (GIS), satellite technologies, and machine learning, this paper has underlined the importance of embracing innovation for effective flood mitigation.

Furthermore, the focus on creating resilience towards floods has highlighted the promising implementation of storage reservoirs along the Yamuna river, a measure with tremendous potential for alleviating downstream flood impacts. Additionally, this paper has delved into river channelization, the construction of protective embankments, the strengthening of drainage systems, the establishment of elevated road structures, and the strategic planting of highly water-absorbing trees along the riverbanks. These structural and non-structural measures, as outlined in Table 2, form a comprehensive framework for building resilience against flood disasters.

In the realm of policy, this paper has incorporated a multi-tiered approach, examining measures at the national, regional, and local levels. Key policy instruments such as the National Water Policy and the Delhi Flood Control Plan have been highlighted, emphasizing their significance in the effective management of floods. The culmination of these discussions provides a holistic understanding of the diverse strategies and tools at our disposal for mitigating and adapting to flood disasters, ensuring a more resilient future for the river Yamuna and the communities that depend on it.

The adoption of sustainable living practices holds a significant promise in mitigating the devastating impacts of flood disasters. These practices, ranging from structural modifications like dams and embankments to nature-based solutions like afforestation and wetland restoration, offer multifaceted benefits for flood resilience, environmental conservation, and community well-being. Dayalbagh's ongoing efforts to restore and rejuvenate the river Yamuna serve as a compelling example of how localized interventions can yield substantial results. Through initiatives like riverbank stabilization, floodplain management, and community education, Dayalbagh has demonstrated that sustainable living is not merely a theoretical ideal but a practical pathway towards long-term resilience against flooding. Their work serves as a model for other communities and policy-makers seeking to harmonize human activity with natural systems for a more resilient and sustainable future.

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## About the Author

Dr. Pami Dua is a Senior Professor of Economics at Delhi School of Economics. New Delhi. She has served the University of Delhi in various capacities including Dean of Academic Activities and Projects; Chairperson, Research Council; Dean, Research of Humanities and Social Sciences; and Coordinator, Internal Quality Assurance Cell of the University of Delhi.

She was a member of the first Monetary Policy Committee of the Reserve Bank of India from 2016 to 2020. She had been the President of the Indian Econometric Society. She has also served as the Principal Coordinator from India (Delhi School of Economics) of the United Nations World Project LINK for forecasting the global economy' for two decades She has undertaken pioneering work in business cycle analysis with respect to India in collaboration with the Economic Cycle Research Institute, New York.

# Role of Emerging Technologies in Restoration/ Rejuvenation of Water in the River Yamuna at Agra

**Prof. P. K. Kalra**
Department of Computer Science and Engineering
IIT Delhi

Restoration and rejuvenation of the Yamuna River is extremely important for river ecosystem protection and the conservation of natural resources for sustainable growth. It is indeed a great initiative taken up the Dayalbagh Community and the Dayalbagh Educational Institute (DEI) to clean the Yamuna river bank and restore and rejuvenate the river bed at Baikunth Dham. Dayalbagh as a community together with DEI can provide a comprehensive and sustainable solution based on local conditions with a scientific approach. Community based effort with the spirit of selfless service will go a long way as opposed to a central policy based approach for such a project. This project also offers extensive opportunities for scientific research and validation that can harness the interdisciplinary cutting edge research at DEI.

Technologies in particular digital technology and tools can help in many ways for scientific research and solutions in the restoration of the rivers in general. They can help in real-time data acquisition, inferencing and performing simulations. There have been some efforts in this regard by some of the government agencies like the Ministry of Jal Shakti to provide a web enabled India Water Resource Information System [1]. However, it should be regularly updated and should report projects that have used the data. In the context of this project, a web portal interfaced with a database may be developed to collect the local data with its time stamp. This may be based on surveys or sensors that may be mobile or placed at different locations. This may pertain to water quality, soil conditions and vegetation, hazardous pollutants and detection of waste, and any other measurement that could help in the ecological restoration strategy. This can help in developing data driven models that can be analysed using modern AI tools offering better accuracy in prediction. IoT (Internet of Things) is also an important technology that spans multiple technology domains from data sensing to networking to data analysis and may be useful in river rejuvenation and its management.

Remote sensing technologies along with artificial intelligence have become one of the most popular strategies for automating water information extraction and intelligent monitoring [2]. In the Indian context, the National Remote Sensing Centre (NRSC) and ISRO have conducted studies using the satellite data and geospatial techniques. These have been used for various large scale applications like aerial photography and digital mapping, infrastructure planning, scanner surveys, aeromagnetic surveys, large scale base maps, topographic and cadastral level mapping, etc [3].

Recently efforts have also been made on AI-based hydromorphological assessment of river restoration using UAV-remote sensing [4][5]. Hydromorphology refers to the physical characteristics of the shape, boundaries and content of a river. Unmanned Aerial Vehicle (UAV) or drones may provide better control in terms of acquisition both in space and time and in combination with the satellite images that might help augment the spatial resolution through techniques like super-resolution. Further, with the rapid development of drones for civilian research, advances in computer vision and image analysis have led to an increased capability of producing both orthophotos and rasterized digital elevation models (DEMs) from drone imagery. Structure from Motion (SfM), a photogrammetric technique provides an automated method for modeling the relative 3D geometry of a scene by image matching a series of overlapping 2D images, which may then be georeferenced to map coordinates. As part of the revival the Allan project being funded by the Biodiversity Challenge Fund, is utilising new technology such as Drones that give a perspective on a landscape at a relatively low cost [6].

IIT Delhi is also actively involved in a research dealing with the water resource management and has a multi-institute project - The Water Security and Sustainable Development Hub [7]. The Hub's activities are focused on promoting integrated sustainable development and management of water resources by using state-of-the-art technologies.

*Corresponding author: pkalra@cse.iitd.ac.in
ISSN 0972-5032 (P); 

Some of these are Hydrological modelling (Surface and Groundwater); Supply-Demand modelling and analysis; Water supply and Sewerage system analysis; Urban flood modelling; water quality monitoring and analysis; and GIS framework development. The CSE department of IIT Delhi is also involved in a small project related to building a participatory decision-support tool to assist the communities in commissioning Natural Resource Management (NRM) including the detection of water bodies. The project relies on an open-source platform and sentinel dataset as time series data available through the Google Earth engine to detect and examine vegetation intensity around the farm ponds. With a long association and a MoU between DEI and IIT Delhi, there could be opportunities for collaborative research projects in some of these areas.

A project of such type requires a systems approach with an integrated effort involving groundwater management, bio-diversity regeneration, waste management, tree plantation and organic farming the way it is being followed in Dayalbagh. "Systems are generally defined as a set of parts that are spatially and temporally interconnected forming a unitary whole and may be influenced by the surrounding environment"[8]. In this context, in the systems approach, one has to adopt restoration strategies to restore the system as a whole with all its inter-relationships [9]. This, however, may not warrant considering the entire project of rejuvenating the Yamuna river as one single complex system because that is not tractable. A practical approach therefore is to consider this as a system under the local settings which can be tuned by considering the interplay interaction of different aspects under supervised interventions. In other words, it may be considered as a system of subsystems. This can be best achieved by empowering the local community to take charge and perform take measures to transform this into a living sub system. It is important to note that the project embarked upon by Dayalbagh is being guided personally by Revered Prof P. S. Satsangi Sahab who is a renowned systems scientist and is considered the father of the International Systems Movement [10].

A brief account of this initiative and its transformative outcomes in a short time has been eloquently captured in the DEI Monthly Newsletter May 20233 issue [11]. It has become a blissful place with a variety of activities – health care, physical exercise by superhumans, cultural programme by children with a musical orchestra, manual and motor boating, and a living lab for various experiments being conducted by DEI. This could only happen because of the visionary guidance with the motto of "Nurture Nature".

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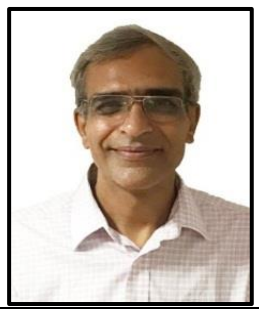

Prem Kumar Kalra is a Professor and Head of the Department of Computer Science and Engineering at the Indian Institute of Technology Delhi. He has also been a Visiting Faculty to the Dayalbagh Educational Institute (DEI), Agra, University of Geneva, Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland, Max-Planck Institute, Germany, and University of Texas Austin, USA. His research interests are in Visual Computing, Multimedia Processing, Computer Vision based Intelligent Systems. He has published over 100 papers in reputed international journals and peer-reviewed conferences. He has a long association with DEI, he has also received the Distinguished Alumni Award from DEI in 2017. He is also a member of the Advisory Committee on Education, DEI. Currently he is the President of the Systems Society of India and the Chief Editor of its journal PARITANTRA.

# Eco-restoration and Beautification of River Banks by Developing Biodiversity Parks

**Prof. S.S Bhojwani***
Former Director, Dayalbagh Educational Institute
(Deemed to be University), Agra

**Shri. P.D. Satsangi**
Executive Director (Rtd.), DCM,
Shriram Consolidated Ltd., Aero City,
New Delhi-110037

***Abstract:*** *The rivers, the source of flowing freshwater, are vital for the existence of life on this planet. They have changed the lifestyle of our ancestors from food gatherers to food growers, and most of the early civilizations sprang up on the riverbanks. The rivers are also a source of hydropower and food for some, serve as a habitat for a large number of flora and fauna, offer beautiful landscapes to the public, and inspiration to the writers, poets and artists. Some rivers are considered to be holy according to the Indian mythology and are worshiped. However, the river water has been polluted and the river ecosystem has been destroyed by human activities like dumping of unprocessed domestic and industrial wastes and toxic chemicals from the agriculture fields into the river, and illegal mining of riverbeds and riverbanks. For the long-term sustainability of our rivers and river landscapes, we need to protect the rivers from these challenges. Unfortunately, the local administration and the NGOs have not shown their to the pathetic condition of river Yamuna in Agra.*

*This paper highlights the initiative of the Ra Dha Sva Aa Mi Satsang Sabha, and DEI (Deemed to be University), Dayalbagh, Agra 282005, to clean and beautify the Yamuna river bed and the bank at the Poiya Ghat the northernmost end of the heritage city of Agra), and to develop a biodiversity park on the riverfront with important plants and provide public-centric services like a testing laboratory., running free multispecialty medical camps, a kiosk selling snacks at a very nominal price, and recreational and educational activities for the children of neighboring villages. Not far from it, the R.S. Sabha runs a primary school for the children of these villagers. There is no fee, and the students also given milk and refreshments free of cost.*

*The article concludes with a hope that the local administration will be inspired by the activities of R.S. Sabha to take up similar projects at some other sites along the Yamuna river in Agra.*

***Keywords:*** *Anupam upvan, Biodiversity Park, Eco-restoration, Riverbank beautification, Yamuna river.*

The riverbank is the land closest to the river water and acts as a transition between the aquatic environment and adjacent land. All great civilizations were born on the riverbanks because the rivers provide a reliable source of water, the most vital natural resource, for drinking and irrigation of the fields, fertile land for cultivation of crops, making man independent from food gathering and hunting practices. The rivers also offer, boat ride and are certainly places of great beauty and enjoyment. Indus civilization, which had originated from the bank of the Indus river, contained over 1000 cities, including Harappa and Mohenjo-Daro. Nearly all the major cities of India are located by the banks of rivers.

All along its path the rivers support vegetation of different types, which together with the animals and other creatures find a comfortable habitat, form a sustainable ecosystem which serves great functions. It regulates the shape and dynamics of the river, provides ideal habitat for many plants and animals and other creatures, and serves as a filtering zone to check the entry of sediments after the floods and pollutants into the river and have an important landscape value, carbon sequestration, recharge of groundwater aquifers, education, and recreation for the urban public. The Vegetation along the riverbanks helps to stabilize the riverbanks by preventing loss of land and property by erosion.

*Corresponding author: bhojwani1940@gmail.com
ISSN 0972-5032 (P); 

However, the modern society, especially since the industrial revolution, has exploited the riverbeds and riverbanks for personal, social, commercial, and religious purposes, variously altered them physically, chemically, and biologically, affected the course of the river flow, and polluted the river water with untreated industrial waste, agrochemicals, oil spills, domestic waste etc, turning some rivers into sewers, which in turn have adversely affected the environment, and biodiversity. As a result, several terrestrial and aquatic plants and animal communities have vanished from the region. Haphazard urban development and illegal human activities such as clearing vegetation away from the riverbank, flooding and heavy rainfalls etc. have caused soil erosion, and the banks have become deserted, resulting in many ecological problems. Loss of vegetation from the riverbanks has also affected the microclimate of the area which provides ideal habitat for a large number of animals. The loss of catchment forests has increased the risk of seasonal floods.

There is an urgent need to wake up and restore the riverbeds/riverbanks to their original beauty and protect them from further degradation by the selfish men, exploitation of the sand from the riverbed by land/builder mafia for personal gains, and impose a strict check on the discharge of untreated sewage, and the industrial waste directly into the river.

Delhi Development Authority, in technical collaboration with the Centre for Management of Degraded Ecosystems, Delhi University, in 2002, undertook a project on the restoration of riverbank habitat along the river Yamuna at Jagatpur village, Wazirabad, Delhi that was damaged by the human activities. The land was highly saline (pH 12) supporting only some saline tolerant species. With considerable hard work for over 7 years the land was converted into a lush green biodiversity park, home to thousands of forest communities, fruit-bearing species, medicinal herbs, and biodiversity-rich wetlands and hundreds of animals, birds and butterflies. The success of this project, the first of its kind in India, encouraged DDA to develop 6 more such diversity parks at different sites along the Yamuna river in Delhi. These biodiversity parks have become sites of ecotourism, and attraction for the urban populations. Developments of such biodiversity parks not only beautifies the area but also serve as a green lung for the city and, if administered properly, prevents unlawful activities on the riverbed and riverbank.

Strictly speaking, eco-restoration refers to restoration to its original state. However, the establishment of Biodiversity Park has a broader meaning. Scope It not only restores the original flora and fauna but is also useful to the urban population by way of educational, cultural and recreational activities and, thus, becomes a part of urban infrastructure. The Yamuna Biodiversity Park in Delhi has two zones, a Nature Conservation Zone with terrestrial communities including a mosaic of grassland and wetlands, and a Visitors' Zone, having many components like herbal garden, butterfly conservatory, a sacred grove, a climber grove, recreational garden, walkways, and a representation of the ecosystem.

For over a decade the Ministry of Environment, Forest and Climate Change, Government of India has been running a programme on beautification of the river banks/river fronts by constructing steps. Plantation, landscaping and provision of basic sanitation facilities and solid waste management to check the pollution of the rivers and river banks. It is a major programme with an outlay of Rs 193 billion (Rs 19,300 crores) covering 13 major rivers of India. However, many of the projects under this programme have deviated from the core objectives of the programme, i.e. conservation, protection and restoration of the biodiversity of rivers and riverfronts by preventing dumping of garbage and untreated industrial wastewater and domestic sewage into the river and mining of river beds that have caused loss or destruction of river and river bank biodiversity. These projects are focusing on the cosmetic beautification of the riverfronts with commercial and recreational angles, involving concrete embankments, and the development of shopping malls, theme parks, parking lots etc., completely ignoring the ecological imbalance of such developments. For example, such developments run the risk of cutting several hundreds of well established native trees. Embankments of the rivers have converted the rivers into canals, destroyed the dynamic nature of the rivers, and disconnected people from the water.

The plight of situation at Poiya Ghat Norternmost tip of Agra city, Dayalbagh, Agra, was so bad that one could only see large patches of muck and filth, littered with plastics, earthen pots and other last rites materials, carcasses and barren pieces of land (Figure 1). It was a sad sight to see chemical based Agriculture and illegal sand mining by the riverbanks. It was evident that the local community was not connected emotionally or physically with the sacred Yamuna river. Human interventions leading to the destruction of Biodiversity were clearly visible at Poiya Ghat.

**Fig. 1. A view of the Yamuna riverbank at Poiya Ghat littered with solid waste before DEI and Ra Dha Sva Aa Mi Satsang Sabha, Dayalbagh launched its programme to clean and beautify it.**

The Ra Dha Sva Aa Mi Satsang Sabha and Dayalbagh Educational Institute (Deemed to be University), Dayalbagh, Agra 282005, have a noble endeavor at their own expenses, to clean the Yamuna riverbed and riverbank at Poiya Ghat (Figure 2), and beautify the area by developing a biodiversity park (Anupam Upvan) a site for recreation, eco-education, and research.

**Fig. 2. A Comparison with the Yamuna River front depicted in Figure 1, reveals a remarkable change.**

The Ra Dha Sva Aa Mi Satsang Sabha Dayalbagh, a charitable and religious society registered in India and as a Charitable Incorporated Organization in England and Wales which strives to serve the last, the least, the lost and the lowest, has proffered about 6.5 Acres of its fertile land to develop Anupam Upvan on the bank of Yamuna river at Poiya Ghat, with ornamental fauna and flora, fruit, and herbal species. With the result, the Anupam Upvaan has about 2750 plants of 35 species (Table 1; Figure 3,4), and more are being planted. Once it is fully developed with the established plantations, walkways etc. it would beautify the area and open new avenues for education, research and recreation and act as a green lung for the residents of the highly polluted city of Agra. If maintained properly it would prevent unlawful activities on

the riverbank and riverbed and further deterioration of the area with the dumping of rubbish discharge of pollutants etc. The plantation in the Biodiversity Park would also prevent soil erosion during the floods. As environmental studies are now mandatory in all the schools and colleges, Anupam Upvan will provide field experience in various ecological processes to the students.


**Fig. 3,4. Yamuna River front at Poiya Ghat in the early stages of development as a Biodiversity Park with the contribution and participation of the Dayalbagh community. It already has a kiosk for refreshment at a very nominal price and a testing laboratory.**

It is worth noting that the Free Medical camps organized at Anupam Upvan attract a large number of residents from the nearby villages for medical diagnosis and medicines without any charges (Figure 5,6). The camp also has children's sections where one can see the rural children playing educational recreation stuff on the computers. They in fact are the first ones to arrive at the camp and the last ones to leave.

The environment during the camp is serene as one can hear the recitation of the "Bhagavad Gita", which helps to create the right atmosphere for the local community to develop a special bonding with their sacred Yamuna river.

The cultural programs presented by the Superman Children in the age group of 4-12 years, twice every day, enriches the riverbank with melodies which are spiritually charged, and the area becomes vibrant with the colours of the dresses worn by these performing children (Figure 7).

The Ra Dha Sva Aa Mi Satsang Sabha has also organized free boat rides for the public in the Yamuna river at Poiya Ghat, which had to be suspended during the monsoons as the water levels in the river has risen.

The Anupam Upvan would act as an eye opener for the local administration to undertake similar projects at other sites along Yamuna river in Agra as has been successfully done by DDA in Delhi. The biodiversity parks developed may be maintained by a specific civic body, ADA, Forest Department or Horticulture Department. Dayalbagh has taken the initiative to develop and maintain the Anupam Upvan Biodiversity Park at Poiya Ghat. It is to provide a clean and green environment for the healthy life of the denizens of Agra and improve the quality of the Yamuna river which is one of the sacred rivers, after the Ganges, according to the Hindu mythology.

**Fig. 5,6. Glimpses of the Medical Camp at Anupam Upvan.**


**Fig. 7. Cultural performance by a group of superman children of the age group 4-12 years at the Anupam Upvan.**

## TABLE 1
## LIST OF PLANTS IN DEI A NUPAM UPVAN AT POIYA GHAT

| S. No. | Common Name | Botanical Name | Economic Importance |
|---|---|---|---|
| 1 | Amaltas | Cassia fistula | Ornamental and Medicinal |
| 2 | Apple | Maluspumila | Fruit |
| 3 | Arjun | Terminalia arjuna | Ornamental and Medicinal; host for tassar silkworm |
| 4 | Bakayan (Chinaberry) | Meliaazedarach | Avenue tree. Bark, leaves, and fruits of medicinal value. Leaves kept in the stored food grains as natural insecticide. |
| 5 | BanyanTree | Ficus benghalensis | Shade tree and Medicinal |
| 6 | Canna lily | Canna indica | Ornamental |
| 7 | Champa (Frangipani) | Plumeria obtusa | Ornamental with fragrant flowers, Medicinal |
| 8 | Chandni (Pinwheel flower) | Tabernaemontana divaricata | Ornamental with white fragrant flowers; Wood used as incense and perfume; pulp around the seed used to make red dye |
| 9 | Chinese juniper | Juniperus chinensis | Ornamental and landscaping |
| 10 | Coconut | Cocos nucifera | Immature nuts provide coconut water as a refreshing drink, coconut meat, ripe nuts source of edible oil, coir and meat used in bakery and confectionary industries. |
| 11 | False Ashoka | Polyalthia longifolia | Ornamental, leaves used for decoration |
| 12 | Ficus (Weeping fig) | Ficus benjamina | Ornamental; popular house plant |
| 13 | Guava | Psidium guajava | Fruit and Medicinal |
| 14 | Harsinghar (Night Jasmine) | Nyctanthes arbor-tristis | Ornamental; sweet fragrant flowers open blossom at night; flowers are the source of an orange dye used to dye silk; flowers used for garlands and worship; Medicinal |
| 15 | Indian Mahogany | Chukrasia tabularis | Timber tree |
| 16 | Jamun | Syzygium cumini | Fruit, timber and ornamental tree |
| 17 | Kachnar | Bauhinia variegata | Ornamental, multipurpose tree – is a source of food, feed, timber, and a brown dye; reddish brown wood used for planking and wooden boxes; medicinal |
| 18 | Kanak Champa | Pterospermum acerifolium | Ornamental with beautiful fragrant flowers; Large leaves used as dinner plates; medicinal. |
| 19 | Karanj (Pongame oil tree) | Pongamia pinnata | Ornamental, Landscaping; seed oil used in soap and as lubricant and is a good insecticide for the crops; Medicinal |
| 20 | Lemon | Citrus limon | Fruit tree |
| 21 | Mahogany | Swietenia macrophylla | Landscaping; reddish brown straight grain, highly durable wood is used for making 1st grade furniture , musical instruments, boats and paneling; medicinal |
| 22 | Mango | Mangifer aindica | Fruit and timber tree |
| 23 | Maulsari (Spanish cherry) | Mimusops elangi | Timber tree with fragrant flowers and edible fruits; Landscaping; medicinal |
| 24 | Money Tree (Malabar chestnut) | Pachira aquatica | Ornamental; nuts are edible |
| 25 | Mulberry | Morus alba | Ornamental tree with edible fruits; host for silkworm |

| | | | |
|---|---|---|---|
| 26 | Neem | Azadirachta indica | Avenue and Medicinal tree. Neem oil is insect repellant(pesticide) and is used in soaps and shampoos |
| 27 | Kewra (Fragrant screw pine) | Pandanus odorifer | Fragrant male flowers; male flowers are the source of kewra water used to enhance aroma in cooking. |
| 28 | Paras papal (Indian Tulips Tree) | Thespesia populnea | Ornamental, Timber tree, and Medicinal |
| 29 | Pipal (Sacred Fig) | Ficus religiosa | Ornamental and Medicinal |
| 30 | Santra (Orange) | Citrus x sinensis | Fruit tree |
| 31 | Saptaparni (Devil's Tree) | Alstonia scholaris | Ornamental; Medicinal |
| 32 | Shisham (Indian Rosewood) | Dalbergia sissoo | Ornamental Timber tree |
| 33 | Silky Oak | Grevillea robusta | Ornamental |
| 34 | Tejpat (Indian Bay-leaf) | Cinnamomum tamala | Spice and Medicinal |

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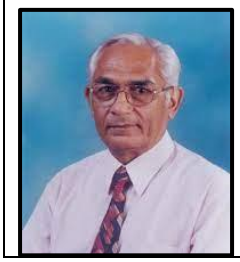

Dr S. S. Bhojwani FNASc, Formerly Professor of Botany, University of Delhi, and Director, D.E.I. (Deemed to be University), is Technical and Financial Advisory and Chairman, Scientific Committee, Department of Agroecology-cum Precision Farming, R.S. Sabha, and President, MCREI Managing Council and Radhasoami Educational Institutions. He has published about 100 research papers in the Journals of international repute, supervised 17 doctoral students, authored 3 books (two of them have been translated into Japanese and Korean languages) and edited 4 volumes in the area based on of Plant Biotechnology. He has been the recipient of several Fellowships to work in the overseas laboratories and has also been on the Editorial Board of several International Journals.

