

राष्ट्रीय विज्ञान संगोष्ठी-२०१३  
NATIONAL SCIENCE SEMINAR-2013



जल सहयोग: मुद्दे और चुनौतियाँ

**WATER**

Co-operation:  
Issues & Challenges

8th October 2013



**Nehru Science Centre**

(National Council of Science Museums)  
Ministry of Culture, Govt. of India

[www.ncsm.org.in](http://www.ncsm.org.in), [www.ncsm.gov.in](http://www.ncsm.gov.in), [www.nehrusciencecentre.gov.in](http://www.nehrusciencecentre.gov.in)

Organised by  
**National Council of Science Museums**  
Ministry of Culture, Govt. of India  
Venue: **Nehru Science Centre, Mumbai**

Supported by



# राष्ट्रीय विज्ञान संगोष्ठी-२०१३

(आठवीं से दसवीं कक्षा तक के विद्यार्थियों के लिए)

## NATIONAL SCIENCE SEMINAR-2013

(For students of class VIII to X)

जल सहयोग : मुद्दे और चुनौतियाँ



# WATER

## Co-operation: Issues & Challenges



आयोजक:  
राष्ट्रीय विज्ञान संग्रहालय परिषद्,  
संस्कृति मंत्रालय, भारत सरकार

Organised by:  
**NATIONAL COUNCIL OF SCIENCE MUSEUMS**  
Ministry of Culture, Govt. of India

वेणु राजामणि  
राष्ट्रपति के प्रेस सचिव

*Venu Rajamony*

*Press Secretary to the President*



राष्ट्रपति सचिवालय,  
राष्ट्रपति भवन,  
नई दिल्ली - 110004

*President's Secretariat,  
Rashtrapati Bhavan,  
New Delhi - 110004*



### MESSAGE

The President of India, Shri Pranab Mukherjee, is happy to know that the National Council of Science Museums (NCSM), an autonomous institution under the Ministry of Culture, Government of India is organising a National Science Seminar -2013 on the theme "Water Cooperation: Issues and Challenges" on October 8, 2013 at Mumbai.

The President extends his warm greetings and felicitations to the organisers and the participants and sends his best wishes for the success of the Seminar.

Press Secretary to the President

चन्द्रेश कुमारी कटोच  
CHANDRESH KUMARI KATOCH



संस्कृति मंत्री  
भारत सरकार  
शास्त्री भवन, नई दिल्ली-110001  
Minister of Culture  
Government of India  
Shastri Bhawan New Delhi-110001

06 SEP 2013

#### MESSAGE

I am extremely happy to know that the National Council of Science Museums is organising the National Students Science Seminar 2013 for school students on the subject "Water Co-operation: Issues & Challenges" to commemorate the United Nations International Year of Water Co-operation.

It is often said that the wars of the future will be fought not for land or minerals but for water. Accordingly, seminars such as this which highlight the need for Water Co-operation are essential to sensitise students from across the country by engaging them in debates and deliberations on the issues and challenges of water conservation.

I am happy to note that the National Council of Science Museums is creating awareness in people on such socially relevant subjects. I also congratulate them for bringing out a special souvenir to mark the occasion.

I wish all success to the programme and extend my best wishes to the organisers and the participants.

Chandresh Kumari Katoch

मुख्य मंत्री  
महाराष्ट्र



Chief Minister  
Maharashtra

24<sup>th</sup> September 2013

#### MESSAGE

I am happy to know that National Council of Science Museums, Ministry of Culture, Government of India, is organizing the National Science Seminar-2013, for School students on "Water Co-operation : Issues & Challenges" at Nehru Science Centre, Mumbai on 8th October, 2013.

United Nations General Assembly declared the year 2013 as the United Nations 'International Year of Water Cooperation'. I am happy to note that the NCSM has chosen this topic for the Science Seminar which is in tune with the UN Resolution. The slogan "Water Everywhere, only if we share" sums up the significance of the need for 'Water Cooperation'.

Water is vital for life, pivotal for human development and necessary to keep our environment healthy. Water knows no borders; an estimated 148 countries share at least one trans-boundary river basin. There is a fixed amount of water on the planet and with increasing population, economic development and changing lifestyles, undue pressure has been put on the world's limited water resources leading to increased competition for water and creating situations of potential conflict. But water can be used as an instrument of peace and development. As rapid urbanization, climate change and growing food needs put ever-increasing pressure on freshwater resources; the objective of the Year is to draw attention to the benefits of cooperation in water management.

I am happy that students from across the country have deliberated on this important issue and the best 35 winners, one each from each of the States and Union Territories of India, have been invited to take part in this National Science Seminar. I wish the organisers and all the participating students and teachers all the Very Best for the Seminar.

Prithviraj Chavan



राष्ट्रीय विज्ञान अकादमी, भारत  
The National Academy of Sciences, India

Gram : NATACADEMY  
Phone : +91-532-2640224(O)  
Fax : +91-532-2641183  
E-mail : allahabad.nasi@gmail.com

**Dr. K. Kasturirangan**

Ph.D., FNASc, FNA, FASc, FNAE, FTWAS.