## About the Author

Mr. Prem Das Satsangi has retired from the post of Executive Director-Energy and Projects in 2022 after working with DCM Shriram Limited for 37 years. He is presently working as an Honorary Volunteer Sewak-Secretary of the Ra Dha Sva Aah Mi Satsang Sabha, Dayalbagh, Agra.

He is a Gold medallist in Mechanical Engineering from the Dayalbagh Engineering College graduating in 1984. He had joined DCM Limited as a Management Trainee and completed his Post-Graduate Diploma in Environment Management, during his employment.

During his tenure with the DCM group, he held several key positions including Business Head for Plastics and Power, Resident Head of a large integrated manufacturing complex and Member of the Corporate Management Board. He has attended Advance Management Programs at Wharton (USA) in 2017, at ISB (Hyderabad) and at XLRI (Jamshedpur).

He has travelled extensively and has served on CII's National Committee on Power and is a fellow Member of Institutions of Engineers.

# What is Required to Rejuvenate the River Yamuna

**Dr. A. K. Gosain**
Professor Emeritus & Founder Director
INRM Consultants Pvt. Ltd. (IIT Delhi Incubated company) R&I Park,
IIT Delhi, Hauz Khas, New Delhi 110016

The river Yamuna originates at Yamunotri, in the Yamunotri Glacier at an elevation of 6,387 m. It drains 366,223 sq. km. of area in its entire stretch of 1,376 km from its origin to Allahabad (present Prayagraj, point of confluence with the river Ganga). The Yamuna is a mighty in itself and has a number of tributaries. The first 200 km stretch of the Yamuna features various tributaries like Rishi Ganga Kunta, Hanuman Ganga, Tons and Giri. In the middle section, Yamuna is joined by small tributaries like Sahibi and Hindon. Later, large rain-fed rivers, such as Chambal, Sind, Betwa, and Ken, join the Yamuna system in the Indo-Gangetic plains.

Out of the entire Yamuna river basin, only the upper stretchs up to Etawah with an area of about 73,000 sq km is problematic and needs to be tackled to rejuvenate the river Yamuna. There are four distinct stretches, namely, the Himalayan stretch, the upper stretch, the Delhi stretch and the lower stretch below Delhi with distinct characteristics. The Delhi stretch with a span of 22 km passing through Delhi is the most polluted stretch. The Himalayan stretch of Yamuna is joined by two tributaries namely Tons and Giri. The riveriver between Hathnikund and Etawah witnesses major abstractions as well as an inflow of polluted water from various cities on its banks.

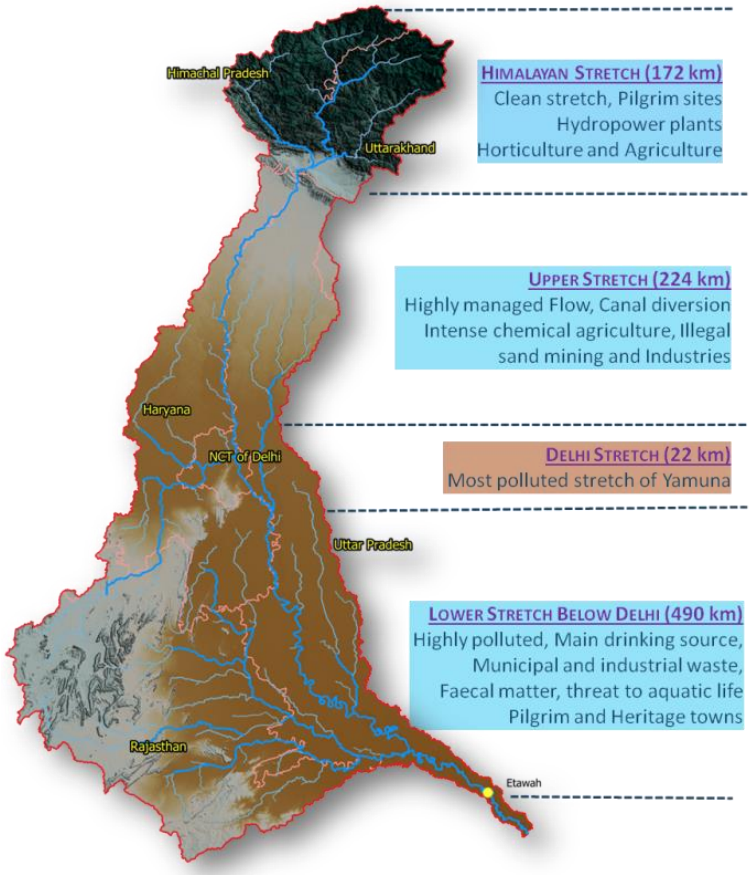


**Fig. 1. Yamuna basin up to Etawah: (i) Himalayan stretch (172 km), (ii) Upper stretch (224 km), (iii) Delhi stretch, and (iv) Lower stretch below Delhi (490 km).**

**Corresponding author:* gosain@civil.iitd.ac.in
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For example, in the Himalayan stretch water is diverted into canal for power generation at various places (Ichari dam, Dak Pathar and Asan barrage). As the river enters the Indo-Gangetic plains at Dak Pathar, the river water is diverted into the Western Yamuna Canal and the Eastern Yamuna canal at Hathnikund/Tajewala in the Yamuna Nagar district of Haryana state. During the dry season, no water is allowed to flow in the river downstream of the Hathnikund barrage.

## What is a Healthy river

The formation of a river is a natural and evolving process that has taken millions of years. There are many factors which define the character of a river. The major ones include hydro-meteorological characteristics of the area, and physiographic features including land use, soil, terrain as well as geology. All these features put together decide as to what shall be the character of the river, whether it shall be perineal or non-perineal, and what shall be the size of the river depending on the flow that gets generated at the specific locations.

The various river stretches, because of their consistent character with respect to the water availability within the natural variability, support many environmental functions including providing habitat to the flora and fauna that adapts to such water availability. This phenomenon is true even for non-perianal rivers. Thus a river stretch shall invariably remain healthy if the natural flow availability in terms of quantity with respect to time does not get altered drastically enabling it to keep performing all the environmental functions.

Sometimes, even if the quantity of flow is not hampered very much but its quality has deteriorated, it shall have a detrimental effect on the flora and fauna. Thus for a river to be healthy, both the quantity and quality of the water have to be preserved. The Upper stretch of the Yamuna river unfortunately has deteriorated on account of both, the quantity (hydrological health) as well as the quality (environmental health).

## Reasons for the Loss of the Health of the river Yamuna

The major reason for the loss of the hydrological health is the diversion of the river water at Hathnikund into the Eastern and Western Yamuna canals. This diversion is mainly done to meet the agriculture and domestic water demand. It is important to understand that such diversion if such a diversion is done mainly during the monsoon period may not have drastic impacts because there is would be sufficient water still left in the river to take care of the environmental demands of the river. However, since we never realized in the recent past that the river requires an environmental flow to be available to perform the environmental functions, we as a society have been diverting the total flow of the river during the lean flow season into the canals, thus making the downstream stretch of the river totally dry. This is precisely the case in the Yamuna river below the Hathnikund Barrage as well.

Besides diversion, the other reason for the reduction in the river water is over-abstraction of the groundwater. The groundwater is a resource in addition to the surface water which gets built up every year during the monsoon when part of the rain falling on the landmass penetrates into the soil and builds the groundwater storage and consequently, the groundwater table of the area rises. As part of the natural process, a part of this groundwater storage supplies water to the river which is flowing at a level much lower than the level attained by the groundwater table because of the gradient created between the general groundwater table and the water level in the river. Such lateral flow from the groundwater to the river is termed as “Baseflow” and is responsible for the flow being available in the river when no stormwater during the rainy period is adding to the river. Most of the rivers that do not get stream flow on account of snow and/or glacier melt for their perenniality are perennial on account of the groundwater contribution being made as baseflow.

In the Upper Yamuna stretch between Hathnikund and Wazirabad (Delhi), the groundwater table has reduced because of the over abstraction of the groundwater mainly for farming. Although this area has surface water irrigation facilities in the form of the Western and Eastern Yamuna Canals, the groundwater usage is so much that the groundwater table is consistently falling down (as reported by the Central Ground Water Board) over the years. In many places, the groundwater table has even gone below the level of water in the adjoining stretch of Yamuna. Under In such a situation instead of gaining water from the groundwater, the river shall lose water to the groundwater because of the reversal of the water table gradient. Such interaction between the surface water and groundwater is very complex and cannot be ascertained unless we take the help of hydrological and groundwater models. Such modelling was performed while formulating the Ganga river Basin Management Plan (GRBMP) by IIT consortia sponsored by the Ministry of Environment, Forest and Climate Change which was submitted in 2014. The groundwater table across the Ganga basin using the SWAT hydrological model and MODFLOW groundwater model in conjunction was first validated using the observed hydro-meteorological data and by incorporating all the diversions as well as groundwater abstractions. Consequently, the validated models were used to estimate the groundwater tables that would have prevailed before the water resources projects were implemented as part of the water resources development. Figure 2 depicts the depth to

water table for pre-monsoon and post-monsoon periods under the present situation as well as under the virgin (Pre-development) period. Further details may be referred from Maheswaran et al (2016).

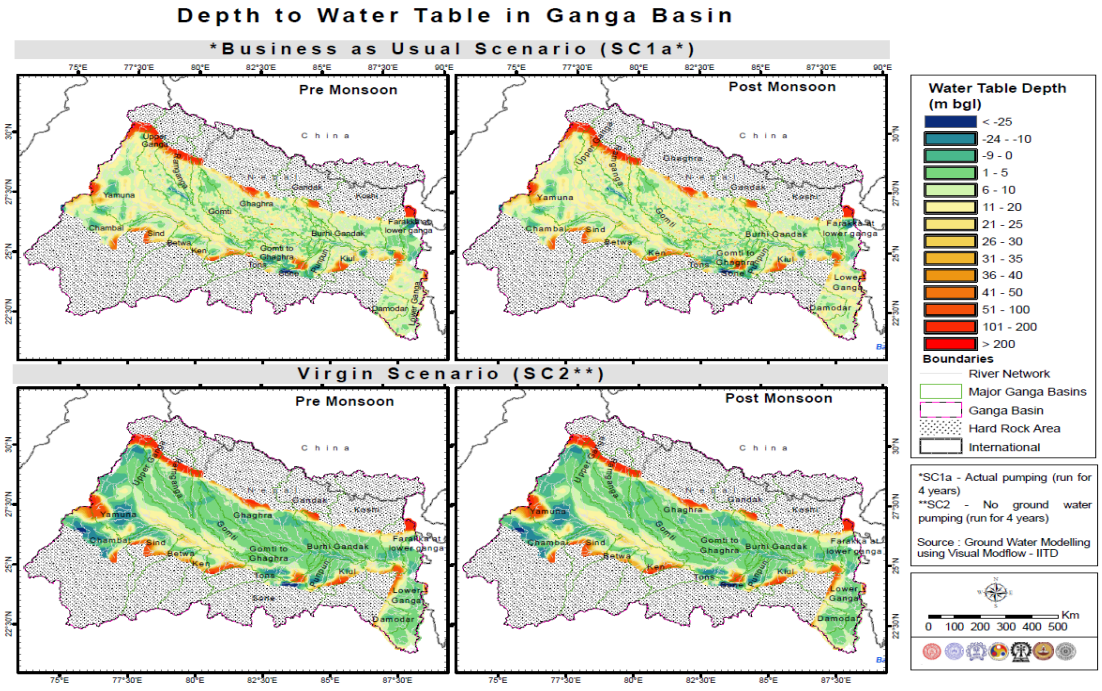


**Fig. 2. Simulated depth to water table for Ganga Basin under present and virgin scenarios**

This hydrological and groundwater modelling set up was further used to quantify the interaction between the surface and ground water under present and pre-development situation. The impact of unabated surface and ground water resource development has been depicted in Figure 3. The stretches of streams of the Ganga basin which have been transformed from gaining to losing stretches have been identified which also include Yamuna stretch. This analysis is very useful for setting the targets that are required to be achieved for rejuvenating the river Yamuna as well as the Ganga as shall be explained below.

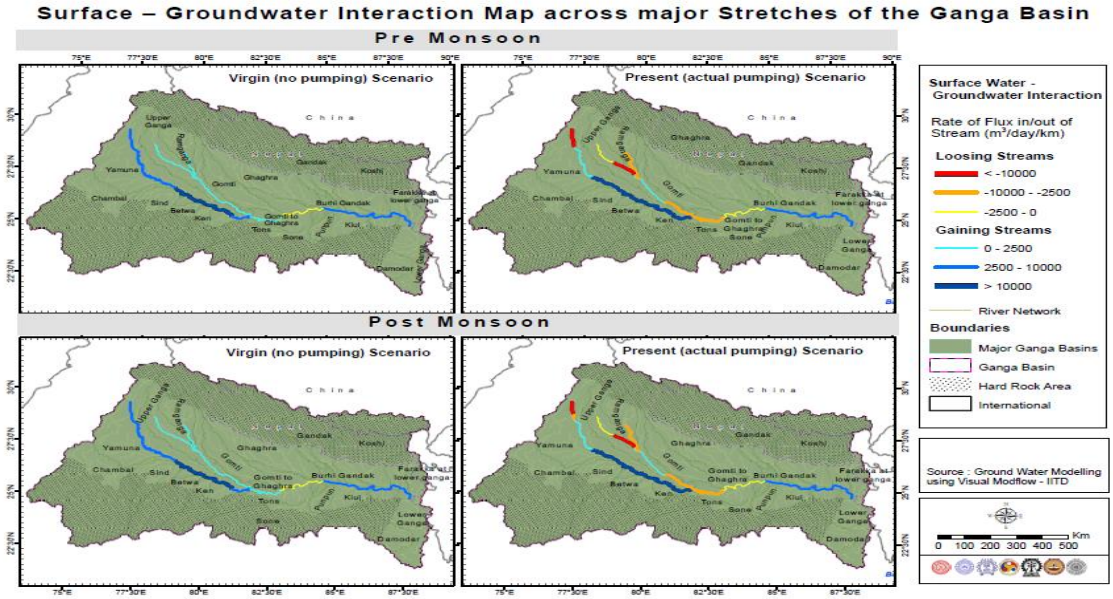


**Fig. 3. Identification of stretches of the Ganga river system that have been transformed from gaining to losing stretches Requirements to rejuvenate the river Yamuna**

As explained above the two major reasons that have deteriorated the quantity of water in r)iver Yamuna below Hathnikund are i) diversion of the non-monsoon flow into Western and Eastern Yamuna canals at Hathnikund and ii) overabstraction of groundwater. Although the Hon'ble Supreme Court has directed that a minimum of about 350 cusecs of water must be released downstream of Hathnikund Barrage as an environmental flow, which as such is too little. Quantification of the environmental flow is an elaborate task involving the habitat requirement of the prevailing species and the Ministry of Jal Shakti is getting scientific studies conducted to quantify the environmental flow requirement in Yamuna. However, the main issue here is that even if the required environment flow is released from the Hathnikund Barrage there is no guarantee that this flow will remain in the river since the groundwater table in the adjoining areas is lower than the water level in the river. Therefore, if the river in this stretch is to remain perennial then the groundwater table has to be brought close to its historical natural levels.

It is important to use the water balance approach to ascertain the water resources available for any specific area under question as well as the overall demand including the agriculture, domestic, industrial and environmental demand. In case the demand is more than the availability of water, then it is not sustainable since there shall be a deficit which invariably be satisfied using the groundwater storage and shall result in declining groundwater tables year after year. It is not far that no groundwater would be left In fact; the groundwater storage is like a backup storage supposed to be used mainly during the time when the monsoon fails.

In order to tackle such a deficit because of enhanced water demand we need to indulge in demand side management rather than taking recourse to enhancing supply locally by rainwater harvesting, watershed management activities, etc., which results in moving water from downstream to upstream and does not generate any water in real sense. Demand side management can be achieved by enhancing the efficiency of the water use by changing the method of irrigation in the agriculture sector and using adept processes in the industrial sector.

A very comprehensive and sophisticated public domain simulation models such as SWAT and MODFLOW that had been used for formulating the Ganga river Basin Management Plan are available to perform these tasks and help the water managers in the integrated water resource management. The paramount advantage of such models is that one can simulate the impacts of the proposed actions towards rejuvenation without actually implementing the same and can help generate consensus by generating and presenting various scenarios to the stakeholders.

So far we have concentrated on the bigger picture at the basin level where the major activity is agriculture. Invariably the water footprints in the basin are also influenced by the cities established on the banks of the rivers as in the case of the river Yamuna in Delhi. This stretch of 22 km of the river Yamuna in Delhi is one of the most polluted river stretches in the world.

## Water Vows of an Urban City (The Case of Delhi)

Every river basin has many cities established within its drainage area. Many of those may be situated on the major rivers while many others are on the smaller tributaries. Yet there shall be some that do not have any stream in the near vicinity but may have some lakes or ponds available within its area. Irrespective of the specific locaton of the city, each one shall be drawing on some portion of the overall water resource of the basin including both surface and groundwater. In some cases the city might also be getting some water transported from the other river basins. For example, the city of Delhi gets water from the river Yamuna, a tributary of the Ganga as well as from the Ganga basin outside the Yamuna basin. It also gets water from the Indus (Sutlej) basin. On top of this a good 10% of its water comes from the local groundwater.

Thus, in order to address the rejuvenation of the river Yamuna, it is equally important to understand the interaction of the river Yamuna with all the cities within its basin. Delhi, being the major city situated on the banks of the river Yamuna, shall be discussed with respect to its interaction with the river Yamuna with respect to water quantity and quality.

## Water Usage of Delhi

The present water usage of Delhi is about 950 million gallon per day (MGD) that includes consumptive use (part that is consumed by the human beings, biomass and industrial processes) and the non-consumptive (part that is returned back, invariably with deteriorated quality in the form of waste water (domestic and/or industrial)). The latter part is approximately 80% of the overall water supplied. Traditionally, the cities started providing the piped water for domestic use but did not make required arrangements to collect the waste water. Till date, even the capital city of Delhi is not having the sewerage infrastructure in more than 40% of the areas to collect the domestic wastewater that is generated. Consequently, this waste water is flowing in the natural drains and waterbodies in Delhi and ultimately landing in the river Yamuna. There are 201 natural drain segments as part of the drainage networks of 22 drains that have outfalls in the Delhi stretch of the river the river Yamuna. All these 201 natural segments carry wastewater all-round the year.

In addition, Delhi has many small and micro scale industries that are working from the residential areas and are not connected to any Common Effluent Treatment Plant (CETP) and therefore are also discharging industrial effluent into storm sewers and/or the natural drains and the water bodies. Consequently, all these drains are seeping the polluted water continuously to the ground and thus polluting the groundwater that is being used by a large number of residents not having access to the piped water. These drains besides recharging the groundwater during the monsoon also support ecology and help preserve urban biodiversity. The environmental services rendered by the natural water bodies are priceless and must be preserved at all costs.

## Water Infrastructure and its Upkeep

The major water infrastructure that is required in any city includes water distribution system (to serve potable water to all), sewerage system (to effectively carry the waste water to the sewage treatment plants), effluent and sewage treatment plants (to treat the wastewater to an acceptable quality before disposal and/or reuse), and storm water drainage system (for disposing storm water effectively to reduce the urban flooding).

Most of the problems of the cities are on account of malfunctioning and/or poor management of these systems or in some cases even the absence of some of these systems. Invariably, in all the cities, the availability and extent of the water infrastructure is not commensurate with the rate at which the population is growing. The city of Delhi has never been able to cope up with the growing population. During the first Five Year plan (1951-56) Delhi's population was 21.66 Lakh. It could produce only 60 MGD of treated water against the requirement of 152 MGD @ 70 Gallon per capita per day. The installed capacity of the STP was only 36 MGD. The population of Delhi kept on increasing in leaps and bound with decadal increase of about 50%, and the present population being close to 20 million, but with the water treatment capacity of 921 MGD and that of sewage treatment of 597 MGD which implies that Delhi has never been able to catch up with the requirement of its basic water infrastructure. Today the situation is that with 40% of Delhi not covered with sewerage infrastructure, such areas have no option but to discharge their wastewater either in the natural water bodies or storm water drains. This wastewater keeps on flowing through the natural drains throughout the year that are supposed to be dry during the non-monsoon period. Figure 4 shows a picture of one such natural storm water drain carrying the wastewater in the month of May, when it is supposed to be dry if the wastewater had not been flowing into it.

**Fig. 4. Picture of a Storm Water Drain in Bharapulla taken captueed in the month of May clearly depicting the flow of waste water.**

Delhi has more than 1500 unauthorized colonies, and the majority of these colonies do not have sewerage networks and therefore they discharge their wastewater into the natural drains and subsequently to the river Yamuna. Additionally there are hundreds of locations where sewers were punctured when silted up or choked so as to provide the temporary

relief to the area before the sewer line is cleaned up and restored to action. It is a pity that the majority of such punctures have not been repaired even after many years and keep on polluting the storm water drains and in turn the river Yamuna, day in and day out.

### Some of the measures to be taken up at the City Level to Rejuvenate the river Yamuna

Actions that are needed to be taken up at the city level to rejuvenate the river Yamuna include but are not limited to:

1.0 At the city level it is important to define the carrying capacity of Delhi keeping in view the availability of water for the consumption of the humans as well as the requirements of the eco-system any deficit in the availability of water faced by the city must be met either through enhancing the water use efficiency or by reusing the treated wastewater.

2.0 The city must ensure that the water infrastructure is performing as per the original design. The management and upkeep of the water infrastructure is a scientific concern and needs well qualified manpower to be engaged. Each of the water infrastructures is a different system having different design requirements and different procedures for its upkeep. If these systems are not looked after properly, which is the case in almost every city big or small, and then the malfunctioning of these systems can create additional problems for the society. Let us take the case of the water distribution network. The pipeline is designed for a specific capacity and has a specific life. Invariably the traditional pipelines had a life of about 40 years. With the passage of time the pipes get corroded and this causes reduction of pressure and discharge. The corrosion leads to leakage. In most of the cities this water that is lost through the leakage and/or pilferage is to the tune of about 50%. Although technologies have become available to indirectly identify the locations of such leakages by deploying sensors and making careful observations. It is equally important to scientifically verify the network for the optimal performance. The faulty pipe segments should be replaced proactively to reduce the loss of water through leakage and indirectly reduce the water demand of the city. Supervisory control and data acquisition (SCADA) systems should be deployed for this purpose.

3.0 Another critical system is sewerage system which is another pipe network that is carrying the waste water from residential areas usually under gravity. Such waste water is carried to an identified Sewage Treatment Plant (STP) where the sewage is treated to a requisite level. The wastewater generated in Delhi is almost double than the treatment capacity created at the STPs resulting in huge quantities of wastewater getting into the river Yamuna and affecting not only the stretch in Delhi but also sending the polluted water to important downstream cities of Mathura and Agra. Delhi must enhance the sewage treatment capacity that shall not only help reduce the water demand of Delhi by reusing the treated water for non-potable uses but also reduce the water pollution of the Yamuna and improve its environmental health.

4.0 Whenever a new city is designed, one important aspect of the design is its storm water drainage system which helps in evacuating the storm water in an efficient manner from the inundated areas of the city. Fixing of the size and gradient of such drains at the street level as well as along the roads is a technical matter that is dependent on terrain, land use and land cover of the area, etc. Usually the networks of such drains are designed to flow under gravity and to be disposed of into a natural drain or water body. Some locations which are in depressions and thus cannot evacuate its water under gravity shall need arrangements to pump out such waters from the flooded area.

The maintenance of storm drains is a very important aspect. Besides the structural maintenance these need to be cleaned to remove any silt that has moved with the storm water and got settled. If silted, the drain loses its effective area to carry the water. Another aspect that has become pronounced is that these days besides silt, huge amounts of solid waste is also landing up in the stormwater drains because of poor solid waste management. Conventionally all the manmade storm water drains were covered with loose stone or concrete slabs, but presently the trend has been to permanently cover these storm water drains. With the result many of the drains have no access to desilting apparatus. Rejuvenating these drains shall help these better environmental functions for the city of Delhi.

5.0 There is no doubt whatsoever that in order to address the water security issues of a city, a Systems' approach is the only way wherein each sub-system related with the water as explained above needs to be analyzed to assess its performance and take measures to restore or enhance its efficacy. It would be worthwhile to invest in creating a GIS based framework that can identify all information on each of the physical infrastructure as well as aspects related to their operational performance. Such frameworks or knowledge platforms are the only ways to engage in the integrated water management that shall help in rejuvenation of river Yamuna.

6.0 Public and stakeholder involvement is a very important step to ensure acceptance and success of an action that is taken in the public interest. However, a prerequisite of such an engagement is the availability of vetted possible options that can be used to address a specific water issue along with the plus and minus of each one of the options. This latter part is always missing since our city level organizations do not have the core competence to generate such options which usually require the application of scientific tools. Thus, effective stakeholder engagement can go a long way in taking informed actions that can be very useful in rejuvenating Yamuna river.

There is a very interesting case of Delhi which shall highlight the importance of the stakeholder consultation. It is a known fact that each locality used to have street level drain that was responsible for carrying the storm water from the roof top to the street drain. Over the years most of these drains have either disappeared completely or have been fragmented to have smooth scooter/car entrance into the house and thus have lost their continuity. With the result these drains became dysfunctional and the streets started getting flooded with storm water even with minimum of rain. It is surprising to know that the residents found out solution to their problem and implemented the same without realizing the implication of their action. It was to connect the pipeline carrying the rooftop water into the sewer line. Apparently, it had the desired effect and resulted in avoidance of the street level flooding. Consequently, whenever it rains in Delhi most of the rooftop water enters the sewer lines which have not been designed to carry this additional water and are responsible for surcharging many segments of the sewers. As a result the sewage starts oozing out of the sewer lines at many locations during the rains in Delhi. Now, unless the residents are made aware of the fact that it is because of their action that some people are suffering with sewage mixed flooding it is difficult for anyone to ever know. The Stakeholder engagement can indeed be an effective and result oriented in such situations provided that the action to be taken as well as the necessity of the purpose is shared with the communities. It is also true that in this particular case it is known that making such connections with the sewer line is illegal. However, if the municipality wishes to rectify such a situation, it has to come out with an alternative for discharging the rooftop water.

### Basin Level Measures to Rejuvenate the Yamuna

Besides the interventions at the level of the city significant measures at the level of the basin are also required if the rejuvenation of the river Yamuna has to be accomplished. As explained earlier, some of the basin level actions include enhancement of water use efficiency by adopting efficient irrigation methods such as drip and sprinklers, changing cropping patterns to adopt less water intensive crops, and reuse of treated water for irrigation to reduce the agriculture demand on water. Once implemented, it shall rejuvenate the river Yamuna and bring back its hydrological as well as environmental health.

Keeping in view the complexity and dynamism of the water systems, frameworks are required to continuously monitor and evaluate the performance of these water systems. Therefore, formulation of GIS based digital twin of the Yamuna Basin shall be a good initiative not only for capturing the most up to date baseline but also for effective monitoring and evaluation of the sub-systems. Such frameworks shall be very helpful in rejuvenating the river Yamuna by taking an intergration of the actions explained above as well as for making the stakeholder engagements more meaningful and participatory.

## About the Author

**Dr A K Gosain,** is an Emeritus Professor of Water Resources Engineering and GIS Technologies, in the Civil Engineering Department, IIT Delhi. Prof. Gosain pioneered the climate change impact assessment on Indian water, a resource that was incorporated in the NATCOM I & II – two National Communications made to the United Nations Framework Convention on climate Chage (UNFCCC).

Prof. Gosain contributed to the formulation of the Ganga river Basin Management Plan (GRBMP), as the Team Leader of the Water Resources Management Group. He has also formulated the Drainage Master Plan of NCT of Delhi for the Delhi Government. He is also a member of the expert committees appointed by the National Green Tribunal to suggest solutions to deal with the ever increasing pollution levels in the Ganga and the Yamuna rivers.

# Reifying "Yamuna": Unpacking the Pluriversal Possibilities for Rejuvenation of the River at Poiaghat, *Swarg Dhaam*, Agra

**Dr. Kalidindi Usha* and Dr. Bhupinder Singh**
Division of Environment Science,
ICAR-Indian Agricultural Research Institute,
New Delhi-110012

***Abstract:*** *The Yamuna is the most important tributary of the Ganga and is one of the most fertile and high grain-yielding river basins in the country, and a boon for agriculture. However, the Yamuna, like many important rivers in the India, is bleeding pollution and is crying for help. It needs a major rejuvenation on the lines of Ganga, the Ganga Action plan-1985, ont thel lines of the Ganga Action Plan, 1985 to save the river Ganga. The challenge lies in harnessing the river, to boost environmentally safe and sustainable activities besides restricting the discharge of highly contaminated industrial and municipal waste and effluents into the Yamuna. Eroded river banks, increased river-bed breadth but with the depleted water table, lost vegetation and biodiversity around the Yamuna, and rising levels of heavy metal and pesticide contaminants on the vegetables grown using the groundwater in the area, are a few of the other challenges that need to be accounted and addressed as we attempt to rejuvenate the Yamuna at the Swarg Dhaam. Agricultural practices around the area should, thus, be altered to utilize the optimum and warranted use of pesticides and fertilizers which otherwise run off to the river and pollute the flowing streams, connected lakes and canals, sediments and the ground water. There is, thus, a need to cleanse the Yamuna and restore its ecosystem, which would require us to take some of the imperative and necessary steps such as treatment of wastes and effluents before these get discharge into the river, checking the overall discharge, saying no to plastic discharge, limit the excessive use of fertilizers and pesticides, go organic, plant trees, improve social awareness etc. It is important that we do not use the rivers only to wash our sins but also value them for their contribution towards the ecosystem and take steps to restore the same.*

***Keywords:*** *Yamuna, Vaikunth Dham alias Swarg Dham, geological and ecological erosion, ecosystem restoration and ecosystem services.*

## INTRODUCTION

The Yamuna is the most important tributary of the Ganga and its source is the Yamunotri glacier. Important pilgrimage centres like Yamunotri, Paonta Sahib, Mathura, Vrindavan, Bateshwar and Allahabad (now Prayagraj) are located on the banks of this river. The Yamuna has religious and socio-economic significance. Yamuna is worshipped in Hinduism as the 'Goddess Yamuna' and as per Hindu mythology is the daughter of the Sun and the sister of the Yama the 'God of Death'. It is a common practice for people to bathe in the sacred waters to rid themselves of sins and the last rites of the dead are also performed at its banks. Additionally, the Yamuna's basin is also one of the most fertile and high grain yielding river basins in the country and a boon for agriculture. The river helps replenish the water table by recharging it with flood water and performing important ecological functions. It sustains aquatic biodiversity and brings with it nutrient rich alluvial sedimentation full of minerals and organic matter, during the monsoon months. About 57 million people depend on Yamuna water as it accounts majorly for the capital's water supplies, but sadly, today it is also referred to as a 'dying holy river. Yamuna like many important rivers in India is bleeding from pollution and is crying for help.

## 1.0 THE YAMUNA CHALLENGE AT VAIKUNTH DHAM

### 1.1. Pollution

Going by the word and experience of the elders, there was a time when the water of Yamuna was pristine blue but today the Yamuna is considered to be one of the most severely polluted rivers in the world.

**Corresponding author: kusha@iari.res.in*
ISSN 0972-5032 (P); 

The Yamuna is particularly polluted downstream of New Delhi, the capital of India, which dumps about 58% of its waste into the river. Pollution is one of the major challenges and the solution lies in making the citizens conscious of the harm they do when they pollute the river, directly and indirectly. Its amelioration would involve effective management of sewage, industrial effluents and solid wastes. Pollution emanates from untreated sewage from areas with no sewerage network; outfall of industrial effluent into drains; dumping of solid waste, construction and demolition waste and bio-medical waste into the drains and the rivers; habitation, dairies and dhobi ghats on river embankments; cultivation, growing vegetable by using chemical fertilizers, pesticides and idol immersion and other rituals. The majority of pollution in the river Yamuna starts from the capital and that the setting up of common effluent treatment plants to treat industrial effluents, restrict the conventional chemical farming along the bank since it pollutes the river with the toxic chemicals like antibiotics, nitrate and heavy metals, Pb, As etc (Mutiyar et al., 2018)

The major sources of pollutants that threaten the Yamuna are enumerated as follows:

### *1.1.1. Household or Domestic Sources*

According to the Central Pollution Control Board (CPCB), at least 90% of the domestic wastewater in the city flows into the Yamuna. This waste water comes from the household activities hence the presence of high content of detergent, laundry chemicals, and phosphate compounds. The samples collected were found to have a phosphate concentration of 0.51 mg/litre, which is higher than the normal range of 0.005 to 0.05mg/litres. This abundance of phosphate formed layers of toxic froth covering the rivers (Plate 1).

**Plate 1: Yamuna a dying river which warrants our immediate attention: Extreme frothing owing to increase in phosphates**

### *1.1.2. Industrial Heavy Metal Pollution*

The catchment area of the river Yamuna around Mathura and Agra cities is highly urbanized and is networked with several drains that discharge a heavy load of pollutants into the river. Rapid urbanization and population growth resulting in industrialization pose a major threat of heavy metal pollution for the nearby water bodies (Lokhande et al., 2021). The water quality monitoring of the river Yamuna has indicated significant presence of several heavy metals in its water. Iron (Fe) was found to be most abundant and even exceeding the permissible limit in the Yamuna water. Such high amounts of heavy metals in the water can cause several health effects such as reduced growth and development, cancer, organ damage, nervous system damage, etc (Jaiswal et al., 2022).

### *1.1.3. Untreated Sewage*

Excess of 800 million litres of largely untreated sewage and ~ 40 million litres of industrial effluents are pumped into the Yamuna daily. As per the CPCB report, these effluents may contain a concentration of 1.1 billion faecal coliform bacteria per 100 millilitres of water as against the standard limit of 500 coliform bacteria per 100 millilitres for uses other than drinking. Sewage treatment plants though have been established, but many times untreated sewage goes directly into the river at a few locations due to non-operational STPs, which further deteriorate water quality issues.

### *1.1.4. Idol Immersion Leading to Increased Toxicity*

Idol worship and following rituals are part of our religious sentiments, but the Yamuna suffers. Immersion of idols during the festivals with cheap lead and chrome paints and plaster of Paris and puja articles such as polythene

bags, foam cut-outs, flowers, food offerings, decorations, metal polish, plastic sheets, and cosmetic items all are a cause for concern for the river's quality. 11 times higher Cr content has been measured post immersions against the permissible limit of 0.05mg/L, iron concentration increased 71 times from the 0.3 mg/L limit. The use of untreated water would increase the chance of toxins and heavy metals entering the food chain through vegetables grown on the floodplains, which can have damaging effects on human health.

#### *1.1.5. Plastic Pollution*

In Agra, the Yamuna has been choked by intense plastic pollution. After the 2017 ban on single-use plastics, there has still been rampant use of plastics which is evident by the production of plastic. These plastics discharges in sewage waste otherwise choke our rivers and their banks (Plate 2).

**Plate 2: Polluted rivers are our own creation and curbing them, is a priority: Plastic chokes**

### 1.2. Floods and Drought

Drought and floods are part of the spatio-temporal dynamics of the Yamuna as at Vaikunth Dham. These water disasters pose a severe threat to crop production and food security. The food security of India is jeopardized due to the higher extent and frequency of floods causing severe damage to the agricultural sector in terms of crop establishment and crop productivity (Brahmanand et al., 2013). About 40 million of land in India is prone to diversified nature of flood events i.e. flash floods (due to heavy downpours within a short period, river floods (due to continuous rain or snow fall in catchment region) and coastal floods (due to storm surges as a result of tropical cyclones). The causes of floods include heavy precipitation in the catchment region, silting of rivers and the reduced carrying capacity of the rivers etc. Similarly, the causes of drought are low precipitation, light soil, lack of proper soil and water conservation measure etc. The diversity of natures of flood and drought makes the management quite complex which further aggravates due to the climate change in the recent years.

### 1.3. Water Quantity and Quality

The river Yamuna in the area has reduced in quantity and depleted water quality over the past decade. There is a need for dredging, desilting, cleaning and encroachments on its flood plain. The biodiversity of this ancient river is also getting dangerously obscure because of the fall in the quantity and quality of water available which is endangering aquatic life. Thus, the availability of water in the Yamuna allround the year is a must. Further the quality of the Yamuna water, in general, and at Vaikunth Dham, in particular, is also an important regulator of the riverine ecosystem and the encompassing ecosystem services, which get affected by anthropogenic and industrial activities and scrupulous discharges along and into the river.

## 2.0 Rejuvenation of the Yamuna: the Need of the Hour for Posterity

Location specific thinking on the rejuvenation of the Yamuna is the need of the hour and shall not only lead to its lifespan extension but also ultimately to its eternal life. The requisites for the rejuvenation of the Yamuna, not only involves slowing down the process of degradation and erosion but also regaining its youth in all facets be it green cover, water table, landscape and biodiversity, and ensuring that no untreated sewage is discharged in the Yamuna around the

Agra stretch. Networking with Delhi and centre on cleansing Yamuna also needs a major invigorating effort on the lines of Ganga, the Ganga Action Plan, launched in 1985. Besides, the support of the regional pollution control boards, and other technical Universities and Institutions would also be a blessing. There is a need to set up an effective and efficient sewerage infrastructure and Sewage Treatment Plants (STPs) in the polluting regions besides the commitment of the society and the individuals to work for afforestation on the river banks leading to increased green cover, measures to contain soil erosion, recharge ground water table, sequester carbon dioxide, catchment area treatment, ecological restoration, moisture conservation, livelihood improvement and income generation. Paving the way for Ecotourism by developing the river fronts, development of eco-parks and bringing awareness amongst the masses for improvement of water quality and flow in the rivers can also improve the surrounding ecosystem and biodiversity and enhance the groundwater recharge sufficiently to provide benefits for drinking water and irrigation.

The advanced technologies in crop improvement and natural resource management such as flood and drought tolerant crop varieties, contingency crop management plans, bundling of various packages of practices, can be integrated to reduce the extent of damage during these events. There is a need to develop robust and reliable bio-physical markers, early warning indicators for the flood and drought along the rivers. Besides, the use of flood or drought tolerant plant types along with a redefined package of practices would help in the successful establishment and a higher crop productivity and would minimize the yield reduction in the event of flood/ drought disaster, particularly when it is expected that the frequency of these extreme events may increase under the future climates due to the climate change scenario.

### 2.1. Ecosystem Restoration: A Complete Overhaul

Broadly, an ecosystem is a community of living organisms (plants, animals and microbes) in conjunction and interacting with the non-living components of their environment. The biotic and abiotic components are linked together through nutrient cycles and energy flows. Energy and carbon enter the ecosystems through photosynthesis, while mineral nutrients are mostly recycled within the ecosystems. Since ecosystem processes are driven by the types and number of species in an ecosystem and the relative abundance of organisms within these species, the species biodiversity plays an important role in the functioning of ecosystem. In general, ecosystems can be assessed in terms of the goods and services they provide to the humans. Ecosystem restoration, on the other hand, means assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. Healthier ecosystems, with richer biodiversity, yield greater benefits such as more fertile soils, bigger yields of timber and fish, and larger stores of greenhouse gases. The plight of our rivers including the Yamuna is known to all and also it is a fact that irrespective of the best of the restoration efforts it is almost impossible to return any ecosystem to its original state. However, it is also a fact that restoration helps and must thus be resorted immediately. One should also not forget the enormous ecosystem service that any ecologically sustainable system provides. Between now and 2030, the restoration of 350 million hectares of degraded terrestrial and aquatic ecosystems could generate US$9 trillion in ecosystem services. The Restoration could also remove 13 to 26 Gigatons of greenhouse gasses from the atmosphere. The economic benefits of such interventions exceed nine times the cost of investment, whereas inaction is at least three times costlier than ecosystem restoration (Kumar et al., 2020). The Rejuvenation of the river Yamuna starting with Vaikunth Dhaam should thus be observed as the beginning of a mass movement aimed at the restoration of complementing ecosystems viz., river, forest, farmland, wetland and the urban society. One must not forget that a river ecosystem – with its intrinsic biodiversity – plays a crucial role in the functional health of the river basin and the ecosystem services provided by the river. To restore its ecological balance, one should understand the dynamics of the river ecosystem and delineate all possible anthropogenic and non-anthropogenic factors affecting it.

### 2.2 Restoration of the Wetland

There is a need to restore wetlands which are important for preserving and enhancing the biodiversity in the wetlands that surround the Vaikunt Dhaam area. Soil salinity however remains a major problem, for which it is important that the salt-loving bushes and plants are planted. Desilting the wetlands up to depths of three to seven meters and spreading the soil elsewhere on the floodplains of the river may be an other initiative required to revive the wetland. Plants like typha, water hyacinth and lotus in the wetlands have the capacity to purify water by removing heavy metal toxins. Further, fish fingerlings should be introduced and native grasses and legumes should be planted to promote soil microbial activity on the wetlands. It is hoped that a restored wetland will harbour an improved diversity of flora and fauna and shall also operate as a home to the migratory birds.

### 2.3 Tree Plantation for a Clean and Green Future

Tree plantation and biodiversity parks need to be scaled up for a better environment, resource use optimization, conservation and protection of human health. There is a need to secure our river bank by planting as many trees as possible. The Tree trunks are also a major sink for carbon dioxide. Besides absorbing $CO_2$, they also avoid runoff of rainwater and hold the soil to prevent soil erosion. Green cover planted at 4 heights i.e., grasses, herbs, shrubs and trees

shall help capture maximum carbon and shall also improve organic matter –carbon in the soil in the days to come. When restored to the lush green cover, it will help mitigate the effect of climate change, which is likely to be felt more acutely in the years to come. However, planting trees can significantly help to reduce atmospheric carbon dioxide, with their deep roots and tall canopies, the trees absorb and transpire more water than do grasses, resulting in drier streams. Choosing the tree species wisely might help, as different species use water at different rates. It is thus important that we go for the plantation of less water consumptive, region adaptive species. The Fast-growing evergreen pines consume large amount of water, whereas indigenous trees such as banyan, Indian fig, peepal, kadamb, shivan, arjun, manvel, bamboo, neem, karanj, golden bamboo, kanchan and deciduous trees like poplar and walnut use less, especially in the winter. Also, planting only some portions of the watershed might achieve the balance of providing wood products for the people without the impact on the basin's water balance. The roots of the tree help to filter water into the soil, thus slowing the rate at which the water levels rise after the rains. This reduces flood flows, particularly from small watershed areas. The afforested parts of the watersheds also prevent the erosion and sediment-leaching that is seen in grassland counterparts. The ideal balance between afforestation and water needs is for one-quarter of the river basin to be planted between 400 and 500 trees per hectare. This can prevent drastic effects on the water availability. Planting trees using seepage water is also an economical and lowcost method when compared with canal linings using concrete, asphalt and other materials. Further, the planted trees, owing to the shading effect, can also reduce temperatures in small rivers by on average 2- 3$^{o}$C compared to un-shaded streams; and more so on hot summer days**.** Lower water temperatures even under extreme climates, shall be within the safe thresholds for river fish, as the trees along the riverbanks indirectly play a critical role in promoting the biodiversity of our waterways. These efforts besides rejuvenating the Yamuna eternally, will also improve the surrounding ecosystem and biodiversity, and thus enhance the groundwater recharge, sufficient to provide benefits for drinking water and irrigation. Further, the plantation of trees will also aid in the groundwater recharge. If the groundwater supply is not stable, the rivers tend to dry out during the summers and flow only during monsoon, essentially changing the river from perennial to seasonal. The best chance for the groundwater stabilization, according to the scientists, is through afforestation to suit the landscape and not through monoculture plantations. The Tree cover will reduce soil erosion during heavy rains, resulting in a more controlled flow of water instead of the floods. The trees will also trap the sediments and pollutants, preventing them from entering into the river. Planting trees helps the whole watershed—removing both pollutants and climate-warming gasses from the air and providing shelter and habitat for the creatures. Planting or allowing trees to grow naturally on and around the river banks can block the run-off of pollutants into waterways, keeping them cleaner, and slowing the flow of water to manage the flood risks.

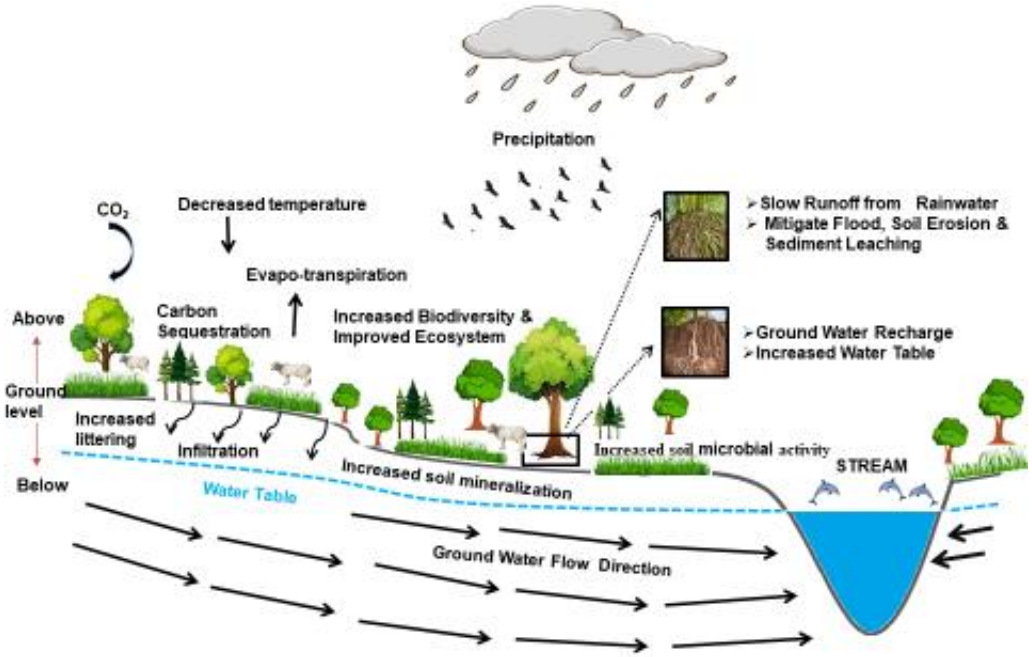


Figure: Impact of Planting Trees on River bank

### 2.4 The Resotoration of Ecosystem

The riparian vegetation is a connecting link between the stream environment and terrestrial catchment. A riparian forest is an area of trees accompanied by shrubs and herbs that is adjacent to the water body. It influences the structure of both aquatic and upland terrestrial communities. The components influenced by the riparian ecosystem are modifying storage capacity and aquifer recharge, in-channel primary and secondary productivity, organic matter quality and quantity, biodiversity and migratory patterns, and biogeochemical pathways and rates. The riparian flora also helps in trapping the pollution, filtering and converting sediments, nutrients and other chemicals. They absorb periodic flood fluxes and supply food cover and thermal protection to the biota. Ecological buffers are important for the riparian ecosystem. They are predominant as the wood plant community, presence of surface water and abundant soil moisture, diversity interspersion of habitat features, and corridor for dispersal and migration. The Riparian vegetation has many functional characteristics. The present situation at Vaikunta Dhaam showcases depleted vegetation, dried wetlands, and wider riverbeds with negligible water streams, all of which needs to be changed. Degradation of riparian zones and streams diminishes the capacity of our water bodies to provide critical ecosystem functions, including the cycling and chemical transformation of nutrients, purification of water, attenuation of floods, maintenance of stream flows and stream temperatures, recharging of groundwater, and the establishment and maintenance of habitats for fish and wildlife.