President, NASI, Allahabad; &  
Member, Planning Commission (Science)  
Govt. of India



5, Lajpatrai Road, लाजपतराय मार्ग  
New Katra, नया कटरा  
Allahabad-211 002, इलाहाबाद

*Message*

I am happy to note that the National Council of Science Museum has been organizing every year a scientific programme for the school students across the country, very popularly known as the National Students Science Seminar, which is a flagship students' event of the Council initiated in 1982. It is also worth praising that so far more than 30,000 school students from all States and UTs have participated in this programme and the event witnessed by more than one million people as audience across the country. The topic - "Water Cooperation: Issues and Challenges", chosen for this year is also very much relevant and in the spirit of conservation-strategies being adopted by the various governmental and non-governmental agencies, it is the need of hour to conserve water and campaign against its misuse. Ensuring that the poor people have access to safe drinking-water and adequate sanitation and also encouraging personal, domestic and community hygiene, will improve the quality of life of millions of individuals. Better management of water resources to reduce the transmission of vector-borne diseases (such as viral diseases carried by mosquitoes) and to make water bodies safe for recreational and other users can not only save many precious lives but also will have extensive direct and indirect economic benefits, from the micro-level of households to the macro-perspective of national economics. The National Academy of Sciences, India, being a premier organization of scientists, engineers and health professionals is seriously concerned about the present situation prevailing in the country in respect of safe water. It is also extremely urgent that a blue print and a road map for providing safe, clean and affordable water and sanitation facilities to all segments of our community along with cleaning up of the rivers and their tributaries need to be drawn up particularly in the context of the new programmes and initiatives being launched by the national government.

Therefore, it is a timely intervention and good initiative to excite the young students to cultivate "water temperament" amongst them for ensuring their active cooperation in achieving the target of Safe Water for All. I convey my good wishes for the success of the event and also to all the young and energetic students for their bright future.

(K) Kasturirangan)  
President, NASI;

Member, Planning Commission, New Delhi

Delhi Address : Planning Commission (Science), Room No. 119, Yojana Bhawan,  
Parliament Street, New Delhi - 110 001; Tel.011-23096568 (O), 23070498(R)



डॉ. कृष्ण लाल  
अध्यक्ष

Dr. Krishan Lal  
President

भारतीय राष्ट्रीय विज्ञान अकादमी  
बहादुर शाह ज़फर मार्ग, नई दिल्ली-110 002  
INDIAN NATIONAL SCIENCE ACADEMY  
Bahadur Shah Zafar Marg, New Delhi-110 002

**MESSAGE**

I am very glad to know that this year's National Students Science Seminar is being organized by the Nehru Science Centre, Mumbai. The topic for this year's Seminar, **Water Cooperation: Issues and Challenges** is of great importance to our Society. The need for water grows with increasing population, industrialization and improvement in standard of living of the citizens. Water is a very precious resource for India. Monsoon rains are one of the major resources and the winter snowfall in Himalayas provides water in rivers like Ganges originating from there during the summer time. The ground water is recharged during the monsoon. However, increased land area under agriculture has put a considerable pressure on water resources. Also, with the fast urbanization and better quality of life more water is needed for human consumption. The resources have to be optimized. One issue of considerable importance is the quality of water, particularly for human consumption. In some eastern parts of the country, there is a problem of arsenic in water with concentrations much higher than the permissible limits. In many other parts, there is a problem of excess fluoride. These lead to dreadful diseases. The river resources get polluted due to discharge of a variety of wastes, industrial effluents as we all sewer drainage. Therefore, the quality of river water is deteriorating with increase in activities related to development. Efforts are being made to use legal measures to tackle this problem.

At the international level, World Health Organization (WHO) has specified important parameters and permissible impurities in water meant for human consumption. However, this needs to be implemented in the entire country. For this purpose, Certified Reference Materials (CRMs) are required so that any measurement made in any analytical laboratory is traceable to national and international standards. I had the pleasure and privilege of starting a National Programme in which nearly 30 laboratories from all over the country participated in preparation of Indian Reference Materials for which, technical name is Bhartiya Nirdeshak Dravyas (BNDs). In the first phase, these covered all toxic elements in water like lead, cadmium, mercury, arsenic, chromium and selenium. Also, BNDs of fluoride, iron and few pesticides in water were also prepared. This programme is still continuing with active participation of several laboratories located all over India.

I congratulate Nehru Science Centre, Mumbai for taking the initiative of focusing young students' attention on Water Cooperation.

I wish all the students, teachers and my friends from Nehru Science Centre success in this venture. I am sure under the leadership of Dr. Shivaprasad Khened, this event will prove to be an important milestone in this series.