## 3.0. The Present and the Future of *Vaikunth Dham*

Vaikunth Dham on the sides of the river Yamuna at Dayalbagh, Agra is currently being used as a dumping yard for the Agra city plastic, polluting the river and causing drying of river preventing its use for irrigation and drinking purposes by the adjacent villagers and the city dwellers. It is important that we care for the lost biodiversity and ecosystem in the area for which it is imperative to revive and restore the green vegetative cover at Vaikunth Dham. Developing an eco-park at the site, with provisions like a periphery jungle with agroforestry plants, water bodies, flora and fauna, amusement park will help to exponentially reduce the air and the noise pollution in the larger surrounding area. An Eco Park will bring an "unprecedented change" in the landscape and would have the capacity of serving as an educational, entertaining, religious, spiritual and rejuvenating 'getaway' destination for the people of Agra and the neighbouring area, tourists from all over India and the world. It would also help in increasing the socio-economic condition of the rural population, opening avenues in creating jobs in the transport sector, food, and tea stalls to meet the needs of the public visiting the place. The green cover will also reduce the water and soil contaminants and cleanse the air to improve the quality of air that we breathe. The tree canopies at the site, after a few years, would serve as an important heat and carbon dioxide ($CO_2$) sinks. The multi-tier vegetation would scrub the air of dust and other particulate matter. By lowering the ambient temperature, the ecologically restored Vaikunta Dhaam would enable the river water to absorb more oxygen, which in turn would promote the growth of microbes that purify sewage and heavy metal containing industrial wastewater.

## 4.0 Role and Responsibility of the Society

Urban people are particularly vulnerable because the cities are heat islands. The lives of the general public shall be affected further if we continue to ignore the plight of our rivers. Drying streams, caused by a drop in the groundwater, can be made to reappear through a planned watershed development approach, including rainwater harvesting, building small check dams and tanks, and tree planting etc. The Society, in general, should thus, take the lead in converting the Yamuna into a biodiversity stretch. Improved ecosystems may also support human health in the event of another covid like situation arising in near the future. The National Green Tribunal had in its orders of July and August 2018 recommended setting up eco-parks that would recreate the vegetation that existed along the river before the urbanisation destroys it.

## CONCLUSION

The possibilities for the rejuvenation of the Yamuna not only involves slowing down the process of degradation, but also reviving its youthfulness across all the facets listed in the manuscript whether it's the fight against pollution or floods/drought or water quality or groundwater recharge or biodiversity or wetlands or soil erosion etc. We need to work to reverse the present barren river fronts into green vibrant canopies bustling with sounds of birds/ creatures that nestle on them, improve the water table, landscape and biodiversity, ensure that no untreated sewage gets discharged into the Yamuna, restrict chemical farming on the river bank and around to limit pollution from toxic chemicals like nitrate, heavy metals Pb, As etc. Planting more trees, shrubs, herbs and grasslands is the best solution for protecting the rivers at geological and hydrological levels. Riparian vegetation plays a critical role in regulating microclimates and water quality; preventing the riverbank erosion and promoting landform stability; subsidizing aquatic and terrestrial food webs; and providing habitat for a wide range of aquatic, amphibious, and terrestrial organisms. The commitment of the society and individuals to work for afforestation on the river banks may help improve the green cover, prevent soil erosion, recharge groundwater tables, and sequester carbon dioxide. Further, the effort shall also ensure ecological

restoration, moisture conservation, livelihood improvement and income generation, and ecotourism by developing eco-parks on the riverfront. These efforts shall also educate our youth about the environmental concerns and improve awareness, as such, amongst the masses for conserving the water quality and the quality for future generations, which can only be met if we restore our rivers like the bleeding Yamuna.

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### About the Author

Dr (Mrs) Kalidindi Usha is working as a Principal Scientist in the Division of Environment Science at ICAR-Indian Agricultural Research Institute, New Delhi. She has about 32 years of research and teaching experience, since her joining the Agricultural Research Services in 1991. She did her Postdoc from Institut für Mikrobiologie, Mikrobiologie & Biotechnologie, Universitat Tuebingen, Tübingen, Germany & Institute of Plant Nutrition, Universitat Hohenheim, Stuttgart, Germany in 2003 in the area of plant nutrition. She has an expertise in the areas of Horticulture, Orchard Management, Plant Nutrition, Agroforestry and Agro Ecosystems to manage drought and flood affected areas, Package of practices of tree species/ agricultural crops/genomics and micro irrigation / water pollution studies and environmental stress management. She is the recipient of several awards and recognitions such as INSA DFG (German) Fellow – 2003, Jawahar Lal Nehru Award 1995 ICAR, Outstanding Scientist Award-2017, Lifetime Achievement award in 2018, by the Indian Society of Tropical Agriculture, Recipient of the Vikram Award from the Systems Society of India, October 2022. She has more than 75 research publications in the top journals.

### About the Author

Dr. Bhupinder Singh joined the Indian Council of Agricultural Research (ICAR) as a Scientist (Plant Physiology) in 1991 and was posted at the Nuclear Research Laboratory, Indian Agricultural Research Institute (IARI), New Delhi in 1992. Presently, he is working as a Principal Scientist and Head at the Centre for Environment Science and Climate Resilient Agriculture (CESCRA), ICAR-IARI. He is also rending the additional responsibility of the Radiological Safety Officer (RSO), at the ICAR-IARI, New Delhi since 2006. He has more than 32 years of research and teaching experience and has focused his research pursuits in the key area of Nutriophysiology and Radiophysiology. He has more than 90 research publications in the reputed international and national journals. He has several awards and recognitions to his credit such as ICAR-Lal Bahadur Shastri Young Scientist Award, DST BOYSCAST fellowship, INSA-DAAD International Scientific Exchange Fellowship, RD Asana Gold Medal, R.H. Dastur (AAAS) awards. He is a fellow of the Indian Society for Plant Physiology (ISPP) and was its elected Vice President for the years 2014-2015.

# यमुना नदी का अद्‌भुत जीर्णोद्धार एवं पवित्र कायाकल्प

**श्री एस.डी. सतसंगी**
इन्चार्ज एवं टेक्निकल ऑफ़िसर, डिस्टेंस एजुकेशन सेन्टर, दयालबाग़, आगरा
एवं
**डॉ. गुर प्यारी मेहरा***
अध्यक्ष, नगर पंचायत, दयालबाग़, आगरा

***संक्षिप्त विवरण*** *ईश्वर द्वारा प्रदत्त अनेक अनमोल उपहारों के अन्तर्गत नदियाँ भारत की सांस्कृतिक, धार्मिक एवं आर्थिक सम्पन्नता के साथ घनिष्ठ संबंध रखती हैं । प्राकृतिक सौन्दर्य से भरपूर नदियों के किनारे बैठ ऋषि मुनियों ने तपस्या कर आत्म सिद्धि को प्राप्त किया । आज भी हम उत्सव एवं त्योहार, अपने विशाल हृदय में समेटने वाली नदियों के समीप मनाते हैं । निःस्वार्थ भाव से अपना सर्वस्व न्योछावर करने वाली नदियों को बदले में हमने प्लास्टिक कचरा एवं गंदगी दी है । वर्तमान में जल अभाव एवं जल आपदा की स्थिति हम सभी के लिये चिंता एवं गंभीरता का विषय है । प्रस्तुत लेख यमुना नदी के जीर्णोद्धार एवं कायाकल्प का एक अनुठा एवं अनुकरणीय समाधान प्रस्तुत करता है ।*

***प्रमुख पाँच शब्द :*** *स्वच्छता एवं चैतन्यता, निष्काम सेवा,* ***Law of Requisite Variety, Ecological Environment & Flow, Sustainable Development***

यमुना नदी भारतवर्ष की पवित्र एवं सर्वाधिक प्राचीन नदियों में महत्वपूर्ण स्थान रखती है। यमुना और गंगा के तट की पुण्यभूमि में आर्यों की पुरातन एवं गौरवशाली संस्कृति विकसित हुई। यमुना नदी भारतीय संस्कृति की दीर्घकालीन परम्पराओं की प्रेरक तथा धार्मिक भावनाओं का प्रमुख आधार रही है। आगरा शहर की संस्कृति, समृद्धि तथा प्राकृतिक सम्पदाओं में यमुना नदी की अहम् भूमिका रही है। जीवनदायिनी यमुना की निर्मल जलधारा निरन्तर कलकल बहती रहे, यह हम सभी की ज़िम्मेदारी है। औद्योगीकरण, एवं अनियोजित विकास के कारण उत्पन्न प्रदूषण ने आज नदियों की नारकीय स्थिति बना दी है। यदि इसके प्रति तत्काल कार्यवाही नहीं की गई तो आने वाली पीढ़ियाँ हमें कभी माफ़ नहीं करेंगी।

दयालबाग़ पोइयाघाट रोड के अंतिम छोर पर स्थित बैकुण्ठधाम के समीप यमुना नदी कुछ समय पूर्व शोचनीय अवस्था में थी। कूड़ा करकट, पॉलिथीन, दूषित जल के निस्तारण व भूमाफ़ियाओं द्वारा किए गए खनन से दम तोड़ रही थी। स्थानीय लोग उसकी दुर्दशा, दुर्गंध व पीड़ा के प्रति उदासीन थे। कूड़े के अम्बार बढ़ते जा रहे थे। वह पुकार रही थी–

**कोई राख लेव मोहि अब की,**
**इकली नारि पड़ी बन भीतर, रोय रही कब की।**

*Corresponding author: mehragp@gmail.com
ISSN 0972-5032 (P); 

सौभाग्य से 5 अप्रैल, 2023 का वह दिन आया– जब परम दयालु, परम कृपालु, अनन्य प्रभुओं की ट्रिनिटी, समस्त ट्रिनिटी के परमात्मा (परमानंद के अखंड स्रोत) **रा धा/धः स्व आ मी** दयाल की दया–दृष्टि यमुना पर पड़ी और उनके दिव्य मिशन के तहत् **रा धा/धः स्व आ मी** मत (दयालबाग़ हैडक्वार्टर) के 'जयघोषित' वर्तमान/वक़्त संत सतगुरु परम पूज्य प्रो. प्रेम सरन सतसंगी साहब (जन्म–9 मार्च, 1939 (86 वर्ष)) प्रख्यात पूर्व छात्र (Alumunus of Eminence IIT(BHU), मिशिगन स्टेट यूनिवर्सिटी तथा यूनिवर्सिटी ऑफ़ वाटरलू) से प्रेरणा व मार्ग–दर्शन पाकर **रा धा/धः स्व आ मी** सतसंग सभा दयालबाग़ जो धर्मार्थ एवं परोपकारी संस्था एवं Charitable Incorporated Organisation है, ने यमुना नदी के जीर्णोद्धार एवं कायाकल्प का महा अभियान प्रारम्भ किया, जिसने एक नई मिसाल पेश की है। उसके साथ न केवल भौतिक जगत् (Macrocosm), अपितु प्रकृति के तहत् सम्पूर्ण ब्रह्मांड में अचम्भित करने वाले सूक्ष्म एवं अतिसूक्ष्म परिवर्तन हुए। यमुना तट **रा धा/धः स्व आ मी** सतसंग सभा की कर्मभूमि बन गया। बीन बाँसुरी की मर्मस्पर्शी व मंत्रमुग्ध करने वाली धुन से चारों दिशाएँ गूँज उठीं।


**बीन बँसुरिया बाजे हैं, राधा सुरतिया नाचे हैं।**

आध्यात्मिकता से पूर्ण वातावरण में बूढ़े, बच्चे व जवान, महिला एवं पुरुष तथा संत सु(परमैन) स्कीम के बच्चे यमुना को स्वच्छ व हरित बनाने के लिए पूरे उत्साह के साथ जुट गए। सुबह, शाम, दोपहर व देर रात तक निष्काम भाव से श्रमदान किया गया। पाटा चलाकर यमुना के तट को समतल व चौड़ा किया गया। मिट्टी काट कर नदी का तल गहरा व जल प्रवाह को गतिशील बनाया गया। स्वच्छता के साथ चैतन्यता का भी समावेश हुआ। कुछ ही सप्ताह में नदी का जल स्तर और जल प्रवाह बढ़ने लगा। बैकुण्ठधाम के सुस्त व गतिहीन परिसर में सुपरमैन बच्चों की खिलखिलाहट, चहचहाहट व सांस्कृतिक कार्यक्रमों ने नई ऊर्जा भर दी।

17 अप्रैल, 2023 को यमुना के भाग जागे। **रा धा/धः स्व आ मी** सतसंग दयालबाग़ के आठवें 'जयघोषित' वर्तमान/ वक़्त संत सतगुरु प्रो. प्रेम सरन सतसंगी साहब ने नौका विहार करने की मौज फ़रमाई। 19 अप्रैल, 2023 को मोटर बोट से विहार किया गया। तत्पश्चात् पहले संत सु(परमैन) बच्चों व महिलाओं को और बाद में अन्य लोगों को निः शुल्क नौका विहार का सौभाग्य प्राप्त हुआ। नौका विहार के दौरान Life Jacket Sanitization व सुरक्षा संबंधी सावधानियों का ध्यान रखा गया। कुछ समय पश्चात् (25 जून 2023 को) परम पूज्य हुज़ूर ने नौका विहार के दौरान स्वयं चप्पू चलाया। जग के खेवनहार को नैया पार लगाते हुए देख चारों ओर हर्ष एवं उल्लास छा गया।

यही नहीं डी.ई.आई. द्वारा 4 मई, 2023 को River Restoration व Rejuvenation 'थीम' पर अंतर्राष्ट्रीय वर्कशॉप आयोजित की गई, जिसमें देश–विदेश के प्रख्यात् संस्थानों के 21 विशेषज्ञों ने अनुभवों एवं वैज्ञानिक अनुसंधानों के आधार पर पर्यावरण व जल आपदा के सम्बन्ध में चर्चा की। जल पुरुष डॉ. राजेन्द्र सिंह ने कहा– "हमें अभी ज़रूरत है, यमुना को शुद्ध सकरा नीरा बनाने के लिए यमुना का Ecological एवं Environmental flow ensure करना।" 'परम पूज्य हुज़ूर ने दयाकर मार्ग–दर्शन करने की मौज फ़रमाई।

उसके बाद वैकुण्ठधाम पर बहुमुखी गतिविधियाँ, समानान्तर रूप में तेज रफ़्तार से प्रारम्भ हुईं। समस्त कम्युनिटी व डी.ई.आई. के सहयोग से पौधे लगाकर अनुपम उपवन Bio-diversity Park लगाया गया तथा कृषि अनुसंधान केन्द्र स्थापित किया गया। डी.ई.आई. के विभिन्न विभागों/संकायों के शिक्षक यमुना के तट से अपने–अपने विषय से संबंधित सैम्पल्स एकत्रित करने में लग गए Laboratory की चार दीवारी से निकल कर अनुसंधान Open Land में आ गए। 'एग्रोइकोलॉजी कम (cum) प्रिसीज़न फ़ार्मिंग', Environment Management, Soil Testing, Civil Engineering, Architect Engineering के विद्यार्थियों को अध्ययन के नए क्षेत्र मिले। विद्यार्थियों ने सभी कार्यों को स्वयं अपने हाथों से करके परोपकार एवं जीवन की सार्थकता को पहचाना–

**परोपकाराय फलन्ति वृक्षाः, परोपकाराय वहन्ति नद्यः।**
**परोपकाराय दुहन्ति गावः, परोपकारार्थम् इदम् शरीरम्।।**

**'मानवता की निष्काम सेवा'** के अंतर्गत स्थानीय लोगों के लिए बहुविशिष्टता युक्त Medical कैम्प लगाए गए जिसमें विशेषज्ञ डॉक्टर्स द्वारा निः शुल्क परामर्श व दवाएँ दी गईं। ग्रामीण बच्चों को आकर्षित करने के लिए विविध सुविधाएँ उपलब्ध करायी गई। e-Kiosk खोला गया जिसमें नाम मात्र दाम पर स्वादिष्ट व पौष्टिक व्यंजन मिलते हैं। जल कुम्भी के पान भी बनाए गए

जो सभी को बहुत पसंद आए। जो स्वास्थ्य वर्धक एवं रोग निवारक क्षमता रखते हैं। भंडार घर में भी भोजन को और अधिक पौष्टिक बनाने के लिए जलकुम्भी का प्रयोग किया गया। यहाँ ग्रामीण बच्चों को सुबह व शाम 3 से 7 बजे तक पढ़ाया जाता है और दोनों समय medical help के लिए डॉक्टर्स उपलब्ध रहते हैं। समाज के The last, the least, the lowest and the lost among the gender free humankind and later for all human beings सुविधाएँ पहुँचायी जा रहीं हैं।

प्रतिदिन सुबह व शाम 'एग्रोइकोलॉजी कम (cum) प्रिसीज़न फ़ार्मिंग' सेवा में कठिन परिश्रम व पसीना बहाने के पश्चात् थकान दूर करने के लिए सभी लोग यमुना तीरे जाते हैं जहाँ संत सु(परमैन) बच्चे आकर्षक परिधानों में पारम्परिक संगीत व नृत्य शैली में नाचते, गाते व बजाते हैं। अपनी 'cutie pie' मुस्कान से सभी का मन मोह लेते हैं। करतल ध्वनि से सब उनका उत्साहवर्धन करते हैं। **'शाहनशाहों के शाहनशाह'**, दाता जी ई–वाहन में बैठ, भर–भर झोली प्रेम की दात लुटाते हैं। प्रेम भक्ति/प्रेम सरन में लीन भक्त जन परमानंद की अनुभूति करते हैं।

"हमने ऐसी योग साधना बताई है कि हम सिमटकर के परमात्मा के परमानंद में रह जायेंगे। सिर्फ यह उसमें चेन्ज (change) है कि इसमें हम dynamic रूप से रहेंगे, गतिशील रूप से रहेंगे और इसलिए ऐसा नहीं है कि वहाँ शांति है, स्तब्धता है, यह सब नहीं, वहाँ तो Orchestra बजता है। सब तरह के instruments बजते हैं। आप उसी में मस्त–मग्न रहेंगे, Orchestra में।"

(परम पूज्य प्रो. प्रेम सरन सतसंगी साहब रा धा/धः स्व आ मी मत दयालबाग़ के आठवें 'जयघोषित' वर्तमान/वक़्त संत सतगुरु एवं चेयरमैन एड्वाइज़री कमेटी ऑन एजुकेशन, दयालबाग़ आगरा दिनांक 09.07.2022)

यह Model सिद्ध करता है कि विकास की प्रक्रिया में आधुनिक संसाधनों व तकनीक से ज़्यादा devotion, अंतःकरण की शुद्धता, जागरुकता एवं चेतनता अधिक महत्वपूर्ण हैं।

"Law of Requistite Variety" यह बताता है कि यदि हम प्रकृति पर नियंत्रण करना चाहते हैं तो हमारे पास कम से कम प्रकृति के बराबर अपेक्षित विविधता होनी जरूरी है। यह गीता से लेकर विश्व की सभी धार्मिक परम्पराओं में उपलब्ध है। जो अन्त में इसका समाधान आध्यात्मिकता के फ्रेमवर्क में बताते हैं।"

(परम पूज्य प्रो. प्रेम सरन सतसंगी साहब रा धा/धः स्व आ मी मत दयालबाग़ के आठवें 'जयघोषित' वर्तमान/वक़्त संत सतगुरु एवं चेयरमैन एड्वाइज़री कमेटी ऑन एजुकेशन, दयालबाग़ आगरा दिनांक 26.11.2020)

**Σ6Q** जीवन शैली, innovation तथा values पर आधारित Sustainable Development का यह मॉडल, Fatherhood of God and Brotherhood of Man तथा Better Worldliness का आदर्श प्रस्तुत करता है जिसमें न केवल मानव जीवन अपितु वन्य जीवन व वनस्पति के संरक्षण व संवर्धन का संदेश है। इसके अतिरिक्त 21 वीं शताब्दी के अन्त तक यह विश्व की लगभग 11 अरब आबादी को स्वस्थ आहार मुहैया करवाने का संकल्प रखते हैं।

सरकारी, ग़ैर सरकारी संगठन, शैक्षणिक संस्थान एवं समाजसेवी संस्थायें इस मॉडल का अनुकरण कर लाभान्वित हो सकते हैं।


## About the Author

S. D. Satsangi, engineer by profession and artist by nature joined Engg. College, Dayalbagh in the year 1978. Passion for Photography and Cinematography bloomed by the Grace, Direction and Encouragement given by Param Guru Huzur Dr. Lal Sahab. From thereafter never looked back and turned as the Scriptwriter, Videographer and Editor of a number of films, Slide and Sound Programmes and Photographic Exhibitions.

At present working as Incharge - Distance Education Centre, Dayalbagh.

## About the Author

डा0 गुर प्यारी मेहरा ऑयल एण्ड नेचुरल गैस कॉरपोरेशन से चीफ़ मैनेजर (एच. आर.) के पद से स्वैच्छिक सेवानिवृत होकर वर्तमान में एक दशक से नगर पंचायत दयालबाग, आगरा की अध्यक्षा के रूप में समाज को स्वच्छ, सुन्दर, स्वस्थ, हरित एवं विकासशील बनाने की निष्काम सेवा में पूर्णतः समर्पित हैं । इसके अतिरिक्त हिन्दी प्रेम प्रचारक साप्ताहिक की असिस्टेंट एडिटर भी हैं । 25 वर्षों के अपने व्यवसायिक कार्य काल में इन्होंने Organisation Development, Executive Motivation, Human Resource Management, Behavioral Safety, (Off Shore Safety) and Women Empowerment आदि अग्रणी क्षेत्रों में विशिष्ट योगदान दिया है। स्वच्छ भारत मिशन के अन्तर्गत अपने नूतन एवं अभिनव प्रयासों के लिये मुख्यमंत्री उत्तर प्रदेश द्वारा पुरस्कृत एवं सम्मानित की गई हैं । समाज की मूलभूत आवश्यकताओं की पूर्ति के प्रति संवेदनशील, उनके जीवन स्तर के उन्नयन तथा सतत् विकास एवं हरित पर्यावरण के संरक्षण के लिए पूर्ण प्रतिबद्धता के साथ कार्यरत हैं ।

# जल संरक्षण

**डॉ. निशीथ गौड़**
सहायक प्राध्यापक, संस्कृत विभाग,
दयालबाग़ एजुकेशनल इन्स्टीट्यूट (डीम्ड विश्वविद्यालय),
दयालबाग़, आगरा–282005

***शोधसार*** *जल संरक्षण हमारा प्रथम कर्त्तव्य है। वैदिक युग में जल संरक्षण की प्रथा प्रचलित थी। जल का कितना महत्व है इसे ऋषिगण भली–भाँति जानते थे। जल प्राणियों का रक्षक होता है इस बात को कहने के पीछे जल के सदुपयोग की, सीमित उपयोग की कामना छिपी हुई है। जल का जीवन में कितना महत्व है, इससे वे सभी को अवगत कराते रहे हैं ताकि लोग जल को व्यर्थ न जाने दें, दूषित न करें अपितु उसके प्रति सम्मान एवं कृतज्ञता की भावना रखें।*

*जल का सदुपयोग, संरक्षण, बाँध निर्माण, जलाशयों के किनारों पर वृक्षारोपण, वर्षा के जल का संग्रहण तथा वार्षिकी जल प्राप्ति हेतु यज्ञ कार्य ये सब सकारात्मक क्रियाएं वैदिक काल में तो थीं ही, साथ ही जल को यदि कोई दूषित करता था तो स्पष्ट निर्देश थे कि 'मा आपो हिंसीः' जल को नष्ट मत करो। वर्तमान में शुद्ध पेय जल समाप्तप्राय है।*

*आज बुद्धिजीवियों को जल के महत्त्व को समझने की आवश्यकता है। यदि समय रहते इस विषय पर चिंतन नहीं किया गया तो निश्चय ही अगला विश्व युद्ध जल के कारण होगा। आज पर्यावरण संकट की स्थिति में ऐसे साधकों की आवश्यकता है जो स्वेच्छा से आगे बढ़कर प्रत्येक जन को पर्यावरण सुधार हेतु आह्वान करें।*

***कूट शब्द***– *वैदिक युग, जल चिकित्सा, प्राण शक्ति, उषा पान, विद्युत जल*

हमारे मनीषियों ने सहस्रों वर्ष पूर्व मानव जीवन के कल्याणार्थ पर्यावरण का महत्त्व और उसकी रक्षा प्रकृति से सान्निध्य, संवेदनशीलता, रोगों के उपचार तथा स्वास्थ्य संबंधी अनेक लाभदायक तत्त्व निकाले थे। जब हमारा मन कलुषित विचारधाराओं से भरा हुआ होता है, तब हम कहते हैं कि हमारा अंतः पर्यावरण प्रदूषित हो गया और जब वायु, जल, पृथ्वी, वनस्पति, ध्वनि आदि प्रदूषित हो जाता है तब पर्यावरण के प्रदूषण को स्वीकार किया जाता है। ध्यातव्य है कि वाह्य पर्यावरण तभी प्रदूषित होता, जब हमारा आंतरिक पर्यावरण अर्थात् मन विकृत होता है। यदि मन में प्रदूषण न हो तो किसी भी प्रकार का वाह्य प्रदूषण नहीं होगा।

वर्षा का जल सबसे निर्मल माना गया है यह जल प्रकृति की विशेष देन है उसे यज्ञ आदि द्वारा बढ़ाना चाहिए और इसे संरक्षित करना चाहिए वर्तमान में हमने वर्षा के जल को अम्लीय बना दिया है। वर्षा का जल रोगनाशक भी है, कल्याणकारी है, इसके संरक्षण हेतु कृत्रिम जलाशयों का उल्लेख ऋग्वेद में प्राप्त होता है।

ऋग्वेद में ऋषियों ने नदियों को माता के समान माना है और उनकी पूजा की है।सभी नदियाँ हमारी रक्षा करें, नदियों का जल सींचने योग्य, पीने योग्य एवं कृषि आदि के उपयोग की गुणवत्ता युक्त बना रहे।[1]

ऋग्वेद में दीर्घतमा ऋषि कहते हैं कि ऐसा प्रयत्न करें जिससे नदियाँ किसी का भी नुकसान न करें। ऐसा प्रयत्न कीजिए कि माता के समान पोषण करने वाली नदियाँ मुझे न निगलें। मंत्र में निगलने से यही तात्पर्य है कि नदियों में बाढ़ पर नियंत्रण रखा जाए इसके लिए वनों का संरक्षण आवश्यक है क्योंकि अतिवृष्टि होने पर घने जंगलों का विनाश नहीं होता, अपितु घास

***Corresponding author:** nishith41@gmail.com*
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और वन वृक्ष खूब बढ़ने लगते हैं। सघन वन के कारण जलधाराएँ वहाँ ठहरती हैं तथा नदियों में बाढ़ की संभावना नहीं रहती है। ऋग्वेद में वनों में वृष्टि का वर्णन इसी संदर्भ में किया गया है। अधिक वृष्टि के समय जल के राजा वरुण वन के ऊपर स्तूप जल राशि देता है और नीचे गिरती हुई जलधारा उस स्तूप के ऊपर ठहरती है जिन्हें अंतरिक्ष में ठहरी हुई किरणें लाती हैं । जल का कितना महत्व है इसे ऋषिगण भली भांति जानते थे। जल प्राणियों का रक्षक होता है इस बात को पुनः पुनः कहने के पीछे जल के सदुपयोग की, सीमित उपयोग की कामना छिपी हुई है। जल का जीवन में कितना महत्व है, इससे वे सभी को अवगत कराते रहे हैं ताकि लोग जल को व्यर्थ न जाने दें, दूषित न करें अपितु उसके प्रति सम्मान एवं कृतज्ञता की भावना रखें।

'धर्मो रक्षति रक्षितः 'धर्म उसी की रक्षा करता है जो धर्म की रक्षा करता है। नैसर्गिक रूप से प्राप्त जल की पवित्रता को बनाए रखने पर ही वह जल हमारी पवित्रता को बनाए रख सकता है। हमारा कर्तव्य है कि हम जल को शुद्ध बनाए रखें। अपने भौतिक विलास के कारण वर्षा के जल को भी हमने अम्लीय वर्षा में रूपांतरित कर दिया है, जबकि वैदिक आर्य ऐसी विलासिता से सर्वथा दूर रहने पर भी सदैव शुद्ध वर्ष की कामना एवं प्रयत्न करते थे।

ऋग्वेद में वर्षा के शुद्ध जल के संग्रहण का निर्देश दिया गया है। वर्षा के जल को एकत्र करने हेतु मानव द्वारा कृत्रिम जलाशय विस्तृत भूमि की खुदाई करके बनाए जाते थे, जिन्हें खनित्रम कहा जाता था। कृत्रिम जलाशयों में ह्रद, पुष्करिणी, शर्यणावत आदि का वर्णन मिलता है, जिन्हें स्थायी एवं नैसर्गिक जलधाराएं जल से आपूर्त रखती हैं ऐसे गहरे सरोवरों को ऋग्वेद में ह्रद कहा गया है।

*आपो न सिन्धुमभि यत्सक्षमक्षरंत् सोमास इन्द्रं कुल्या इव ह्रदम्।* [2]

नदियाँ एवं जलधाराएँ जैसे समुद्र की ओर बहती हैं, छोटी नहरें जैसे तालाब की ओर बहती हैं , इसी प्रकार नदियाँ, नहरे, तालाब आदि का उल्लेख भी मिलता है।

सोम औषधि से युक्त जलाशय विशाल बताए गए हैं, जो औषधीय गुणों से युक्त कहे गए हैं। छोटे–छोटे सरोवरों को पुष्करिणी की संज्ञा दी गई है। छोटी झीलों या सरोवरों के समान पुष्करिणी का भी जलीय स्थिर रूपों के अंतर्गत उल्लेख है। ऋग्वेद में पवन द्वारा जल के शुद्धिकरण को भी दर्शाया गया है।

*यदेषाम् पृषती रथे प्रष्टिर्वहति रोहितः।*
*यान्ति शुभ्रा रिणन्नपः।।* [3]

जल ही जीवन का आधार है। अधिकांश जीव जल में ही जन्म लेते हैं और उसी में रहते हैं। हे जलधारको! मेरे निकट आओ। तुम अमृत हो।

शुद्ध जल मनुष्य को दीर्घायु प्रदान करने वाला, प्राणों का रक्षक तथा कल्याणकारी है। यह भाव निम्न ऋचा में देखिए–

*शं नो देवीरभिष्टय आपो भवन्तु पीतये।*
*शं योरभि स्रवन्तु नः।।* [4]

एक सामाजिक प्राणी होने के कारण हमारा कर्तव्य है कि हम अपने पर्यावरण को स्वच्छ रखें और प्रदूषित होने से बचाएं। इसके लिए सभी मनुष्यों को अपने पर्यावरण के प्रति जागरूक होना अत्यंत आवश्यक है, तभी हम अपने पर्यावरण को बचा सकते हैं। पर्यावरण की रक्षा के लिए सरकार द्वारा कुछ अधिनियम भी बनाए गए हैं जैसे वायु अधिनियम 1981, जल अधिनियम 1974 और हमारे प्रधानमंत्री ने स्वच्छ भारत अभियान चलाकर लोगों को जागरूक करने का भी प्रयास किया है।

## जल चिकित्सा

वेदों में जल को अमृत बताया गया है और इसके आचमन से कफ निवृत्ति भी बताई गई है। जल के प्रक्षालन से अंग प्रत्यङ्गों से आलस्य दूर भागता है, जल को शुद्धकर्त्ता बताया गया है। तॉबे के जल पात्र में रखा हुआ जल विशेष प्रभाव युक्त होकर ऑतों के रोग को दूर करता है। यह पश्चिमी वैज्ञानिकों का मत है।अथर्ववेद में सूर्य की धूप में जल सेवन को कल्याणकारी औषधि बताया गया है–

*देवस्य सवितुः सवे कर्म कृण्वन्तु मानुषाः।*
*शं नो भवन्त्वप ओषधीः शिवाः।।* [5]

अर्थात् सूर्य देवता की प्रेरणा में रहकर मनुष्य कर्म करें तो जल औषधि बनकर हमारे लिए कल्याणकारी होता है।

## लुई कूने की स्नान चिकित्सा

फ्रांस में लुई कूने ने कूने स्नान पद्धति द्वारा टब में स्नान द्वारा पेटग्रस्त सब रोगों को दूर करने की बात कही है। प्राकृतिक चिकित्सक उसका उपयोग करते हैं।

सोते समय पैर धोकर सोने से स्वप्न दोष नहीं होता, नींद अच्छी आती है। प्रातः काल खाली पेट पानी पीने से पेट के विकार ठीक होते हैं तथा मुंह में पानी भरकर दोनों आँखों पर छीटें मारने से न केवल ज्योति बढ़ती है, बल्कि मोतिया बिंदु तक कट जाता है। योग पद्धति में कुंजल क्रिया से पेट के सब रोग दूर होने की बात विख्यात है।

## उषा पान

जल चिकित्सा की कई पद्धतियाँ हैं।जल के शरीर के अंदर जाने से मल निष्कासन होता है। दूषित पदार्थ पसीने एवं मूत्रादि बनकर जल में घुलकर ही निकलते हैं। जल में उपस्थित स्वाभाविक विद्युत से भी रोग नष्ट होते हैं और सूक्ष्म ज्ञान तंतुओं के चक्र सक्रिय हो जाते हैं। जल के सूक्ष्म अंश से ही हमारे प्राण बनते हैं,ऐसा छांदोग्योपनिषद् के षष्ठ प्रपाठक में बताया गया है।

बुद्धि प्रखर होती है तथा मस्तिष्क की क्षमताएं प्रकट होती हैं।प्रातः स्राव होने वाली ग्रंथियों के स्राव पर इसका अच्छा प्रभाव पड़ता है, इसलिए खाली पेट जल पीने का रिवाज चाणक्य नीति में भी है। एक स्थल पर कहा गया है–

*अजीर्णे भेषजं वारि*
*जीर्णे वारि बलप्रदम्।।*

अर्थात् कुछ अजीर्ण रह गया हो तो वह प्रातः काल जल सेवन से ठीक हो जाता है और यदि न भी हो तो खुश्की दूर हो जाती है। शरीर की गर्मी निकालने में भी जल अद्भुत है। यह शरीरस्थ यूरिक एसिड और ऑक्जेलिक एसिड को घोलकर बराबर निकाल देता है। इस जलपान को आयुर्वेद में उषा पान की संज्ञा दी गई है।

## उषा पान की विधि–

रात्रि को सोने से पूर्व तांबे की कलशी या लोटे में स्वच्छ छाना हुआ जल रख लेते हैं। उसे लकड़ी के स्टैंड पर रखना चाहिए क्योंकि पानी में प्राणशक्ति होती है और लकड़ी होने से ऊर्जा को नीचे नहीं जाने देती। रात्रि भर ताम्र पात्र में रहने से इसमें विद्युत शक्ति उत्पन्न होती है। इस जल को सूर्योदय से पूर्व उषा काल में नाक द्वारा पिया जाता है । प्रारंभ में नाक के द्वारा पीने से कुछ कष्ट होगा पर अभ्यास से वह कष्ट होना बंद हो जाता है। उषा पान का प्रारंभ ग्रीष्मऋतु में होना चाहिए। उसमें

तुलसी और बेलपत्र डाल दें तो प्रथम से पेट के कीड़े और द्वितीय से मधुमेह वालों को विशेष लाभ होता है। रुद्राक्ष डालने से उच्च रक्तचाप वालों को लाभ होता है। उषा पान के बाद अग्निसार व उदराकर्षण करने से मल की शुद्धि होती है।

## प्राण शक्ति का नियमन

अमेरिका में रोजरी हील कॉलेज के फेलोव चेयरमैन जुस्टा स्मिथ हाथ से स्पर्श कर रोगों का इलाज करते हैं। प्रसिद्ध शोधकर्ता और एन्ड्रिजा पुहारिन ने इसकी प्रक्रिया की वैज्ञानिक जांच करने हेतु जुस्टा से पानी से भरा पात्र स्पर्श करने को कहा और देखा कि जल पर तो कोई प्रभाव नहीं पड़ा पर जल में उपस्थित जीवाणु उससे प्रभावित हुए। इससे सिद्ध हुआ कि जल में उपस्थित जीवाणु प्राणशक्ति का नियमन करते हैं। हाथ रगड़ने से चुंबक पैदा होती है। चुंबक के क्षेत्र में जल में विभिन्न आयनों का निर्माण होता है।

## विद्युत जल

हमारे देश में से नेहरू ने विद्युत प्रभावित जल से पौधों को जल्दी उगाने और उनसे ऐसी अच्छी फसल लेने के सफल परीक्षण किए हैं। यह भी तभी संभव है जब जल में विभिन्न आयन पैदा होकर प्राण शक्ति का नियमन करें।

## मिट्टी का घड़ा

घर में मिट्टी का जल कलश भर कर रखते हैं। वह मिट्टी वालुका युक्त होती है। उसके छोटे–छोटे छिद्रों में से जलकण रिसते हैं और आकाशीय वायु उनको वाष्प कण में बदलती है तथा एक ग्राम जल से वाष्प बनने में 536 कैलोरी गर्मी की जो आवश्यकता पड़ती है वह गर्मी अंदर के पानी से ले ली जाती है और पानी ठंडा हो जाता है। शीतल जल प्राप्त करने की यह भारतीय पद्धति अपनी निजी उपलब्धि है। मिट्टी के पात्र में रखे जल में से मिट्टी ही कीटाणु नाशक का भी काम करती है।

## कलश के आकार का जल पर प्रभाव

कलश को हम पिरामिड की शक्ल वाला कह सकते हैं। भारत में यज्ञ मंडप पर भी जल कलश भर कर रखे जाते हैं। मिस्र देश में पिरामिडों की अद्‌भुत शक्ति की अलौकिक गाथायें हैं। वैज्ञानिकों ने भी उन पर परीक्षण किए हैं । उनका मत है कि पिरामिड शक्ल के कारण विशेष विद्युत प्रभाव उत्पन्न होता है। अतः उसके अंदर रखी वस्तु नष्ट नहीं होती। उसी प्रकार के गत्तों के पिरामिड बनाकर कुछ प्रयोग किए गए हैं। एक खास ऊंचाई से ऐसे पिरामिड पर रेजर ब्लेड रखने से वह खराब नहीं होता और न उसमें जंग लगती है। आजकल पश्चिम में कई प्रकार की वस्तुओं को इसी आकार के डिब्बों में रखकर बेचा जा रहा है।

*जल से आंखों के रोग दूर होना*
*आपोहिष्ठा मयोभुवस्ता न ऊर्जे दधातन।*
*महे रणाय चक्षसे।* [6]

जल सुखकारी है । उसे बल के लिए, अत्यधिक आनंद के लिए और दर्शनशक्ति पाने के लिए प्रयुक्त करो।

अथर्ववेद की एक ऋचा में कहा गया है कि जल से ही देखने सुनने एवं बोलने की शक्ति प्राप्त होती है। भूख, दुःख, चिंता, मृत्यु के त्यागपूर्वक अमृत (आनंद) प्राप्त होता है–

*आदित्यपश्याम्युत वा श्रृणोम्या मा घोषो गच्छति वाङ्मासाम्।*
*मन्ये भेजानो अमृतस्य तर्हि हिरण्यवर्णा अतृपं यदा वः।।* [7]

तात्पर्य यह है कि देखने, सुनने एवं बोलने की शक्ति बिना पर्याप्त जल के उपयोग के नहीं आती। जल ही जीवन का आधार है। अधिकांश जीव जल में ही जन्म लेते हैं और उसी में रहते हैं। हे जलधारको! मेरे निकट आओ। तुम अमृत हो।

जल चेहरे का सौंदर्य तथा कोमलता और कांति बढ़ाने में औषधिरूप है। भोजन के पाचन में अधिक जल पीना आवश्यक है। जब तीव्रगामी सारथि रथ पर चढ़कर जल से युक्त स्थानों की ओर वायु ले जाता है तब वह वायु जल को स्वच्छ करते हुए जाता है। वायु के तेज झोंकें जल पर स्थित मलिनता को किनारे लगा देते हैं, जिससे शुद्ध जल चमक उठता है। यदि जल प्रदूषित होता है, तो इसका शुद्धीकरण कराया जाए। जैसा कि वर्तमान में अपशिष्ट या रासायनिक घोल तो समुद्र में आए दिन प्रवाहित होते ही हैं किंतु परमाणु परीक्षण से भी जल की गुणवत्ता को समाप्त किया जा रहा है, जबकि ऋग्वेद में ऐसा वर्णन है जिससे ज्ञात होता है कि उस समय समुद्र की रक्षा भी की जाती थी–

*याभिः सिन्धुमवथ याभिस्तूर्वथ याभिर्दशस्यथा क्रिविम्।*
*मयो नो भूतोतिभिर्मयोभुवः शिवाभिरसचद्विषः।।* [8]

हर्षदायक हे मरुदगणों! जिन रक्षण शक्तियों के द्वारा अपने समुद्र को संरक्षित किया,जिनसे कूप (जल संग्रह स्थल) तैयार किए जिनसे अपने शत्रुओं को नष्ट किया, उन्हीं शक्तियों के द्वारा हमें सुख प्रदान करें।

वर्तमान में शुद्ध पेय जल समाप्तप्राय है। आज बुद्धिजीवियों को जल के महत्व को समझने की आवश्यकता है। यदि समय रहते इस विषय पर चिंतन नहीं किया गया तो निश्चय ही अगला विश्व युद्ध जल के कारण होगा।[9] आज पर्यावरण संकट की स्थिति में ऐसे उत्साही साधकों की आवश्यकता है जो स्वेच्छा से आगे बढ़कर प्रत्येक जन को पर्यावरण सुधार हेतु आह्वान करें।

## संदर्भ –


1. ऋग्वेद 7/50/4
2. ऋग्वेद 10/43/7
3. ऋग्वेद 8/7/28
4. ऋग्वेद 10/9/4
5. अथर्ववेद 6/23/3
6. ऋग्वेद 10/9/1
7. अथर्ववेद 3/13/6
8. ऋग्वेद 8/7/28
9. ऋग्वेद 8/20/24


## About the Author

डॉ निशीथ गौड़ आकाशवाणी की एक नाटक कलाकार हैं। वर्तमान में भी आकाशवाणी आगरा से कहानियों का प्रसारण निरंतर हो रहा है। विगत 12 वर्षों से दयालबाग एजुकेशनल इंस्टीट्यूट (डीम्ड विश्वविद्यालय) दयालबाग, आगरा में सहायक प्राध्यापक के पद पर कार्यरत हैं। लगभग 35 से अधिक राष्ट्रीय एवं अंतर्राष्ट्रीय शोध संगोष्ठियों में प्रतिभागिता प्रदान की है। 20 शोध पत्र राष्ट्रीय एवं अंतर्राष्ट्रीय पत्रिकाओं में प्रकाशित हैं। 50 से अधिक आलेख प्रकाशित हैं।

आपने अनेक पुरस्कार प्राप्त किए हैं, जिसमें ज्वेल ऑफ इंडिया, वर्धा नागपुर लोकरत्न राष्ट्रीय पुरस्कार, वर्धा आउटस्टैंडिग फैकल्टी अवार्ड, चेन्नई, चौधरी खूमसिंह अवॉर्ड, अलवर, राजस्थान, बेस्ट पेपर अवॉर्ड एवं हिंदी सेवी विदुषी सम्मान, कथा यू के, लंदन के द्वारा प्राप्त हुआ। आपका जीवन संस्कृत एवं संस्कृति के प्रति समर्पित रहा है।

# Rejuvenation, Restoration and Resuscitation of the Yamuna River System: A Clarion Call

**Prof. Anand Mohan**
Dayalbagh Educational Institute
(Deemed to be University)
Dayalbagh, Agra 282005, India

***Abstract:*** *The Yamuna river, a lifeline of northern India, has long served as a symbol of cultural and ecological heritage. However, unbridled urban development, industrialization, and unregulated human activities have inflicted severe degradation upon this once mighty watercourse. The Yamuna river is facing severe problems such as increasing pollution, reducing water levels, and ecological imbalances in the contemporary times. We need to hear the river's clarion call for an immediate rejuvenation, restoration, resuscitation and revival. Amidst these challenges, a beacon of hope emerges from the initiative and relentless endeavours of the Dayalbagh Educational Institute and Dayalbagh in Agra. This paper adjures for a clarion call to action for the rejuvenation, restoration, and resuscitation of the Yamuna river System. It underlines the urgency of addressing the challenges holistically, with a collaborative approach among the stakeholders. By adopting sustainable practices, innovative technologies, and informed policies, we can pave the way for a revived Yamuna river that would sustain ecological balance, provide clean water for all, and retains its cultural and spiritual significance for the generations to come.*

***Keywords:*** *River System, Yamuna river, Restoration, Remote Sensing, Bacteriophage, Self- Cleansing*

## INTRODUCTION

We all have heard the saying that "A river is Nature at its best". Nature has given us a spectrum of bounties in the form of mountains, landscapes, oceans, glaciers, flowers, trees, fruits, lakes and rivers all over the world. No one has been able to escape the spellbound scenic beauty of colourful nature. India has also been bestowed with an enriching bouquet of physical nature from the Himalayas to Cape Comorin. It has a wide variety of flora and fauna like the diverse cultures and religions in India. The Indian subcontinent's flora and fauna are eye candy for its nature lovers [1]. Similarly, a river is a self-organizing system involving both biotic and abiotic interaction. This leads to the emergence of biodiversity supporting a variety of life forms. The study of river ecosystems would require a framework based on nonlinear-stochastic system exhibiting various features like emergent structures, bifurcation, multiple equilibria etc.A recent study provides evidence of plant-driven self-organization leading to emergent buffering of river flows. In a wider context it is known that the underlying stochasticity (both internal as well as environmental) plays a significant role, particularly when one is in the vicinity of critical points. Both continuous and discontinuous transitions may result in moving from a higher equilibrium state to another state corresponding to a lower equilibrium and poor water quality. Thus, a river ecosystem may be resilient up to a certain level of human interventions by way of exploitation of the river resources. A river system provides home to millions of people and characterizes widespread activities e.g., agriculture, livestock, fisheries, manufacturing etc. More than 40% of the total Indian population resides in the extensive catchment areas of the rivers systems.

The Ganges Foreland basin is the most magnificent landscape on the Indian subcontinent. Its origin is related to the Himalayan mountain building through time. Drained by numerous Himalayan and Cratonic-fed rivers, it is a densely populated and extensively cultivated area. In the basin, the Ganga is the trunk river and after confluence with the Yamuna at Allahabad it becomes the axial river of the basin. Before Allahabad, the Yamuna river is the axial river which occupies the lowest elevation in the basins and drains parallel to peripheral bulge, the cratonic Chambal, Betwa and Dhasan are the major tributaries of the Yamuna river (Fig.1). Therefore, the Yamuna river carries a mixed sediment load derived both from the Himalaya as well as the Craton. All these rivers are flowing incised into the doab surface which is the most extensive and the oldest geomorphic element of the Ganges Plain. Within the river valleys are the river terraces, which are the older sediments deposited during the period of higher discharge by the river occupying the valley.