(Krishan Lal)

Date: 11 September 2013  
Place: New Delhi

- ☐ टेलीफोन/Tel : 91-11-2323 5865 (Dir), 2323 5153, 2322 1931 - 2322 1950 (ई.पी.ए.बी.एक्स./EPABX)  
☐ फैक्स/Fax : 91-11-2323 1095, 2323 5648 ☐ ई-मेल/E-mail : president@insa.nic.in, esoffice@insa.nic.in  
डी.एस.टी. रमणा अध्येता, पूर्व निदेशक, राष्ट्रीय भौतिक प्रयोगशाला, डॉ. के. एस. कृष्णन मार्ग, नई दिल्ली-110012  
DST-Ramanna Fellow, Former Director, National Physical Laboratory, Dr. K. S. Krishnan Marg, New Delhi-110012  
☐ टेलीफोन/Tel : 91-11-4560 9104, 4560 8513 ☐ फैक्स/Fax : +91-11-4560 9310, 4560 9104



**भारतीय विज्ञान अकादमी**  
डाक पेटी सं. 8005, सी.वी. रामन अवेन्यू, बेंगलूर - 560 080, भारत  
**Indian Academy of Sciences**  
P.B. No. 8005, C.V. Raman Avenue, Bangalore - 560 080, India

**Message of Professor Dipankar Chatterji, President of the Indian Academy of Sciences for the special souvenir being published as part of the National Science Seminar 2013.**

I am happy to note that the National Science Seminar 2013 is being held on the focal theme "Water Co-operation: Issues and Challenges". I congratulate the National Council of Science Museums for this national initiative aimed at providing opportunities to students of high schools to take up a small time research on specific scientific problems under the focal theme. I am happy that the current year's event is organized by the Nehru Science Centre and the prize winning contestants will be rewarded with prizes of scientific significance.

The focal theme of the Seminar "Water Co-operation: Issues and Challenges" is of great importance considering water as a vital natural resource requiring a multidisciplinary approach blending natural, social sciences, education, culture and communication for better understanding the issues and challenges. The need to create scientific awareness, education amongst all sections of the society on the enhancement of cooperation and on the challenges facing water management in the backdrop of its ever increasing demand for access does not need emphasis. I am hopeful that the seminar will have scientific deliberations of great interest and wish the National Science Seminar all success.

I am hopeful that the students and teachers participating in this national program will have a productive scientific session.

Professor **Dipankar Chatterji**  
President, Indian Academy of Sciences



**NCSM** राष्ट्रीय विज्ञान संग्रहालय परिषद्  
ब्लॉक-जी एन, सेक्टर-व  
बिधान नगर, कोलकाता - 700091  
**NATIONAL COUNCIL OF SCIENCE MUSEUMS**  
BLOCK-GN, SECTOR-V, BIDHAN NAGAR, KOLKATA-700091, INDIA  
PHONE : (91) (33) 23579347, 23570850, 23575545  
FAX : (91) (33) 23576008  
e-mail : sciencecentre@ncsm.gov.in; dgo@ncsm.gov.in  
www.ncsm.gov.in, www.ncsm.org.in

**MESSAGE**

I am happy to note that the National Council of Science Museums is organizing a National Science Seminar on the topic **Water Cooperation: Issues and Challenges** for the school students. This is all the more important considering that the UN has declared the year 2013 to be the International year of Water Cooperation.

Water is central to all forms of life and it is for this reason that our Blue Planet, the Planet Earth, is unique in our unending cosmos. Water cooperation is a key resource to security, poverty eradication, social equity and gender equality. Inclusive and participatory governance of water and cooperation between different user groups can help to overcome inequity in access to water, enhance water security and overcome water scarcity and thus contribute to poverty eradication and to improving living conditions and educational opportunities, especially for women and children.

Contrary to common belief, good examples of water cooperation greatly outshine water-related conflicts. The Indus Waters Treaty signed by India and Pakistan in 1960 has survived three major conflicts and is still in force today. The potential for water cooperation is great and its benefits, whether in economic, social or environmental terms, are considerable. All water systems are extremely complex, be they management systems at the local or national level, internationally shared river basins or parts of the natural hydrological cycle. Managing these systems requires multiple actors, from users and managers to experts from various disciplines and decision-makers.

Cooperation is crucial not only to ensure the sustainable and equitable distribution of water but also to foster and maintain peaceful relations within and among communities. I am sure deliberations on this all important issue will provide an excellent opportunity to the students to imbibe the spirit of cooperation and this can start from the classroom itself.

I take this opportunity to wish the students, their parents, teachers, the school authorities and the National Council of Science Museums all the very best for the seminar and hope that the best student win this year's seminar and be adjudged the National Winner.

(Prof. R.C. Solti)  
Chairman  
Governing Body, NCSM

## Message from the benevolent supporters



**Mr. Suresh L. Goklaney**  
Executive Vice Chairman, Eureka Forbes Ltd

**EUREKA FORBES**  
Your friend for life

The Eureka Forbes commitment to creating a happy, healthy, safe and pollution-free world has always gone beyond bringing our customers the means to live happier, healthier lives through our products.

Indeed, it is our firm belief that unpolluted water and air are the birthright of every Indian and that it is imperative to conserve our precious water, air and other natural resources for future generations so that they may get the very best that life's got to give.

Towards this end, we set up a dedicated body to promote environmental conservation - Eureka Forbes Institute of Environment. It has undertaken many landmark initiatives, laying special emphasis on educating our citizens of tomorrow and encouraging them to spread the environmental conservation message. These include India's first & only environment-centric quiz for school children and Euro Ambassadors which enthused school children to be ambassadors of the environment in their homes and neighborhoods.