**Corresponding author:* anand.abhu@gmail.com
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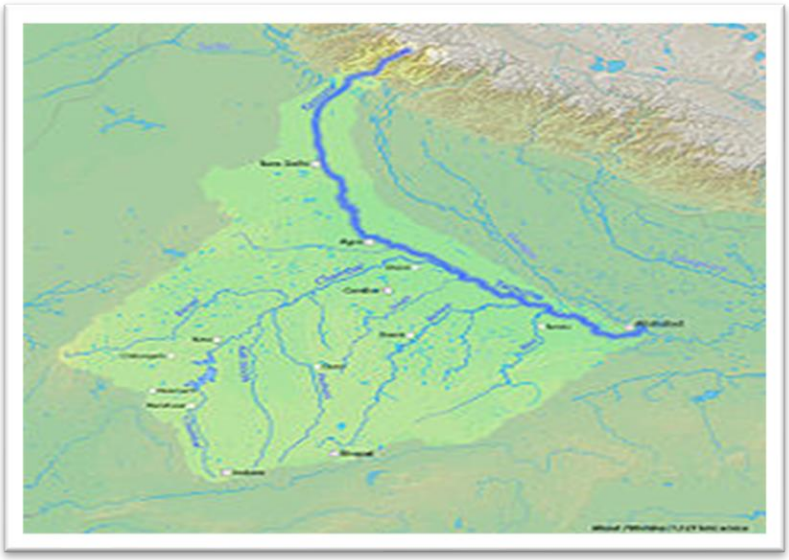

**Fig. 1. Major Tributaries of Yamuna River**

Near Agra, the Yamuna river is flowing following the SE slope. Its valley is very narrow probably because of the incision. The valley is less than a kilometer wide. Its shows distorted meanders both in the upstream and downstream of the Agra city separated by a straight channel (Fig. 2). It has a very narrow flood plain. People have occupied the river valley terrace and even the abandoned floodplain areas which is not a healthy practice endangering riverine environment. During the high-magnitude floods, these areas are flooded causing loss of property and life. During the summer mid-channel bars appear in the river. However, during the floods these bars are submerged. Along narrow stretches, the flow energy is higher but due to sediment load the channels are constricted. At Agra, the river shows the channel shift and evidenced by meanders cars and silted-up lakes.

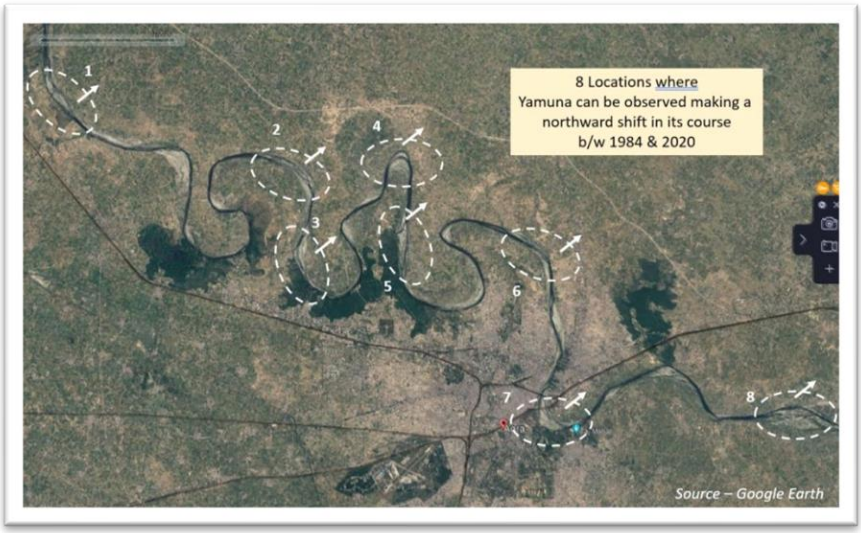


**Fig. 2. Landsat Imagery View of Yamuna River at Agra**

It's bizarre and painful to see the plight of the present-day Yamuna river in Agra. A mammoth task lies ahead of the determined and dedicated citizens of Agra who have a sense of belonging with water. The significance of the river rejuvenation relates to controlling floods and reducing the damage thus caused by their fury. A healthy river system has the capability to retain excess water preventing flooding in the downstream localities. As a consequence, many lives, property and assets are saved. This has a direct implication for water scarcity, improving water quality, restoring the ecosystem and providing space for systematic development. During COVID-19, the shutdown across the globe observed marked reduction of pollution load in the rivers. It saves mankind from consuming polluted water which causes waterborne diseases and other health hazards.

Likewise, unthreatened sewage, untreated waste, and industrial waste all pollute our rivers. The rivers are not meant to be the dumping grounds. The burden of ever-growing population along the river banks is intruding the privacy of naturally flowing rivers. As a result a holistic policy frame is recommended for re-establishing the livelihood of riverine local communities.

## HISTORICAL PERSPECTIVE

The significance of 'water' as one of the Panch Tatva (air, water, earth, sky and fire) is well known. It has been rightly said, "Pure water is the world's first and foremost medicine". It is also believed that "All water is holy water." Life cannot exist without water....it is the humans that depend upon nature, and not vice versa. In the words of Harrison Ford, "Nature doesn't need people, people need nature, nature would survive the extinction of the human being and go on just fine, but human culture, human beings, cannot survive without nature [2]". Therefore, it has been rightly affirmed by Loren Eiseley "If there is magic on this planet, it is contained in water [3]".

The Yamuna river is one of the seven sacred rivers of our nation. Historically, it is believed that the people of the Indus Valley civilization worshiped the rivers. The most significant rivers in the faith are the Saptanadi: (the seven sacred rivers) the Ganges, Yamuna, Sindhu, Narmada, Godavari, Krishna, and Kaveri. The longest tributary of the Ganges in India, the Yamuna is an immensely significant river in its own right. It is believed to have originated from the Yamunotri glacier and travels for a distance of 1,376 km before it unites with the river Ganges and Saraswati and forms confluence (the auspicious Sangam) at Allahabad. Merging with the holy Ganges it falls into the Bay of Bengal [4].

According to the Puranas Yamuna is known as Yami in early texts, while in later literature, she is called Kalindi. In Hindu scriptures, she is the daughter of Surya, the Sun God, and Sanjna, the Cloud Goddess. Like the Ganges, the Yamuna river is highly venerated in Hinduism in the form of a river as the Goddess Yamuna. The Yamuna is considered as a river of heaven. The Rig Veda includes the Yamuna river as one of the seven sacred rivers, along with the Ganges. There are many myths and legends related to this sacred river Yamuna. Other texts, however, say that she was the daughter of Brahma. The twin sister of Yama, the God of Death, Yamuna is also associated with God Krishna, and is mentioned as one of his eight consorts (ashtabharya). Lord Krishna whom most of the Hindus worship, had a very close association with the river Yamuna. His birth in Vrindavan, situated on the banks of the sacred river Yamuna and the homage it paid to Him by touching His feet as He was carried to Gokul across the river, and His childhood that was spent on its bank, are an inspiration and significant cause to maintain the sanctity of the holy river. Even the Mughal rulers loved the varying moods of the Yamuna and adorned its banks with magnificent buildings like Red Fort at Delhi, the Agra Fort and Taj Mahal, the dream in marble. Delhi, the Capital of our great nation is also situated along the bank of this river. This sacred river surrounds the city of Taj and flows adjacent to the seventh wonder of the world --the Taj Mahal, the magnificent monument of the world that allures tourists.

## REJUVENATION, RESTORATION AND RESUSCITATION OF THE RIVER SYSTEM

The restoration of the Yamuna river is crucial not only for slowing down its degradation but also for restoring its grandeur in various aspects, such as the green cover, water table, landscape, and biodiversity. Several measures need to be implemented to achieve this, including curbing untreated sewage discharge and promoting eco-friendly practices. The pouring of toxic chemicals into the river should be restricted as they pollute the river with lethal chemicals like nitrate, heavy metals, lead, arsenic, etc. The agricultural produce grown in sewage water is a greater source of waterborne diseases and a threat to both humans as well as animals.

Despite efforts, the pollution levels in the Yamuna river have seen little reduction. Delhi, covering only 2% of the river's length, contributes to over 70% of its pollution. Therefore, restoring the river in Delhi is of utmost importance for its overall health and well-being. There is a need to sensitize people through education and training to have a value system to have low concern for self and high concern for others. This value orientation will enable them to conserve water; minimize waste; prevent throwing waste – both solid and liquid in the river Yamuna and show respect to Mother Earth and the rivers.

The emphasis should be on prevention rather than damage control. We can contribute to improving the Yamuna river by using effective sewage treatment plants. Society and individuals must commit to planting trees along the riverbanks to increase the green cover. Afforestation will help prevent soil erosion and recharge the groundwater table. It will also aid in sequestering carbon dioxide and developing catchment areas. Promoting eco-friendly practices during the festivals like using biodegradable materials for idols can also be an effective step. These efforts will reduce the pollution and restore the river's ecology. Moreover, conserving moisture will be crucial for the river's health and the well-being of people living around it. We can also boost livelihoods and income by promoting eco-tourism through the development of riverfronts and eco-parks. Raising awareness among the masses about water quality improvement and flow in the river is essential. Lastly, encouraging rainwater harvesting, reducing slums, and working together with neighbouring states are also vital for long-term rejuvenation. These are true objectives for the restoration and

resuscitation of the lost pride of the Yamuna river. Digital technology, including remote sensing, artificial intelligence, machine learning, and data science, has proved valuable in scientific research and decision-making. Bio-sensors and IoT can help monitor biodiversity and river bank health. Real-time monitoring of water quality using advanced technology should be implemented to ensure the effectiveness of restoration efforts.

**Fig. 3. Biodiversity Park at the Yamuna River Bank**

Dayalbagh as a community together with DEI, under the tutelage of Revered Prof. Satsangi, is offering an impetus towards a sustainable solution based on local conditions with a scientific approach. A systems approach requiring an integrated effort combining groundwater management, bio-diversity regeneration, tree plantation, and organic farming is followed here. The local community at Dayalbagh has shown remarkable dedication and selflessness in their efforts to rejuvenate the river Yamuna in Agra. Embracing the principle of dignity of labour, they have come together to engage in a spirit of selfless service for the betterment of the community and the environment. With their unwavering commitment, they have transformed the once dull and polluted riverscape into a breathtakingly beautiful panorama. One of their significant contributions has been the planting of around 5000 medicinal and herbal plants along the riverbanks, envisioning a future enriched grove that will not only enhance the aesthetics but also bring numerous health benefits (Fig.3). Through their collective endeavours, the Dayalbagh community sets an inspiring example of how individuals can make a positive impact and create a sustainable change for their surroundings. Their actions serve as a reminder of the power of unity and the potential to revive and preserve our natural resources for the generations to come.

## THE SCIENCE BEHIND SELF-CLEANSING PROPERTIES OF THE GANGES WATERS

The Ganga water is used as a holy water in all the Hindu rituals since it does not putrefy even after storage for long periods. It creates curiosity among the scientific community to know the main cause behind the purifying capacity of the Ganga river water. In this connection, the first time the presence of marked antibacterial activity against Vibrio cholera in the Ganga river water was reported by Ernest Hankin in 1896. He recorded that Vibrio Cholera which is the causative agent of cholera died within three hours in Ganges water, but persisted for 48 hours in distilled water [5]. Hankin also showed that the Ganges' anti-cholera properties disappeared after boiling the water, indicating that the antimicrobial agent can be destroyed by heat and is not a "magical" characteristic but rather a molecular one. Thus, the disinfecting property of the river Ganga was mysterious over the decades for many around the globe. Later on, a French microbiologist D'Herelles in 1922 used the attributed term bactriophage (i.e., bacteria-killing viruses) for the invisible factor responsible for the antibacterial property of the Ganges [6]. The bacteriophages destroy the pathogenic cholera bacteria present in the river Ganga. Regarding the source of these bacteriophage, it is believed this prokaryotic virus existed in the earlier time scale in the Himalayan permafrost conditions (where the river Ganga originates) as an abiotic particle that was gradually released with the arrival of melting climatic conditions. Several investigations have been carried out on the well-known self-cleansing properties of the Ganges waters; almost all the investigators attribute the presence of characteristic bacteriophages in combination with the trace element abundances in the Ganges waters to provide the resilience for the Ganga water to remain characteristically clean in spite of the addition to its pollution coming from myriad sources [7,8].

Nautiyal conducted a study to understand the certain novel antimicrobial attribute which is responsible for the magically self-cleaning properties of the Ganga river water [9]. His experiments with the Ganga water spiked with pathogenic Escherichia coli serotype indicated the role of antimicrobial peptides (AMPs). AMPs are part of the innate

immune system and an important component of immune defence. They are produced by plants, animals, insects, and single-celled organisms, and possess antimicrobial properties. More than 70 years ago, Sir Alexander Fleming, the renowned discoverer of penicillin, warned about a potential future where the misuse of antibiotics would lead to a world without their effectiveness [10]. The Ganges river's ancient and revered water hold the promise of being a source of discovery for the future of human health.

The National Environmental Engineering Research Institute (NEERI) at Nagpur in their report entitled: “Assessment of Water Quality and Sediment to Understand Special Properties of the river Ganga” have come out with the following facts:

(A) Five pathogenic species of bacteria (Escherichia, Enterobacter, Salmonella, Shigella, Vibrio) were isolated from the Ganga, Yamuna and the Narmada and their numbers compared with the bacteriophages present in the river water. Because bacteriophages are a kind of virus that kills bacteria, they are frequently found in proximity to each other.

(B) In the river Ganga, the bacteriophages were detected to be approximately three times more in proportion than bacterial isolates.

(C) Samples drawn from the Ganga contained almost 1,100 kinds of bacteriophage, and proportionally there were less than 200 species detected in the samples obtained from the Yamuna and the Narmada.

## RIVER THAMES: A CASE STUDY

An innovative endeavour to purify the Yamuna river by the Dayalbagh community reminds of something similar followed by the British to cleanse river Thames. An area of King George’s Park in Wandsworth celebrated the start of spring with new trees, as part of the Queen’s Green Canopy initiative. Tideway, the company building London’s super sewer to remove more than 95% of sewage pollution from the capital’s river is engaged in the tree plantation within the corner of the park that has been supporting the work to clean up the river. These trees will be a lasting legacy of the Queen’s Jubilee and will be there for the community to enjoy for generations. It’s fitting that this legacy sits alongside Tideway’s work to improve the river environment; contributing to the essential work everyone must contribute to sustain the planet Earth [11]. Who cleans whom may remain a matter of debate but the Nature brings us to a common platform – to serve humanity with sustainable goals.

## CONCLUSION

How can we as the natives of this wonderful city of Taj, allow an oxymoronic riverscape of the beautiful monument on one side and the polluted river Yamuna on the other side? Why has it turned up to be so repellent? Water once contaminated becomes harmful to all the living beings. It is time for the greed and selfishness of man to be checked and enable the rivers to breathe and carry the purity in their flow. The father of our nation, Mahatma Gandhi has said, “The best way to find yourself is to lose yourself in the service of others.” We all need to revive the lost glory of the river. Both Dayalbagh and DEI that has been relentlessly serving mankind for more than a century and a half, had taken up the task to clean the banks of the Yamuna river at Agra. Dayalbagh holds the objective of establishing better worldliness and helping mankind to reach its goal of life. Keeping in mind the well-being of the inhabitants of not only the city of Taj, but also of those closely residing in the rural setups near the river, it initiated the drive of cleaning the banks of the river, in April 2023. Now the serene banks of the tributary are visited by all age groups with families; they enjoy the kempt environment which is far from the madding crowd of the city. The cultural presentation of the tiny tots of Dayalbagh is the cherry on the cake. The motor boat and the manual boat ride with the melodious folk in the background, sponsored by Dayalbagh, make one and all feel just out of the world. These activities of jollities are open to all. There is a need for suasion because the initiative of the Government to cleanse the holy Ganges imparts an incentive to purge the Yamuna river as well. We have to perform swiftly but firmly because we are racing against time. The heartbeat of unabated water flowing with roaring clamour down the stream gives a message for its inhabitants to let her smooth flow carry on without any hindrance. Only those who have a sense of commitment for saving water would be able to gauge her throbbing pulse and tell about the good work rivers have uncompensated towards the advancement of our civilization.

## ACKNOWLEDGMENTS

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## About the Author

**Prof. Anand Mohan** has earned B.Sc. degree in Physics, Mathematics and Geology (Hons.) in 1976, and Ph.D. in Metamorphic Petrology from Banaras Hindu University in 1983.

Prof. Anand Mohan has a rich experience spanning upto 23 years of graduate and post-graduate teaching in the areas of Metamorphic Petrology, Mineralogy, Precambrian Geology and Application of Thermodynamics of Pterological Problems.

Prof. Anand Mohan has 50 research papers, 275 citations of publications to his authorship credit. He has also edited a book entitled 'Milestones in Petrology and Future Perspectives' Memoir 52, published by the Geological Society of India, Bangalore.

Presently he is serving the Dayalbagh Educational Institute as the **Registrar**.

# Restoration/Rejuvenation of Water in the River Yamuna, Agra

**Prof. Huzur Saran**
Department of Computer Science & Engineering
Indian Institute of Technology Delhi

***Keywords:*** *Erosion Control, Precision Agroecology, 3D IoT Visualisation, Dayalbagh Community, Sustainable Development Goals*

The Dayalbagh community has been following the ancient Aryan practices since the inception of the Ra Dha Sva Aa Mi religion in 1818, which is over 205 years ago. They have also been practising modern scientific methods, particularly in the context of meditational practices like Sahaj Surat Shabd Yog, aimed at internal and external progress while staying close to nature. The community is dedicated to conserving natural resources and combating climate change, aligning with the national and international mandates for forestation, agriculture, and water resource enhancement.

Dayalbagh Educational Institute conducts medical camps for the villagers and fishermen, utilizing motorized boats for transportation. Their objective is to combat the negative climate impact, create awareness in the rural society, and maintain air and water quality according to WHO and UNESCO standards and the United Nations Sustainable Development Goals (SDGs).

Restoring the Yamuna river in the context of the Dayalbagh community's conservation efforts can benefit from the integration of agroecology and technology such as IoT sensors and drones in the river rejuvenation initiatives. These techniques can enhance the ability to monitor, manage, and restore the Yamuna river effectively while engaging local communities and promoting transparency in the process. Since DEI has an active MoU with IIT Delhi, there is scope for significant interaction on collaboration. Some technology based approaches would include:

## 1. WATER QUALITY MONITORING WITH IOT SENSORS:

a. Deploy a network of IoT sensors along the river at key locations to continuously monitor water quality parameters, such as pH levels, dissolved oxygen, turbidity, and pollutant concentrations.
b. Use these sensors to collect real-time data and transmit it to a central database via wireless networks.
c. Implement machine learning algorithms to analyze the data and generate alerts or reports when the pollution levels exceed acceptable limits.
d. Enable authorities and communities to make informed decisions regarding water treatment and pollution control measures.
e. Build flow models to understand the contributing sources to the major pollutants.

## 2. DRONE-BASED AERIAL SURVEILLANCE FOR EROSION CONTROL AND VEGETATION MONITORING:

a. Use drones equipped with high-resolution cameras and sensors to conduct regular aerial surveys of the river and its surroundings. Drones can cover large areas quickly and provide a bird's-eye view, making it easier to identify the sources of pollution and take immediate action.
b. Drones can help monitor the dumping of waste, industrial discharges, or deforestation in the river's catchment area.
c. Employ drones to monitor the health of riparian zones and vegetation along the riverbanks.
d. Detect areas prone to erosion or invasive species infestation and take timely corrective measures.
e. Use the data collected to plan and implement erosion control strategies, such as planting native vegetation or installing erosion control structures.

## 3. DATA INTEGRATION AND VISUALIZATION:

a. Integrate data from IoT sensors and drones into a comprehensive river management system.
b. Develop user-friendly dashboards and visualization tools to present data in a format that is accessible to researchers.

***Corresponding author:** saran@cse.iitd.ac.in*
ISSN 0972-5032 (P); 

### 4. COMMUNITY ENGAGEMENT:

a. **Mobile Apps**: Use IoT-based mobile applications that allow community members to report pollution incidents or illegal dumping into the river. This crowd-sourced data can be used for targeted cleanup efforts.
b. **Education and Awareness**: Use technology to disseminate information about the importance of river restoration, sustainable farming, and water conservation.

### 5. POLLUTION SOURCE IDENTIFICATION:

a. Use Geographic Information System (GIS) technology to map and identify pollution sources, such as industrial discharges and agricultural runoff, which are affecting the river's health.
b. Implement drones and satellite imagery for aerial surveillance to locate illegal discharges and land-use changes along the riverbanks.

### 6. RIVERBED DESILTING/MANAGEMENT:

a. Employ technology with the Community Volunteers for riverbank stabilisation, and trash collectors to efficiently remove silt, debris, and pollutants from the riverbed.

### 7. AGRICULTURAL PRACTICES:

a. Promote agroecological farming practices among the local farmers to reduce chemical pesticide and fertilizer usage. This includes crop rotation, organic farming, and integrated pest management.
b. Use precision agriculture techniques and smart farming technologies to optimize resource use and minimize the impact of agriculture on the river's water quality.

### 8. RIPARIAN BUFFER ZONES:

a. Establish and maintain riparian buffer zones along the riverbanks using native vegetation. These buffer zones act as natural filters, reducing the flow of pollutants into the river.
b. Employ geospatial tools to plan the optimal locations for buffer zones based on land characteristics and ecological needs.

### 9. RESEARCH AND INNOVATION:

a. Support research initiatives focused on improving agroecological practices and technologies for sustainable agriculture and river restoration.
b. **Innovation Hubs:** Encourage innovation in wastewater treatment and pollution prevention through partnerships with research institutions and startups.

By combining technology and agroecological principles, the Dayalbagh community and other stakeholders can work towards restoring the Yamuna river, preserving its natural ecosystem, and promoting sustainable development in the region. Collaboration with the government bodies, NGOs, and environmental agencies will be crucial in implementing these strategies effectively.

## About the Author

Prof. Huzur Saran is a Professor in the Department of Computer Science at IIT, Delhi. He is currently the Head of the Bharti School of Telecom Technology & Management, IIT, Delhi & also Co-ordinates the Centre of Excellence in CyberSecurity at IIT, Delhi. He has also served as the Head of the Computer Science Dept. at the Amar Nath & Shashi Khosla School of IT, and the Computer Services Centre at IIT, Delhi. Prior to joining IIT, Delhi in 1990, he did his Ph. D in Computer Science from the University of California, Berkeley in 1989 and, a B.Tech from IIT, Delhi in 1983. His research is focused on Wireless Networks, Computer Systems and Security and Algorithms.

Prof Saran has been actively working in 5G wireless technologies. He is currently a Lead Investigator for the 5G Research Project funded by the Department of Telecom, Govt of India. During 2000-2002 he was a Visiting Professor at the Information Systems Lab, Stanford where he worked on the media access control layer of an early 4G wireless system. Dr Saran has been a consultant in the past with AT&T Research, New Jersey and Lucent Bell Labs in the area of Network Performance Analysis. In the area of CyberSecurity, he was an adviser during 2003-2010 to Solidcore a Software Security Startup which was acquired by MacAfee for its Dynamic Whitelisting Technology.

# Yamuna River's Health: Assessment for Restoration

**Prof. A. M. Kayastha**
School of Biotechnology, Institute of Science
Banaras Hindu University, Varanasi 221005

***Abstract:*** *River rejuvenation refers to the revival of a river's erosive ability whereby a river has reached the base level and regains energy, beginning to erode actively downwards once again. The river Yamuna is one of the sacred rivers of India. Besides Delhi, the Capital of India, two other major cities, Mathura and Agra, (within 200 Km distance downstream of Delhi) are of the greatest historical and cultural importance. However, this very stretch of the river is also one of the most heavily polluted and degraded rivers that stretches in the country. Although the flow of the river Yamuna was diverted at Tajewala (Haryana) more than a century ago, the lean season flows in the river have been eliminated downstream at Tajewal (now Hathnikund) over the recent decades. Delhi and other cities have witnessed rapid growth and development, which has also resulted in huge quantities of sewage and wastewater that are not treated fully before discharge into the river. The vast floodplains, which serve as a floodway and help discharge groundwater, have also gradually been eliminated to a great extent and encroached upon by gradual reclamation by dumping solid waters and construction of various buildings. This has reduced the flood-carrying capacity, groundwater recharge capacity, and other biodiversity-related embankments, bunds, roads, flyovers, guide bunds and spurs, several bridges, and barrages.*

***Keywords:*** *The Yamuna River, Pollution, Rejuvenation, Degraded Ecosystems, Wetlands*

## STATUS OF THE RIVER YAMUNA:

The river Yamuna is one of the sacred Himalayan rivers originating from the Yamunotri glaciers range of lower Himalaya. The river travels over a distance of 1370 Km across Uttarakhand, Himachal Pradesh, Haryana, Delhi, Rajasthan, and Uttar Pradesh and finally joins the Ganga at Prayagraj; its basin spreads over an area of 66,220 Sq. Km., which constitute 42.5% of the total Ganga river basin. About 14 hydroelectric projects were completed and several were proposed within the Yamuna river basin. A total of 6 barrages have been constructed across the river.

The report of the high-powered committee on the Yamuna river Development has summarized the status of pollution in different sections of the river. The deterioration of the quality in the river is due to the complete withdrawal of fresh water for irrigation and drinking purposes and cumulative discharges of domestic, industrial, and agricultural wastewater into the river, all of which has transformed the river into an open sewer in the Delhi-Agra stretch. This is adversely impacting riparian ecosystems and endangering public health inhabitants. The report further showed an increase in Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Bacteriological analysis has revealed an increase in fecal Coliform and total Coliform, the trend in water quality is critically worse and alarming in Yamuna. In August 2023, the worst state of fecal coliform in the river was 68 times the maximum permitted limit and 340 times the desirable limit. The Central Pollution Control Board also confirmed that water in Yamuna is unfit for any purpose by humans; even animals are reluctant to drink its water because of the stink. Besides solid waste dumping in Yamuna, washing of the clothes, cattle and bathing and open defecation by the large population residing near the river catchment has contributed to the pollution of the river.

Encroachment and rampant dumping of municipal and construction on the floodplains have stultified the river and impaired its natural ability to rejuvenate itself. The quality of water will not improve unless the flow in the river is increased. The Yamuna had remained stagnant for almost nine months of the year. With no flow, there was no dilution of the river downstream. Given deeming the overall shortage of water in the Yamuna basin, the possibility of additional fresh water becoming available for dilution appears to be remote in the foreseeable future.

**Corresponding author:* *kayasthabhu@gmail.com*
ISSN 0972-5032 (P); 

**Fig. 1. river Yamuna Bubbling with Toxic Foam**

**Fig. 2. Animals Bathing in river Yamuna**

**Fig. 3. Status of river Yamuna during summer**

## FLOODPLAINS AND RESTORATION OF THE YAMUNA:

It is important to examine the scientific literature on the ecology, conservation, and restoration of rivers worldwide in order to ensure understanding of the scientific principles on the bases of which the case of the river Yamuna can be taken up for its restoration and conservation. I would briefly highlight the salient features of the basic principles that must underlie any conservation and restoration effort for its success.

The ecological integrity of a river depends upon its uninterrupted flow, its seasonally high flows, and the nature of sediments carried by the river. The natural functions of a river are governed by the characteristics of its channel, flow regime, water quality, biological diversity, and the riparian and floodplain habitats and their interactions. According to an Australian ecologist, "Floodplains are as important to rivers as bark to trees. Most of the processes that drive life in rivers happen around their edges. Just as the sap flows through the outermost ring of a tree, not through its center, the lifeblood of river ebbs and flows on its floodplains. The vegetation growing there is not mere decoration it is a river's roots and leaves."

Seasonally high flows, such as those during the rainy season, exceed the channel capacity and spill over the river banks flooding areas on either side. Internationally, the area lying laterally to the river channels and flooded at least once in 100 years is considered as the floodplain. The floodplains play a critical role in determining the ecological characteristics of a river and provide many ecosystem services. They form a crucial link between the adjacent upland terrestrial habitats and the river. The major and most important functions of floodplains include (i) Moderation of flood peaks through temporary retentions of water and spread of water (ii) Enhancement of groundwater recharge in a larger area and improvement of groundwater quality (iii) Stabilization of banks for vegetation and maintaining channel forms (iv) Maintenance of high biodiversity and high production of natural resources (v) Provision for fresh sediments with high fertility (vi) Filtering sediments, chemical and nutrients from upslope sources, and thereby improving water quality and (vii) Maintenance of good stream habitat for aquatic animals like fish.

River restoration refers to bringing back an ecosystem to its original or earlier conditions in terms of its biophysical state and its ecological processes. Restoration of an aquatic system aims at re-establishing the "pre-disturbances aquatic functions and related physical, chemical and biological characteristics. Restoration is a holistic process not achieved through the isolated manipulation of individual elements" (U.S. National Research Council). Restoration therefore requires addressing the root causes of degradation which may have also changed in their nature and magnitude over time. Restoration of a river requires interventions to improve channel morphology, flow regime, water quality, biological diversity, and the riparian of floodplain habitats in a manner that ensures their interactions. Improvement of flow regime and water quality is critical to the restoration of a river and necessarily requires a catchment-wide action. Continued discharge of wastewater without adequate treatment and the absence of adequate flows will negate all efforts to improve the channel, biodiversity, and floodplain habitats.

The channel habitat restoration in an alluvial river such as Yamuna requires dredging out accumulated sediments and sludge, and some re-meandering. The Non-structural approaches such as the plantation of appropriate vegetation should be encouraged. The floodplain habitats with appropriate wetland vegetation help improve the water quality further, and depending upon the extent of floodplain areas and the amount and quality of wastewater, the river water quality can be restored to a fairly high level. Floodplain restoration involves the creation of habitats on low-lying land by reconfiguration to promote and enhance interaction between river and adjacent areas through hydrological linkages.

To improve the quality of river water, some innovative and holistic approaches may include:

1. Wetlands in the floodplains
2. Recycling of wastewater (and thereby reducing the demand for fresh water)
3. Dredging or removal of silt from the river banks
4. Plantation of trees along the river banks
5. Rain harvesting
6. Creating off-river reservoirs upstream
7. Improving water use efficiency of agriculture
8. Gradual switching over from water-intensive agronomic practices to low water efficient crops needs to be introduced

The wetlands can store millions of gallons of flood water recharge ground water and enhance the river flow during the lean period; some of these wetlands can be used for recreation purposes. Almost 85% of the water that is diverted from river Yamuna through barrages is used for agriculture and therefore water conservation through improved agricultural practices is crucial in improving the river, Yamuna. Surprisingly, only 20% of the treated wastewater is presently used efficiently, which needs to be improved as the water table has declined to alarming levels. It is ironical that treated sewage wastewater, which is presently being released into drains is harnessed for non-domestic uses like washing

operations in factories, service stations, metro, and bus transport hubs. This must be made mandatory for the parks and gardens.

## CONCLUSION:

Several High-Powered Committees on Yamuna river Development constituted by the Honorable Prime Minister did not spell out any action plans for the rejuvenation of the river but have simply summarized the status. Some more critical opinions have been received from C.R. Babu, Professor Emeritus at the Centre for Environmental Management of Degraded Ecosystems, University of Delhi. "The new Yamuna riiver project proposed jointly by Virginia University, Spanish Government, and Delhi Jal Board is nothing new and simply repeats what has beensaid earlier about the woes of the city and the river". He further says "It does not tell the action plans for the rejuvenation of the river and its riparian ecosystem that generate ecological services including the storage of flood water, enhanced recharging of groundwater, flood regulation, treatment of sewage before and after discharging into the river." "The Yamuna was at its natural best in terms of flow and without the influence of 22 drains in discharging pollutants in it". "There would also be additional situations, but the overall data would have given a real picture of the river," said Babu, very recently. Therefore, the workshop on Rejuvenation and Restoration river Yamuna riverorganized by DEI (Deemed to be University) Dayalbagh was a timely action and a very distinguishable initiative for public awareness and turned out to be very successful. Many useful suggestions/action plans emerged out of this workshop by the researchers/experts. Dayalbagh community and DEI are jointly working on cleaning of the river Yamuna in Agra; the effort made by them is commendable and is getting visibility to the Agra administration and the public. This community-based social effort clearly shows that the government alone cannot clean any river let it be Yamuna unless there is a public-government co-operation.

## CONFLICT OF INTEREST:

There is no conflict of interest with anyone in publishing the proceedings of the workshop.

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## About the Author


Dr. Arvind M. Kayastha is working as a Senior Professor at the School of Biotechnology, Institute of Sciences, BHU, Varanasi. He has been the Coordinator of the School of Biotechnology. His main area of research has been on Enzymology and Enzyme Technology. He has been a Fellow of The National Academy of Sciences, Allahabad since 2003, a Fellow of the National Academy of Agricultural Sciences, New Delhi since 2007, and a Fellow of the National Academy of Medical Sciences, New Delhi since 2021. He was a Visiting Fellow at the National Institutes of Health (NIH), USA, and the Department of Biochemistry, University of California, riverside, U.S.A. He has been the recipient of the UGC Career Award, the Prof. CNR Award, and the Most Productive Researchers Award, twice. He has been a member of the Editorial Board and Associate Editor of several scientific journals of Springer Nature. He has published more than 100 research papers/review articles in peer-reviewed International Journals and a dozen International Book Chapters. At present, his h-index is 40, i10-index is 100 and Total Citations are more than 4600.

# Restoration and Rejuvenation of Water in the River Yamuna

**Prof. Satya Prakash**
In-charge, Air & Water Quality, Dayalbagh,
Former Head of Nuclear Chemistry, Bhabha Atomic Research Centre,
Mumbai – 400094

The Dayalbagh Healthcare Habitat model is a truly world-class model. It has a holistic approach towards efficient and eco-friendly management of all the natural and man-made resources.

An important part of this model is ensuring a healthy river Yamuna which is a perennial source of water for not only Agra but hundreds of towns and villages.

The efforts jointly made by the Radhasoami Satsang Sabha, Dayalbagh, Agra and DEI (Deemed to be University), Agra in addressing the critical problems of the river Yamuna are commendable and worth emulating across the length of the river from its source in Yamunotri to its Sangam at Prayagraj.

**Some of the Initiatives taken by the Radhasoami Satsang Sabha, Dayalbagh, are as follows:-**

1. Practicing 100% organic farming across its nearly 1200 acres of farm land. Many of these farm lands are near the river bank. Therefore, no chemical pollution being passes into the river through Dayalbagh's farm lands.

2. Cleaning the river bank near Vaikunth Dham and removing tons of waste accumulated over the years due to insensitivity of the local administration towards the river Yamuna which is respected and worshipped as Goddess Yamuna in Hinduism. The most commendable aspect of this is the peerless methodology deployed for the cleaning. It was not done by using fuel guzzling heavy engineering machinery but by the followers (Satsangis) of the Radhasoami Satsang, Dayalbagh using their simple hands used as equipment tools as a part of its community service.

3. Mild dredging little away from the river bank and creating effective and leveled dykes-all had been done using hand pulled leveling equipment.

4. Planting thousands of trees on its farm land adjacent to the river bank for soil conservation and embankment.

5. Beautification of some sites near the river bank to create serene and healthy spots for the benefit of the citizens of Agra. Holding live cultural performances of various Indian Dance Forms by the children of the community. The performances were thematically associated with the river Yamuna and our motherland. Providing good quality and low cost (no-profit basis) snacks and beverage to the visitors.

   The purpose was that the people who benefit from the river should engage in activities around the river and thus the idea of good river management gets embedded in the denizens at the conscious and sub-conscious level.

6. To assess the water quality, DEI has set up the Water and Soil testing labs near the river bank. Periodically the pH and Most Probable Number (MPN) of the Coliform Bacteria is tested and published. While the pH is well within the WHO prescribed limits for potable water the Most Probable Number (MPN) of Coliform Bacteria is on the higher side.

7. Implementation of the rain water harvesting by Dayalbagh has helped recharging of ground water tables and to the extent reduced consumption of Yamuna water.

8. Dayalbagh has offered its own land at zero cost for building Sewage Treatment Plant which under a special arrangement supplies the treated water back to Dayalbagh farms for irrigation purpose. Thus, the requirement of water for farming is met in this way thereby reducing the consumption of river water consumption.

**Corresponding author:* profsatyap@gmail.com
ISSN 0972-5032 (P); 

**It would be worth analyzing to evaluate the additional efforts that can be made to rejuvenate the river Yamuna and the quality of its water. Some of the possible options in this regard, have been recommended as follows:**

1. The dredging and deepening of the river bed to increase the holding capacity of the river is something that has been found to be useful in river management. This also allows creating water ways for transportation.

2. Building stop dams in a planned and systematic manner across the length of the river will help increase the holding capacity of the Yamuna. The data suggests that only about 5% of the annual water flow of Yamuna (97 billion cubic meters) is consumed. Rest of it largely flows out in to Bay of Bengal.

3. On the lines of the Dayalbagh model, the river front in every city could be used for developing fountain parks which will not only have socio-economic benefits but also result in aeration of the river water which is essential for the water and aquatic life forms.

4. While concrete construction near the bank is prohibited, it can be seen that corruption and connivance between enforcement agencies and private business parties has led to massive concretization near river banks thus destroying the flood zones and buffer zones. The model of privatisation DBOT – Design, Build, Operate and Transfer of the National Highway Development Program led to accelerated development of highway networks and effective management of the roads by ensuring effective toll fee collection. Similarly, theft of electricity has reduced upon privatisation of electricity distribution companies and the tariff receivables started getting realised effectively. Perhaps the privatisation of the river bank for creating eco-friendly tourism and water ways thus creating economic interest for bidders, will ensure implementation of centrally formulated policies and laws for the effective river management.

5. Similar solutions are required for factories and industries which pour tones of waste and chemicals into the river Yamuna. It is estimated that Delhi causes 80% pollution in Yamuna. This is again due to corruption and thus use of technologies like the real time pollution sensors would be very helpful. The extent, to which Air Quality Monitoring is being done in the cities by the Government and Private players, is missing in terms of measuring pollution in the river and other water resources. Real time measurement and publication of the water resource / river water pollution levels will put public pressure for policy change and effective regulation in this regard. As far as innovation is considered we can learn from Edward De Bono, the leader of lateral thinking. His suggestion in California, USA that factories should have their water inlet from down-stream and outlet of factory should be up-stream made a huge difference. It meant that if a factory pours pollutants in to the river it gets it back first and thus to that extent gets penalised automatically. This ended up becoming legislation in over 13 countries and should be implemented in India as well.

6. The Government of India has spent a lot of money in river restoration projects however; these projects have not been that successful. Let us take a look at the Yamuna Action Plan (YAP) which is a bilateral project between the Government of India and Government of Japan and had started in 1993. It is one of the largest river restoration projects in India and is being executed by the National River Conservation Directorate, under the Ministry of Environment and Forests, Government of India. The phase I, began in 1993 and ended in 2003. Thereafter, the phase two of YAP was started and thereafter the phase 3 of YAP was launched which has a fund allocation of Rs 1656 Crores under International Assistance from Japan. However, the state of River Yamuna remains to be far from desirable. Thus, there is a need to open up private investment in to river management. This will allow sufficient capital to flow in for the purpose and help achieve environmental goals while being economically viable. The same can be regulated by a Central Authority.

7. The Government also has the option of requesting Charitable and Non-Governmental Organisations like the Radhasoami Satsang Sabha, Dayalbagh, Agra to help in delivering social goals like river management. The benefit is that Charitable Institutions like Dayalbagh can execute tasks at far lesser cost (being a no-profit organisation) and be far more efficient and effective in terms of quality and timely completion of tasks. Government should be the funding entity in such collaborative projects.

8. There is a need to have the usage of Yamuna water monitored effectively. There are thousands of illicit connections. Those who are permitted to draw water from the rivers are drawing water beyond the permitted levels. Another dimension is that the withdrawal of water which is to be periodically disclosed by Industries and Factories to the State Pollution Control Boards (as required by legislation) is not being done. There is an absence of credible data to evaluate the withdrawal of water from rivers in general and Yamuna in particular.

9. The shift from Thermal Power to Renewable Energy Sources will also help in saving water. It is estimated that over 85% of Industrial Water consumption is by the Thermal Power Stations (nearly 35 Billion Cubic Meter) for

cooling purpose. The shift from Thermal Power to Solar or Wind power is expected to bring down the Industrial Water consumption by 75%.

10. The Indian Rivers Interlinking Project has not taken off except for one linkage between the Krishna and the Godavari. The project is being managed by India's National Water Development Agency (NWDA) under Ministry of Jal Shakti, Government of India. NWDA has studied and prepared reports on 14 inter-link projects for Himalayan component, 16 inter-link projects for peninsular component and 37 intrastate river linking projects. The plans have not progressed due to legal entanglements and resistance by a section of environmentalists. However, a majority of environmentalists feel that given the geographical gaps in demand and supply of rain water in India, the benefits of the Indian Rivers Interlinking Project far outweigh its down side. In context of Yamuna, the annual withdrawals exceed the natural endowments and therefore the Indian Rivers Interlinking Project will be beneficial for maintaining the water levels in Yamuna.

11. Huge amount of water from the rivers is used for irrigation. While it is essential to give the farmers access to sufficient water, the use of irrigation system is far from being efficient. A lot of this water is getting wasted due to non-usage of new age agricultural technologies like Drip Irrigation. If the precision farming technologies are made easily accessible and its usage is made mandatory with sufficient funding from the banks to the farmers to set up the technologies it will go a long way in frugal usage of water. Thus, ensuring minimization of the river water wastage.

    Perhaps implementing some of the suggestions given above may help in rejuvenation and restoration of the river Yamuna.

## About the Author

Prof. Satya Prakash was born on 1st January, 1942 at Dayalbagh, Agra. He pursued his schooling and higher education from Allahabad, completing his M.Sc. in Chemistry in 1963 from the Allahabad University.

He was appointed as a Scientist Grade 1 in the Radiochemistry Division at the Bhabha Atomic Research Centre (BARC) at Trombay, Bombay in 1964.

His reserach was in the field of Nuclear Fission. He did extensive work on the mass, charge and kinetic energy distribution in fission of Uranium – 233, Plutonium – 239, Californium – 252 etc. This culminated into he being awarded Ph.D from Bombay University in 1972 under the guidance of a nuclear scientist Dr. M V Ramaniah.

He was fortunate to have played an important role in the Nuclear Program of India unveiled in 1974.

As the Head of the Nuclear Chemistry Division at BARC, Prof. Satya Prakash lead a team of 20 scientists. He was appointed as an expert by the International Atomic Energy Agency, Vienna to study the dispersion of radioactivity over Europe because of the 1986 Chernobyl Nuclear Disaster in the erst while Soviet Union.

In 1991, he joined the Dayalbagh Educational Institute (Deemed to be University) as Professor and Head of the Department of Chemistry, Faculty of Science where he introduced the studies on uptake of heavy metals like Chromium, Mercury and Lead in plants using radioisotopes. He guided 16 Ph.Ds and published over 100 research papers in the reputed national and international journals before retiring in 2002.

He was awarded the Life Time Achievement Award by the Systems Society of India on May 23, 2021. As a resident of Dayalbagh, he is presently serving the community as a Mohalla Sarpanch and is responsible for the Air and Water Quality management using the system's approach at Dayalbagh, Agra.

# Enlivening Blue River Yamuna

**Dr. S. K. Satsangi**
Medical Officer In Charge
Saran Ashram Hospital
Dayalbagh Agra

***Keywords:*** *Diversion, Abstraction, Pollution, Encroachment, Free flow*

Yamuna is one of the Sacred rivers in Hinduism, second to the Ganga, the Holiest river of Hinduism of which she is the main tributary. Her confluence with Ganga and Saraswati (Mythical River) at Prayagraj is called Triveni Sangam which is a holy pilgrimage spot.

There are many mythological sayings associated with Yamuna. As, she is the daughter of Sun, who changed color with the sufferings and sorrows of Lord Shiva who jumped into Yamuna to overcome the sorrows and memories of Sati.

Kali Dah by Lord Krishna. Krishna defeated and banished the serpent Kalia in Yamuna.

"कर्मेसु सर्वम मम सुप्रभातम्"

This is the prayer our old Rishis used to offer to the rivers including Yamuna. They say, invoke you Yamuna Maa to make my morning blissful. They treat the river Yamuna in reverence like a mother deity. **यमुना मैया**. **But** in the present day the condition of the river is not such that one may feel blissful men or blessed. The dirty water, foul smell and heavily infected water frightens us. No one can dare take a dip in such a river. Drinking such water invites diseases. The condition of the river Yamuna is so pathetic that we feel ashamed of exclaiming her as "MAA".

The source of the Yamuna lays in the Yamunotri Glacier at an elevation of 6,387 metres (20,955 ft), on the south-western slopes of Banderpooch peaks, which lies in the Mussoorie range of the Lower Himalayas, north of Haridwar in Uttarkashi district, Uttarakhand. Many tributaries join her in its long course of 1376 km when it joins River Ganga at Triveni Sangam a Holy pious confluence in Prayagraj.

A large number of habitations are there on its bank like Dak Pathar- Yamuna Nagar- Sonipat-Delhi-Mathura-Agra and one of the most important places is Dayalbagh. Dayalbagh is unique in a way that the river Yamuna changes its course and gives space for Dayalbagh. Dayalbagh is surrounded by the Yamuna which is the Headquarter of the Ra Dha Sva Aa Mi faith. The Dayalbagh is situated on the southern banks of the river Yamuna.

**Biological Oxygen Demand** is very pathetic. Yamuna is very poor in its downstream and unfit for even bathing what to say of drinking the water.

Recommended Primary Water Quality Criteria for Various Uses**:**

| | CLASS | |
|---|---|---|
| Drinking water without treatment | A | Total colliform organism MPN/100ml 50 or less ph-6.5-8.5. Dissolved Oxygen 6mg/litre. BOD -2mg/lit. |
| Outdoor Bathing | B | Colliform organism 500 or less MPN/100ml ph 6.5-8.5 dissolved oxygen 5mg/Lit BOD-3mg/Lit |
| Drinking water with Conventional by disinfection | C | Colliform 5000 MPN/100ml Ph 6-9 dissolved oxygen 4mg/lit BOD 3mg/Lit |
| Propagation of Wild life | | PH 6.5-8.5 dissolved oxygen 4mg/lit. Free ammonia (as N) less 12mg/Lit or less. |

***Corresponding author:*** *sksatsangi@gmail.com*
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The the present scenario the quality of water in the Yamuna is not suitable for drinking, bathing and propagation of wild life. The following causes have been identified for this poor quality of water in the river.

a. **Diversion and over abstraction of water**: For the generation of power, for irrigation and for the water is over drawn from the river by diverting its course through barrage, dam, canals etc.., which degrades the quality of water as it hampers the free flow of water in the river.

b. **Unbridled pollution**: from domestic pollutants, industrial pollution and agricultural pollution is rampant. A result of this is that the Yamuna is one of the most polluted rivers in the country. The ecology of over drawn disturbs the system

c. **Encroachment in flood plain**: Encroachment by concrete buildings in the flood plain has disturbed the ecosystem. The Ecosystem has a positive impact not just within the bank but it spreads over the whole basin.

d. **Poor flow of water**: Over abstraction and excessive use of water has decreased the flow of water in the river. Poor flow in the river with input of pollutants all through has resulted in the poor quality of water which is full of bacteria and debris etc.., making it unfit for human use.

**HOW TO RECLAIM YAMUNA?**

- The River has a unique ecosystem. Smooth flow in the river in all seasons minimizes the damage of river.
- We have to regulate the flow of water from the dam and barrage.
- Also, should regulate the flood water to minimize the damage of property and also the damage to living creatures.
- We need to support the growth of aquatic and vegetation from algae to massive trees on the bank.
- We should sustain diverse aquatic fauna from insects to large fish and crocodiles. **No sewage / effluent or solid waste** should go in the river. Encroachment over the river bed and the flood plain should be removed and flood plain should be secured as it is not a waste land. They play an extremely critical hydrological function in the passage of flood water and recharging of ground water.

Though the condition of river is worse it is not irreversible. We can adhere to the following ways and means to improve the condition of the river

1. **Education**: By massive campaigning, the public should be educated with the importance of a clean river with its associated health and other benefits.
2. **Advocacy**: We should advocate the public for the wise use of the river water. For this NGO's should hold meetings in public and emphasize for rationing the water so that the free flow of the river is maintained throughout the year. NGO's like Yamuna Jiye Abhiyan and Yamuna Satyagraha are already taking such initiatives. We should promote such voluntary organizations for this noble cause.
3. **State of water of the river**: The quality of the river should be monitored regularly by studying its BOD, dissolved harmful solutes and other dangerous chemicals. Further the quantity of water in the river is also very important for its health which should be maintained to the optimum level as recommended.
4. **State of flood plains**: Should be free from encroachment for the smooth passage of the flood water. Further thick plantation with native plants will help in maintaining it by controlling erosion of the soil.
5. **Drainage of domestic, industrial and agricultural waste**: This needs to be properly treated and diverted to check pollution.
6. **Quality of drinking water** and other notable features should be strictly monitored and the set norms must be followed.