Other important initiatives include rainwater harvesting that has resulted in over 600 mn litres of rainwater being saved till date; [www.waterwonderfulworld.org](http://www.waterwonderfulworld.org) a website dedicated to spreading awareness on water conservation; Pollution Watch - monitoring water & air pollution levels in key cities and telecasting them on a prominent national television channel; 'Project Jal Amrut' - augmenting the water resources in drought prone rural areas through rainwater harvesting as well as 'Rotary Aqua' (our alliance with the Rotary Club) which undertook the 'Stop Leaking Taps' initiative in Mumbai to conserve water along with programmes to popularise rainwater harvesting, sustainable water practices and the need for safe drinking water in schools, hospitals and public places. We even have the Euro School of Environment set-up to formalise environmental education and create eco-friendly citizens.

We are delighted to partner the National Council of Science Museums (NCSM) in the National Science Seminar 2013. The topic "Water Co-operation: Issues & Challenges" is truly of vital importance and being associated with efforts like these will go a long way towards realising a cherished dream of our company - 'safe drinking water for every Indian'.

We compliment NCSM for the yeoman service that it is doing the nation by imparting science education in a non-formal way, imparting a scientific temper and enhancing the understanding of science, particularly among students, through such initiatives. The popularity that the National Seminar enjoys is testament to the success of this endeavour and we wish it even greater success in the years ahead.

My Best to the children, future of India

## of National Science Seminar 2013



**R.K. DUBEY**  
CMD, Canara Bank

 केनरा बैंक  
Canara Bank

I am happy to note that National Council of Science Museums, on the eve of the International Year of Water Cooperation,

is organizing this year's National Science Seminar 2013 on the topic Water Cooperation: Issues and Challenges. Canara Bank is privileged to support this nationwide event.

In recent years, the demand for water for drinking, irrigation and wastewater services has increased manifold. But we still do not have access to safe drinking water and adequate sanitation because of rapid population growth and the process of industrialisation. There are challenges of limited irrigation scheduling knowledge, water pollution, siltation of reservoirs, departmental management of water resources rather than a holistic approach leading to administrative delays, inefficiency, inadequate and untimely availability of assistance. In view of such huge challenges, there is an imperative need for developing a comprehensive understanding of the operational, strategic and commercial challenges in water projects and assessing water economic value chain drivers and risk management. We also need to explore latest technologies to enhance efficiencies and unravel the maze of complex regulations and legal requirements.

While the government has to play a major role, public-private partnerships are needed to ensure the growth and viability of the water sector.

Canara Bank, on its part, is dedicated to support the Governmental and Non Governmental initiatives in addressing water issues. We introduced the Jalayoga Scheme, in the year 1996 to commemorate Bank's 90th year of establishment, expressly to provide safe drinking water to SC/ST/Backward communities of rural areas coming under lead districts of the Bank.

We have also introduced Rural Self Employment Training Institutes in several parts of rural India, for helping the unemployed youth in rural areas. We are very sensitive to gender issues and our bank has special commitment for women. The Centre for Entrepreneurship Development for Women has been expressly established by us towards economic empowerment of women. Nammuru Santhe (Mobile sales van) is another initiative of the Canara Bank, in which we have sponsored a Retail Mobile Marketing Van for Display cum Sale of House hold products, articles made by Self - Help Groups, Small women entrepreneurs, Artisans, Self Employed women etc.

I am sure the National Science Seminar, which involves school students from across the country, will go a long way in sensitizing the people about the urgent need for water cooperation.

I wish this laudable venture all success!

foraword



**Shri G. S. Rautela**  
Director General, NCSM

## Water is a basic requirement for life in all forms yet water resources are facing increasing demand from and competition among users.

It is well known that due to global trends of increasing population, increasing natural resource consumption, and decreasing natural resource availability, the natural key resources on earth are depleting at a fast rate. We need to be judicious in use of the natural resources. Gandhiji rightly said **'There is enough for every body's need but not enough for anybody's greed'**.

Water is an extremely vital resource which makes this Planet unique and is a primary cause for sustenance and diversity of life on our Planet. Globally it is estimated that six to eight million

people die annually from the consequences of disasters and water-related diseases. Increasing population and increased industrial development will substantially increase water consumption. Water knows no border. 148 countries share at least one trans-boundary river basins. Water cooperation is an obligatory necessity for our modern world and we, as citizens, need to address this and face the issues and challenges that come with it. There is a need for co-operation among cities, states and nations. United Nations has rightly declared 2013 as the International Year of Water Co-operation.

History shows a strong link between economic development and water resources development. There are abundant examples of how water has contributed to economic development and how development has demanded increased harnessing of water. Our requirements for water to meet our fundamental needs and our collective pursuit of higher living standards, coupled with the need for water to sustain our planet's fragile ecosystems, make water unique among our planet's natural resources.

It is becoming increasingly important to create general awareness and develop a coordinated effort to face the challenge of water scarcity and provide forum for learning and dialogue among masses to address the water issue. It is estimated that by 2050, 40% of the world's population will face severe drinking water problems. Conservation of surface water is, therefore, important because it acts as the immediate source of water.

By the year 2020, to quote a report, majority of the Indian cities will run dry. In India, supply of safe drinking water too is fast dwindling primarily due to mismanagement of water resources. Over-pumping and pollution are also significant contributors. In addition to this, increased demand usually threatens the sustainability of the environment in situations of scarcity, water scarcity management is also extremely crucial to achieving the goals of environmental sustainability.

I hope seminar of this type will create better understanding of issues involved and pave way for better state, national and international co-operation for water. Through such activities, National Council of Science Museums is aspiring to nurture young minds to innovate, discover, invent and develop a culture of innovation and science in the country. The National Students Science Seminar programme of NCSM is one such activity of NCSM which has inspired many young students to pursue careers in science and technology.

I look forward to thought provoking presentations at the national finals when some new thoughts and ideas may be put forth by the participants towards solving the water crisis.

G. S. Rautela



Quanesis



# 2013 International Year of Water Cooperation

## INTRODUCTION

United Nations General Assembly declared the year 2013 as the United Nations International Year of Water Cooperation vide its Resolution A/RES/65/154. Water is the very basis of life and is the foundation for human survival and development. Sustainable and equitable use of water over millennia has been ensured by cultural adaptation to water availability through water conservation technologies, agricultural systems and cropping patterns adapted to different climatic zones, and conservation-based life styles. But in the last few decades the consequences of population growth, industrialization and urbanisation, and the associated consumerist culture, have interfered with the natural hydrological cycle of rainfall, soil moisture, groundwater, surface water and storage of all sizes. This has led to overuse, abuse and pollution of our vital water resources and has disturbed the quality and the natural cleansing capacity of water. This has resulted in an urgent need to recognize the threatening consequences of water scarcity, minimizing the negative impacts of the overuse and misuse of water and to ensure that our precious water resources are used optimally in removing poverty and achieving economic and human development. It is in recognition of these compelling situations that United Nations has passed this resolution.

The slogan "Water Water Everywhere only if we share" sums up the significance of the need for water cooperation. The UN also has proclaimed the decade 2005-2015 as the International Decade for Action, "Water for Life". It is in recognition of this that the National Council of Science Museums, Ministry of Culture, Government of India has chosen the topic "Water Cooperation: Issues and Challenges" for this

year's National Science Seminar. Children from across the country have deliberated on this topic at different levels on the urgent need for water cooperation among different stake holders across the globe and have expressed their opinion on this subject. 35 students, the respective winners of all the 35 states and union territories of India will be participating at the National Science Seminar on 8th October at Nehru Science Centre Mumbai.

On 20th December 2010, the United Nations General Assembly declared 2013 as the United Nations International Year of Water Cooperation, following a proposal by Tajikistan. World Water Day, celebrated each year on 22 March, will be dedicated to the same theme. UNESCO was appointed by UN-Water to coordinate the Year and Day. National Council of Science Museums too has joined various national and international bodies in organizing events, activities and programmes to sensitize the citizens of India on this all important topic, which is the need of the hour for all of us. National Science Seminar is one of the most important activities that NCSM is organizing for the school students to create awareness on this topic for students across India.

Diverse activities around the world, including the National Science Seminar that National Council of Science Museums is organizing, will help raise awareness of the potential of and challenges to water cooperation, facilitate dialogue among stakeholders, and promote innovative solutions. World Water Day on 22 March 2013, also on the theme of water cooperation, was one of the key events of the Year, on the occasion of which all the science centres across the country under the National Council of Science Museums, have organized series of events activities and programmes to promote the significance of the World Water Day.

## WATER COOPERATION

Our planet Earth, also known as the Blue Planet, is unique in the unending cosmos that we inhabit. What sets us apart from the rest of the universe is the life providing substance, water that is abundantly available on our planet. Water is vital for life, pivotal for human development and necessary to keep our environment healthy. It knows no borders. For instance, 148 countries share at least one transboundary river basin. There is a fixed amount of water on the planet and with increasing population, economic development and changing lifestyles, undue pressure has been put on the world's limited water resources leading to increased competition for water and creating situations of potential conflict. But water can be used as an instrument of peace and development as every action involving water management requires effective cooperation between multiple actors whether at the local or international level. As rapid urbanization, climate change and growing food needs put ever-increasing pressure on freshwater resources; the objective of the Year is to draw attention to the benefits of cooperation in water management, including water diplomacy, transboundary water management and financial cooperation.

Contrary to common belief, good examples of water cooperation greatly outshine water-related conflicts. The Indus Waters Treaty signed by India and Pakistan in 1960 has survived three major conflicts and is still in force today. The potential for water cooperation is great and its benefits, whether in economic, social or environmental terms, are considerable. All water systems are extremely complex, be they management systems at the local or national level, internationally shared river basins or parts of the natural hydrological cycle. Managing these systems requires multiple actors, from users and managers to experts from various disciplines and decision-makers.

Cooperation is crucial not only to ensure the sustainable and equitable distribution of water but also to foster and maintain peaceful relations within and among communities. At the government level, different ministries can cooperate and mainstream awareness on water management into other sectors; at the community level users can cooperate through water users' associations; at the transboundary level, joint management institutions can help to distribute and protect shared resources; and at the international level, various UN agencies can work together to promote the sustainable management of water worldwide. Cooperation mechanisms vary in terms of decision-making structures, levels of participation and rules and regulations. They can take the form of informal agreements or formal institutions, and they range from a simple exchange of information to joint management mechanisms.