## VIGIL:

All the parameters mentioned above are mandatory for maintaining a sound health of the river Yamuna. We should constantly be vigilant about the status for the welfare of Yamuna. Collection of Pooja and religious material should be collected, in the bank itself to prevent it from going into the river.

## YAMUNA AT DAYALBAGH

- Dayalbagh is a charitable and religious institution which has taken care of the river Yamuna in a very scientific way. Dayalbagh is an agriculture based institution, the economy of which is dependent on agriculture. Selfless Seva is the objective associated with agriculture.
- Dayalbagh does not take water for agriculture/irrigation in the lean season.
- Uses treated sewage water from the sewage treatment plant for irrigation. Thus, diverting the drainage water in going to River Yamuna.
- A thick plantation of native plants like peepal, neem, bamboo, pakar, karanj etc…have already been planted in the 6 km stretch of the Yamuna river around Dayalbagh.
- Recently, 6 acre of land has been developed on the bank of the river Yamuna as a Biodiversity Park with variety of plants in the same including medicinal, condiments and spices' plants.
- No permanent concrete structure is made for the free flow of flood water.
- The Quality of water is regularly monitored.
- The significance of the river Yamuna and clean water is taught to the students by showing them the actual work going on the bank of the river in their physical presence at the site itself.
- No drainage is directly drained in the river Yamuna in the area of Dayalbagh.
- Moreover Dayalbagh keeps a constant vigil on the above measure for maintaining the quality of water and flow of the river to its optimum.

## About the Author

Dr. Saran Kumar Satsangi is one of the leading Ophthalmologists of Agra and is currently working as the Medical Officer In-Charge of Saran Ashram Hospital, Dayalbagh, Agra. Born and brought up in the city if Mirzapur, Dr. Satsangi completed his early education in Mirzapur and did MBBS and Masters from Moti Lal Nehru Medical College, Allahabad. He joined as a Lecturer in the Department of Ophthalmology, SN Medical College, Agra. After serving for 35 years as a Professor and Head of the Department, he took retirement in the year 2019.

Dr. Satsangi is also known for his social work and service among many charitable organizations and NGOs. He had led and conducted many free medical camps in the nearby villages and operated more than thousands of eye patients free of cost for social causes. Dr Satsangi has started a successful Keratoplasties in 1985 and later established an Eye Bank in Agra. His area of interest is community medical and eye care service.

# Restoration/Rejuvenation of Water in the River Yamuna

**Er. B.S. Ahuja, M.E. (Civil), FIE (India)**
Technical & Financial Advisor (Water), RS Satsang Sabha,
Dayalbagh, Agra 282005

River Rejuvenation indicates revival of water flow in the river and also bringing back the pristine quality existed before the onslaught of development. This is aptly included in the Vision of Ganga Rejuvenation as "restoring the wholesomeness of the river defined in terms of ensuring "Aviral Dhara" (Continuous Flow"),"Nirmal Dhara" ("Unpolluted Flow"), Geologic and ecological integrity". It is always essential to learn from similar exercises taken up in the past to bring about an effective planning in new endeavours. Accordingly, it is proposed to discuss about the similar rejuvenation work taken in different parts of the world, and also India and then to plan for the rejuvenation of water in River Yamuna.

## CASE STUDIES OUTSIDE INDIA

River rejuvenation of the river Rhine River and the river Thames are the classic examples outside India. The River Rhine originates in the glacial regions of the Swiss Alps and on with its 1,320-km journey, it flows through industrialised areas in Switzerland, France, Luxembourg, Germany and the Netherlands. The River forms a source for drinking water and the industries along its path are the major issues of pollution in the river Rhine. The International cooperation and untiring efforts of various agencies in these participating countries in restoring the quality of water for three decades have resulted in the reappearance of salmon earlier than expected. The maintenance of STPs and its quality standards by all stakeholders were instrumental in the success of the programme

The Thames runs 229 miles from Kemble in Gloucestershire to Southend-on-Sea in Essex, where it flows into the North Sea. He has experienced pressures from expanding numbers of city dwellers since medieval times at the place where it bisects London. The river was declared biologically dead in 1957 and the restoration work included establishment of STPs, biotic monitoring, privatization of water companies and accompanied legislation. The cumulative effect resulted in appearance of various species of fishes. The installation of bubbler or oxygenators to increase DO was a turning point in the project

## EFFORTS IN INDIA

The National Mission for Clean Ganga (NMCG) is a registered society under the Ministry of Jal Shakti to coordinate the various activities to clean the Ganga. The main pillars include sewerage treatment infrastructure, river-surface cleaning, afforestation, industrial effluent monitoring, river front development, Bio diversity, public awareness and Ganga Gram. The efforts not only include the cleaning of the river but also to augment the flow in the tributaries of the river so that the river becomes "aviral" and "nirmal".

## EFFORTS IN YAMUNA FRONT AT POIYA GHAT SECTION, AGRA

The Yamuna is the second-largest tributary river of the Ganges by discharge and the longest tributary in India. Originating from the Yamunotri Glacier at a height of about 4,500 m on the southwestern slopes of Bandarpunch peaks of the Lower Himalaya in Uttarakhand and it merges with the Ganges at Triveni Sangam, Prayagraj, which is a site of the Kumbh Mela. It travels a total length of 1,376 kilometres and has a drainage system of 366,223 square kilometres, which is 40.2% of the entire Ganges Basin. Dayalbagh has taken an initiative to clean the river Yamuna along the Poiya Ghat stretching about 1 km and also to increase the flow of the river in the stretch. The activities which can augment the flow in the Yamuna are enumerated below and a brief on each aspect along with the action taken up by Dayalbagh have been briefly described below.

1. Augmenting the source
2. Groundwater related measures
3. Geological aspects

*Corresponding author: bsahuja.db@gmail.com
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4. Establishment of Sewage Treatment Plants
5. Cleaning river or dredging or de-silting
6. Afforestation
7. Check dams upstream of the Poiyaghat section.
8. Monitoring and management of water quality of the river water

### 1. Augmenting the Source

The sources of water in the river during monsoon season are the yield from the river catchment due to rainfall and base flow from the groundwater system, while the sources of water during non-monsoon season are the snow melt from higher reaches (Himalayas, as in the case of the Yamuna river) and base flow from groundwater system. The reduction in flow in the river is resultant of the reduced rainfall and base flow due to lowering of water level in the aquifer system during monsoon season and increased snow melt due to climate change may also alter the flow in the rivers. A staggered release of water from Haryana can avert the floods during the rainy season and also at the same time may result in continuous flow of water in the river Yamuna.

### 2. Groundwater Related Measures

The flow in the river during non-monsoon period is due to contribution from groundwater. The flow takes place due to head difference between groundwater system and river head. The shallow water table contributes towards generating flow to the river. Shallow water table results due to lesser extraction in comparison to annual recharge. Lesser ground water extraction can be achieved through either the supply side or demand side measures. The Supply side measures - water conservation/augmentation measures, which includes rainwater harvesting, use of treated water etc. The Demand side measures include- smart irrigation, cropping change, piped water supply etc.

In Dayalbagh, both the demand side and supply side measures are taken up for the water conservation. The treated water is used for irrigation in Dayalbagh there by groundwater extraction is curtailed. Groundwater conserved is groundwater saved and it may result in rising of groundwater levels, which may ultimately lead to increased base flow to the river. Roof top rainwater harvesting has been installed in Dayalbagh and it augments the natural recharge to the groundwater system. The implementation of rainwater harvesting in Dayalbagh may result in the increase in the groundwater storage, which may lead to increase in head in groundwater system. The higher head in the groundwater system can lead to increased base flow. Thus, the measures taken by Dayalbagh may lead to increased base flow to the river and can effectively increase the flow in the river.

### 3. Geological Aspects

The river migration or meandering is the geological phenomenon, which can be broadly termed as geomorphological feature. Geomorphological studies and the role of active tectonics pertaining to river rejuvenation is an important aspect worth looking into with the help of satellite imageries.

### 4. Sewage Treatment Plant

The flow can be increased by augmenting the treated water which is let into the Yamuna. Dayalbagh has provided land for construction of STPs and in response to that, Jal nigam, Agra has signed an agreement for supplying 16 MLD treated waste water to Dayalbagh with a stipulation that 14MLD will be supplied in Phase 1 and 2 MLD will be supplied in Phase 2. Presently, there is one 14MLD STP, which is operating on the bank of the river Yamuna, which supplies about 10 to 11 MLD to Dayalbagh for irrigation purposes and 31 MLD STP in Phase 2 is under construction. The excess treated water after supplying to Dayalbagh will be let into the river Yamuna, upstream of Poiyaghat section. The existing STP can be made more robust and also additional STP can be established and more domestic waste could be channelized to STP to increase the quantity. In addition, the maintenance of streams carrying rain water, joining the river for disposal of rain water together with the maintenance of surface drains/ open nallahs carrying city waste water after treatment into the river can further augment the flow in the river.

### 5. Cleaning River or Dredging or De-silting

Yamuna river at Agra is in the middle stage velocity of the water greatly reduced in comparison to the higher reaches, resulting deposition of silts in the river bed during the course of flow. The deposition of silt along the bank and within the river courses can alter the flow direction in subsequent monsoon, resulting in indentation of low-lying areas and alteration of river channel. The streamlining of the river beds and flattening of mounds of silts deposition in the river channel can smoothen the flow in the river. Further, cleaning of the debris, including plastics, waste clothes and other

solid suspended particles can improve the health of the river and also provide better environment. The cleaning of the river and river banks can also aid in the flood plain of Yamuna extending beyond the river course on either side.

In Poiyaghat section, Dayalbagh has undertaken the removal of debris from the river and the banks as a service-oriented program, which has resulted in a pristine environment. Further, the anomalous dunes in the course of the rivers were flattened resulting in the smooth flow of the river. In the current flood situations along the course of the river Yamuna witnessed a very little impact as to these obstructions that the flood water restricted to the flood plains in the Poiyaghat section had been removed.

### 6. Afforestation

Plantation of trees along the river banks. It can alter amount of precipitation to increase the flow. Around 2500 tree saplings have been planted, in the poiyaghat area which not only gives stability to the soil and flood plain but also helps in the sustainability of the flood plain.

### 7. Check Dams upstream of Poiyaghat section

The check dams across the river can also aid in regulating the flow so as to provide water during the initial period of non-monsoon. Many check dams tend to form stream pools. Under low-flow circumstances, water either infiltrates into the ground, evaporates, or seeps through or under the dam. Groundwater system also gets additional recharge due to these check dams resulting in the rise in water level and subsequent increase in the base flow. Under high flow flood conditions, the water flows over or through the structure. The Coarse and medium-grained sediment from runoff tends to be deposited behind the check dams, while finer grains flow through. Floating garbage is also trapped by the check dams, increasing their effectiveness as water quality control measures.

A construction of a series of check dams in the stretch from Poiya Ghat section can aid in regulating the flow in the river.

### 8. Monitoring and Management of Water Quality of the River water

The issue of pollution in Ganga and its chief tributary the river Yamuna is very similar to that of issues faced in the Rhine and the Thames rivers in Europe. A very strict regimen is to be formulated and executed, if the desired quality is to be achieved in this river water. The Government of India has also taken the cue from the ongoing / completed projects in different parts of the World to tackle the restoration of rivers in the country.

Dayalbagh has taken up cleaning activities to remove the debris and suspended articles from the river water in the Poiyaghat section The additional discharge of treated waste water in the the Yamuna river can help in diluting the river water and improving the water quality of the rivers.

## About the Author

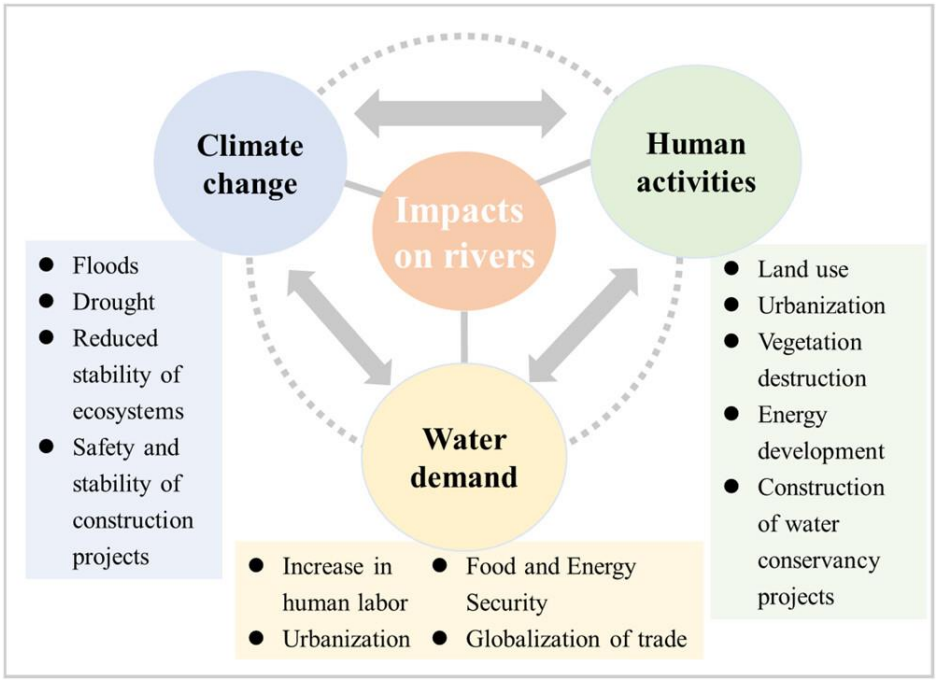
**Er B S Ahuja ME(Civil), FIE (India),** After graduation, he had worked as a Lecturer in of Civil Engineering at Guru Nanak Engineering College, Ludhiana for 6 years. Shri B S Ahuja has co-authored “A Text Book of Applied Mechanics” for the Diploma and AMIE students. He was appointed as a Sub Divisional Engineer in PHED Department through Punjab Public Service Commission in 1970. While in service he pursued Master of Engineering (Civil) with distinction in 1982 and superannuated in 1997 as Superintending Engineer. During these 27 years he had a vast experience for planning, designing and execution of eminent projects such as Infrastructures of Water Supply, Sewerage, Storm Water Drainage, Sewage Treatment Plants, Water Treatment Works, Over Head Water Tanks. On request he worked on deputations with Punjab Water supply and Sewerage Board, Punjab State Small Scale Industries and Export Department, Punjab Mandi Board. On special mission he has also worked on deputation with the Punjab Municipal Corporation to revive and upgrade the operation and maintenance of water supply and sewerage system. Since 2010. he has been serving as a as Technical and Financial Advisor (Water) and the Head of the Water Supply Department, Dayalbagh, Agra

# Yamuna River in the City of Taj - Sustainability through Dayalbagh Way of Life

**Shri Puneet Chowdhry**
General Manager, Department of Agroecology-cum-Precision Farming,
Dayalbagh, Agra

Our ecosystems and human societies have always been supported by the rivers. Therefore, the health of the rivers is crucial to the earth's sustainable development. Climate change and human activities, have led to great changes in the circulation and development of the rivers, to such an extent that instead of being used for sustaining life on the earth, they are being exploited for material gains. In this context, achieving an effective balance between river protection and human development is necessary.

The impact of climate change, human activities and water demand on the rivers has been in the figure below[1].




In spite of the best efforts from the government and civic authorities, the river Yamuna in the city of Taj, Agra, is in a state of shambles where at several places, it resembles a water stream. Chemical waste, plastic waste, agro-chemicals run off - all contribute to pollute the river Yamuna which is supposed to be one of the sacred rivers of India.

As it meanders through Agra it shrinks to a small stream in summer, because of water being diverted to canals for irrigation and domestic consumption. It has become one of the most-polluted rivers in India, because vast quantities of sewage are discharged directly into it as it passes in its course through extremely densely populated areas. Yamuna Action Plan was implemented in the early 1990s by the national government, with financial assistance from Japan, a multiphase project that has been partly successful at reducing the river's pollution levels.

Dayalbagh and DEI (Deemed to be University) have started a river bank restoration project in Agra, near Dayalbagh area in a place called Poiyaghat which aims at undoing the damage to the river bank due to illegal sand mining, accumulation of plastic waste and removing various other obstructions to the natural flow of the river along its naturally designed course.

**Corresponding author:* puneet.chowdhry@gmail.com
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Hundreds of community members had joined this act of selfless service, twice a day, for several weeks. This resulted in expansion of the river bank resulting in increasing the span of the river water. The entire surroundings were cleaned of all plastic, cloth and metal waste, resulting in a sandy river bank, inviting people of Agra to have a stroll along with their families. The question is, "Can a project like Yamuna Action Plan really clean our water bodies"? The answer is probably doubtful because we are yet to see sustainability in such solutions which can change the face of our rivers. We all can see that in the present scenario technology has changed our lives, our lifestyles, our approach towards problems, in short anything that we can think of. Man has made major advancements in every field resulting in increased life expectancy, development of life saving drugs, high speed communication systems etc. But at the same time man has also been responsible for damaging the environment and disturbing the ecological balance of the planet earth, to such an extent that we have to seriously think of how to make life sustainable on this planet and how to feed 11 billion people by 2050.

The question is what do I think while throwing a piece of polythene on the road and what would happen if millions of people do that on a single day in the entire nation or planet? All this is a matter of the value system of the community, society and the nation. How far has the government been able to check the value system of the people? It is the responsibility of the Religion and Education to retain the value system of the people. In this context, DEI and Dayalbagh have taken a major step in restoring the environs of the river Yamuna near Dayalbagh in Agra.

We will be able to restore our natural resources and win over the challenges of the climate change, only if we change our lifestyles. We have to shed away the thought of 'how to save enough for my future' to 'how to save life on Earth' that changes the game from a micro level problem to a macro level problem that has to be dealt at an individual level. Here is where the 'Dayalbagh way of life' comes to our rescue as it provides a holistic solution to the myriad of problems that the world is facing today.

'The Dayalbagh way of life', illustrates a sharing and caring approach towards the fellow humans, animals and nature alike, which is action oriented and ever evolving. It is a barter (sharing and caring) economy, focusing on nurturing the nature, thus presenting a novel way of developing the ecology through Agroecology and Precision Farming practices. It finds its roots in the principles of 'Better Worldliness' propounded by its founder, the fifth Revered Leader of the Ra-Dha-Sva-Aa-Mi Faith, Sir Sahabji Maharaj, who laid the foundation of Dayalbagh on January 20, 1915. Since then, relentless and untiring efforts are being made by its community to preserve the environment, the results of which, today even surpasses the goals of United Nations, termed as 'Sustainable Development Goals' or SDG's. At present 'Sustainability' is a key term in various charters and declarations of the United Nations, G-20 meetings or any other major conference on climate change. In Dayalbagh, one can see how is Sustainability developed and nurtured each and every day.

1. The 1200 acre Agroecology farm is being irrigated by the Yamuna water and through the treated water from Sewage Treatment Plant, under specific agreements with the State Government or its entities. No bore well has been dug in the last several decades for irrigation of the agriculture farms, thus maintaining the water table of this area. This is certainly a very significant achievement and illustrates the intent of preserving our natural resources for our future generations and fighting the challenges of the climate change. In the areas around Dayalbagh, there is unchecked proliferation of bore wells, in spite of the restrictions of the government which prohibited this without permission. Elsewhere, many villagers tap the Yamuna river water for irrigation which has been ignored.

2. The air and water quality is monitored on a daily basis. Our results show that our parameters for the air quality are much better than those in Sanjay Place, which is a nearby area. Misting, water spray, making the area green are some of the initiatives which are constantly carried out continuously to maintain the air quality.

3. There are discussions about 'Sustainability' elsewhere; but we are not only promoting sustainability, in Dayalbagh but also practicing it every moment. When the world is only committing to reduce the carbon footprint, Dayalbagh is 'Walking the Talk' here.

    a. There is a cap on the electrical power that can be consumed per household in a month. Each household is consciously aware to conserve power to stick to in that limit.
    b. Air conditioners are not promoted in the colony.
    c. Use of two wheelers is not allowed in the colony and there is also a check on the use of four wheelers, inside the colony.
    d. Bicycle is the most common mode of transport. The community has its own public transport through the use of the electric three wheelers.
    e. Use of solar energy can be found in almost all the institutional buildings and every second or third household. The installed capacity of the solar energy in Dayalbagh is about 1.3 MW and is increasing every day.

f. All the followers lead a very simple life with minimal needs, thus reducing the waste.
g. 100% organic farming is practised, with no use of chemicals. This reduces the soil and water pollution. All bio-fertilizers, bio-insecticides etc. are prepared in-house using the cow dung and cow urine as basic ingredients.
h. Dayalbagh promotes Lacto-vegetarian diet, only.
i. It has its own Dairy farm, and the cattle are fed on the organic green fodder. The animals are not killed for meat etc., but are supported and taken care of, till their last breath.
j. The household waste is segregated into bio-degradable and bio-non degradable waste. Kitchen waste, leaf litter etc. is processed to produce high quality organic compost.
k. Food is prepared in the Community Kitchen for the followers of the community at one place using green energy, thus reducing food preparation cost and food wastage.
l. Bio-diversity parks are developed which have a variety of trees. These areas are considered to be the lungs of the Agra City.
m. The entire area is developed as a 'Green Belt'. Multi-story buildings are not allowed. There are concrete jungles all around Dayalbagh, but Dayalbagh still preserves the ecology of the area by adopting Agro-ecological practices supported by a life of minimum needs.

Thus, Dayalbagh reduces carbon footprint through the Transportation policies, Food policies, Home / Living practices and more importantly, by actions in every area. It is difficult to find a community that supports the national and international programs independently, at its own expenses, without the intervention and support or external source.

It can be observed that the problem of rivers getting polluted or the climate changes that are taking place or the new infections surfacing, are all because of our changed lifestyle. For example, plastic was considered to be a wonderful material few decades back but today it is the biggest pollutant and also has health hazards. But can we change our lifestyle and discard plastic from our lives? Probably not, because of the scale of the plastic industries in our economy, ease of use and so many other benefits. So, we continue to live with the hazards, waiting for the inevitable to happen one day.

The Yamuna river is only a small element in this universe but Dayalbagh has demonstrated how a community of a few thousands can change the condition of this river within two to three weeks. The commitment, the intent, the approach and the action of Selfless Service find its roots in the concept called 'Dayalbagh Way of Life' which can alone solve such problems, only if adopted by all the members of the community, across the cities, nations and continents.

## REFERENCE

[1] Image-- Rivers: Linking nature, life, and civilization; Hao Wang, Guohua He; https://doi.org/10.1002/rvr2.7

## About the Author

Shri Puneet Chowdhry is the General Manager, Department of Agroecology cum Precision Farming, Ra-Dha-Sva-Aa-Mi Satsang Sabha, Dayalbagh, Agra where community agriculture field work is a way of life. Here hundreds of followers of the Ra-Dha-Sva-Aa-Mi Faith, come to the fields twice a day in a spirit of "Selfless Service" towards the attainment of their goal of 'Fatherhood of God and Brotherhood of Man'. He and his team are working towards the goal of making agriculture in Dayalbagh sustainable, with the principles of Agroecology. The department has taken bold steps in switching over from conventional farming (using chemical fertilisers, insecticides, herbicides etc.) in 1000 acres farm to 100% natural farming where all bio-fertilisers, pesticides etc. are produced in-house using the principles of natural farming.

He has completed B.Sc. Engineering in Mechanical Engineering from the Dayalbagh Educational Institute (Deemed to be University) and has 20 years of rich experience in Automobile Industry with Tata Motors, Hyundai Motors, General Motors and Mahindra & Mahindra. He has opted out of industry as a career option in 2009 and is now involved in system oriented charitable work.