For ensuring efficacy of the objective of sensitizing the world on this all important topic the mandate for achieving this was bestowed on the UN – Water agency. UN-Water is the inter-agency coordination mechanism for all freshwater and sanitation-related issues. Based on a history of close collaboration among UN agencies it was established in 2003 by the UN High Level Committee on Programmes. UN-Water aims to foster greater co-operation and information sharing among its members and other international partners.

## Cooperation in sharing of River waters

Rivers cross political boundaries and international cooperation is necessary to share the water resources of a transboundary river basin between upstream and downstream users with different and sometimes conflicting needs, claims and cultures. Even in our country we constantly read about the conflicts between two riparian states when it comes to sharing and cooperating in water use from the Rivers that cuts across states. Tensions raise high when water becomes scarce as can be seen in the agitations that people resort to in addressing water sharing the examples of which in India are seen and exemplified in the mass agitation sometimes resulting in human loss of lives while addressing issues of Cauvery

water sharing between Karnataka and Tamilnadu. Such situation exists all across the country. Countries also need to cooperate on the sharing of transboundary groundwater, an important and increasing source of freshwater. If any of the people involved in water management do not cooperate, the 'cooperation chain' is broken and water resources will not be managed in the most effective way, with adverse effects on human lives and the economy. When water resources are cooperatively shared and managed, peace, prosperity and sustainable development are more likely to be achieved.

## Water cooperation is central to security, poverty eradication, social equity and gender equality

Inclusive and participatory governance of water and cooperation between different user groups can help to overcome inequity in access to water, enhance water security and overcome water scarcity and thus contribute to poverty eradication and to improving living conditions and educational opportunities, especially for women and children. Water cooperation is very effective in generating economic benefits for society. All economic activities depend on water. Cooperation can lead to a more efficient and sustainable use of water resources, including through joint management plans creating mutual benefits and better living standards. Water cooperation is also crucial to preserve water resources and in protecting the environment, which is now a key issue for our planet. Water cooperation supports the sharing of knowledge concerning the scientific aspects of water including data and information exchange, management strategies and best practices and knowledge about the role of water in preserving ecosystems, fundamental to human wellbeing and sustainable development.

Planning and implementation of water resource projects is central to betterment of human society. It involves a number of socio-economic aspects and issues such as environmental sustainability, appropriate resettlement and rehabilitation of project-affected people and livestock, public health concerns of water impoundment, dam safety etc. Common approaches and guidelines are necessary on these matters. Moreover, certain problems and weaknesses have affected a large number of water resources projects. There have been substantial time and cost overruns on projects. Problems of water logging and soil salinity have emerged in some irrigation commands, leading to the degradation of agricultural land. Complex issues of equity and social justice in regard to water distribution are required to be addressed. The development and overexploitation of groundwater resources have raised the concern and need for judicious and scientific resource management and conservation. All these concerns need to be addressed on the basis of common policies and strategies for ensuring inclusive development and betterment of human society.

### WATER COOPERATION BUILDS PEACE

Water management and access to the source of water can be a major source of a conflict, but it is also a catalyst for cooperation and peace building. Cooperation on such a practical and vital issue as water management can help overcome cultural, political and social tensions, and can build trust between different groups, communities, regions or states. The best example of this can be seen in the Indus Water Treaty signed between India and Pakistan.



## FACTS AND FIGURES RELATED TO WATER

It is estimated that 85% of the world population lives in the driest half of the planet. An estimated 780 million people do not have access to clean water and almost 2.5 billion do not have access to adequate sanitation. Six to eight million people die annually from the consequences of disasters and water-related diseases mostly in under developed and developing countries. Various estimates indicate that, based on business as usual, close to 3.5 planet Earths would be needed to sustain a global population achieving the current lifestyle of the average European or North American. Global population growth projections of 2–3 billion people over the next 40 years, combined with changing diets, result in a predicted increase in food demand of 70% by 2050. Over half of the world population lives in urban areas, and the number of urban dwellers grows each day. Urban areas, although better served than rural areas, are struggling to keep up with population growth.

The energy demand from hydropower and other renewable energy resources are likely to increase 60% by 2050. The exponential increase in population and the demand of increased food are interconnected.

For removing the hunger of people one needs to increase the agricultural output, which will directly lead to substantially increasing both water and energy consumption, leading to increased competition for water between water-using sectors. Water availability is expected to decrease in many regions. Yet future global agricultural water consumption alone is estimated to increase by over 19% by 2050, and will be even greater in the absence of any technological progress or policy intervention.

Water for irrigation and food production constitutes one of the greatest pressures on freshwater resources. Agriculture accounts for close to 70% of global freshwater withdrawals (up to 90% in some fast-growing economies). Shifting diets from predominantly starch-based to meat and dairy require more water. Producing 1 kg of rice, for example, requires roughly 3,500 Litres of water, 1 kg of beef 15,000 L. This dietary shift is the greatest to impact on water consumption over the past 30 years, and is likely to continue well into the middle of the twenty-first century.

## THE IMPACT OF CLIMATE CHANGE

The IPCC predicts that water stress will increase in central and southern Europe, and that by the 2070s, the number of people affected will rise from 28 to 44 million. Summer flows are likely to drop by up to 80% in southern Europe and some parts of central and Eastern Europe. The cost of adapting to the impacts of a 2° C rise in global average temperature could range from US\$70 to \$100 billion per year between 2020 and 2050 (World Bank, 2010). Of this cost, between US\$ 13.7 billion (drier scenario) and \$19.2 billion (wetter scenario) will be related to water, predominantly through water supply and flood management.

## A RESOURCE WITHOUT BORDERS

Water is not confined to political borders. There are 276 transboundary river basins in the world (64 transboundary river basins in Africa, 60 in Asia, 68 in Europe, 46 in North America and 38 in South America).

One hundred eighty-five out of the 276 transboundary river basins, about two-thirds, are shared by two countries. 256 are shared by 2, 3 or 4 countries (92.7%), and 20 are shared by five or more countries (7.2%), the maximum being 18 countries sharing a same transboundary river basin (Danube). The Russian Federation shares 30 transboundary river basins with riparian countries, Chile and United States 19, Argentina and China 18, Canada 15, Guinea 14, Guatemala 13, and France 10.

Africa has about one-third of the world's major international water basins. Virtually all sub-Saharan African countries, as well as Egypt, share at least one international water basin. Depending on how they are counted, there are between 63 (UNEP, 2010) and 80 (UNECA, 2000) transboundary river and lake basins on the African continent.

Most rich nations are maintaining or increasing their consumption of natural resources (WWF, 2010), but are exporting their footprints to producer, and typically, poorer nations. European and North American populations consume a considerable amount of virtual water embedded in imported food and products. Each person in North America and Europe (excluding former Soviet Union countries) consumes at least 3 m<sup>3</sup> per day of virtual water in imported food, compared to 1.4 m<sup>3</sup> per day in Asia and 1.1 m<sup>3</sup> per day in Africa (Zimmer and Renault). Land grabbing is another increasingly common phenomenon. Saudi Arabia, one of the Middle East's largest cereal growers, announced it would cut cereal production by 12% a year to reduce the unsustainable use of groundwater. To protect its water and food security, the Saudi government issued incentives to Saudi corporations to lease large tracts of land in Africa for agricultural production. By investing in Africa to produce its staple crops, Saudi Arabia is saving the equivalent of hundreds of millions of gallons of water per year and reducing the rate of depletion of its fossil aquifers. Nearly all Arab countries suffer from water scarcity. An estimated 66% of the Arab region's available surface freshwater originates outside the region.

Pollution knows no borders either. Up to 90% of wastewater in developing countries flows untreated into rivers, lakes and highly productive coastal zones, threatening health, food security and access to safe drinking and bathing water. Eighty-five percent of used water worldwide is not collected or treated, in developing countries.

## COOPERATION, A CONTRASTED REALITY

There are numerous examples where transboundary waters have proved to be a source of cooperation. Nearly 450 agreements on international waters were signed between 1820 and 2007 (OSU, 2007). Over 90 international water agreements were drawn up to help manage shared water basins on the African continent (UNEP, 2010). Yet 60% of the world's 276 international river basins lack any type of cooperative management framework. UN-Water conducted a global survey in 2011 to determine progress towards sustainable management of water resources using integrated approaches. Preliminary findings from the analysis of data from more than 125 countries show

that there has been widespread adoption of integrated approaches with significant impact on development and water management practices at the country level: 64% of countries have developed integrated water resources management (IWRM) plans, as called for in the Johannesburg Plan of Implementation, and 34% report an advanced stage of implementation. However, progress appears to have slowed in low and medium Human Development Index (HDI) countries since the 2008 survey.



## Need for sharing of water - Indian scenario.

Availability of water in India is highly uneven in both space and time. Precipitation (Rainfall) is confined to only about three or four months in a year. It varies from an average 100 mm in the western parts of Rajasthan to over 10000 mm at Cherrapunji in Meghalaya. Rivers and underground aquifers often cut across state boundaries. Water, as a resource is one and indivisible: rainfall, river waters, surface ponds and lakes and ground water are all part of one system.

In India the production of food grains has increased from around 50 million tonnes in the fifties to about 208 million tonnes in the Year 1999-2000. This will have to be raised to around 350 million tonnes by the year 2025 to keep pace with the population growth and for ensuring a hunger free India. The

drinking water needs of people and livestock have also to be met. Domestic and industrial water needs have largely been concentrated in or near major cities. However, the demand in rural areas is expected to increase sharply as the development programmes improve economic conditions of the rural masses. Demand for water for hydro and thermal power generation and for other industrial uses is also increasing substantially. As a result, water, which is already a scarce resource, will become even scarcer in future.

India, like several other countries, has to share its waters with its neighboring countries and even within the country several states have to share their water from the rivers and often this leads to unwarranted conflict necessitating the requirement for effective water cooperation within the country and also amongst different states and with other countries that India shares its river water with. India shares six rivers with its neighbour Pakistan and for this an effective Indo - Pak Indus treaty signed in the year 1960 is in place and has served both the countries in avoiding water conflicts. India and Nepal have signed the Sharda treaty (1927), the Kosi treaty (1954, amended in 1966), the Gandak treaty (1959, amended in 1964), the Tanakpur (1991) and the Mahakali treaty of 1996 which facilitate the two countries in water cooperation. India has signed the Farakka Water Treaty for sharing of Ganga water with Bangladesh, yet lot needs to be done when it comes to sharing the Teesta river water, the treaty of which was very close to being signed but had to be abandoned for political reasons. India and China have continued to play a blame game when it comes to sharing of the Brahmaputra river waters for which no formal treaty exists.

The situation within the country is no different. The most glaring amongst them are the Krishna -

Godavari water dispute between the warring states of Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Orissa, the Cauvery water dispute between Karnataka and Tamil Nadu and the Ravi - Beas dispute between Punjab and Haryana.

There is an ever increasing potential of water conflicts in India at various levels. This is officially recognized in the 12th five Year Plan of Government of India: "... conflicts across competing uses and users of water are growing by the day." India's National Water Policy acknowledges this in the very first paragraph: "With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups." The role of demand side management becomes key when one of the key factors in increasing conflicts is increasing demands. However, in a growth-oriented and market-dominated situation, demand is sacrosanct, demand management is an anathema. There is little serious attention today towards demand management in India.

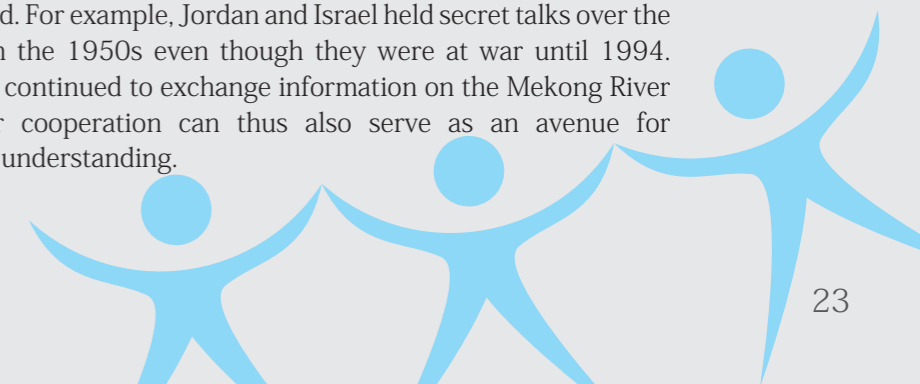
At non government level, Forum for Policy Dialogue on Water Conflicts in India has been in existence since 2004, first surveying, recording and understanding water conflicts and then moving towards conflict resolution. A recently released report on water situation in India by UNICEF, FAO and Saci-Waters says: "Water conflicts are broadly classified into the following seven categories. These are conflicts over equitable access, competing uses, water quality and pollution, dams and displacements, privatization of water, industrialization and inter-state conflicts." The conflicts over competing uses would include sectors like urban, rural, industrial, commercial, agriculture, ecosystem and also inter-generation users. Other kinds of conflicts include: Intra basin and inter basin conflicts, international conflicts and conflicts between the state and people.

## INTANGIBLE CULTURAL HERITAGE OF HUMANITY

The Valencia Water court Every Thursday at midday in the cathedral square in Valencia (Spain), at the first strike of twelve on the bell, an "alguacil" or constable comes out of an adjoining building. He is followed by eight men dressed in the long black shirts traditionally worn by farmers in the region. They are members of the ancient institution of the Tribuna del Agua. In public hearings, the court settles disputes on the distribution of water among the eight channels that irrigate the 17,000 hectares of land from the huertan where citrus fruits, rice, grapes and peaches are grown for the Spanish and international markets. It was inscribed on UNESCO's Representative List of the Intangible Cultural Heritage of Humanity. This ancient water cooperation ritual epitomises its need in modern times. In recognition of its unique character this ancient ritual has been recognised and inscribed on UNESCO's representative list of the Intangible Heritage of Humanity.

## Water cooperation as a peacemaking strategy

Water can also be a catalyst for cooperation and for building peaceful relations beyond the resource itself. Often negotiations over a practical issue such as water provide a basis for dialogue even when political relations are strained. For example, Jordan and Israel held secret talks over the management of the Jordan River from the 1950s even though they were at war until 1994. Cambodia, Laos, Thailand and Vietnam continued to exchange information on the Mekong River throughout the Vietnam War. Water cooperation can thus also serve as an avenue for peacemaking, building trust and mutual understanding.





## Why care about water cooperation

Water is a vital element for human existence and all ecosystems on Earth, naturally shared through the hydrological cycle. It is the most precious resource on our planet. The fulfillment of basic human needs, our environment, socio-economic development and poverty reduction are all heavily dependent on water. Although there is enough freshwater on the globe for everyone, resources are unevenly distributed in time and space. In many regions, clean freshwater is becoming increasingly scarce due to population growth, urbanization, changes in lifestyle, economic development, pollution and climate change. The growing pressure on water resources creates potential competition between different uses and users and makes it more difficult to manage water in a sustainable and equitable manner. Good management of water is especially challenging due to some of its unique characteristics: the hydrological cycle is highly complex and perturbations have multiple effects on quantity, quality and availability elsewhere; water cuts across all social, environmental and economic activities and touches upon multiple sectors; and water does not respect political and cultural boundaries, be they local, regional or national.

Water is a shared resource and its management needs to take into account a wide variety of conflicting interests. Water cooperation is crucial to peace and sustainable development. Cooperation is essential to strike a balance between the different needs and priorities for sound water management. The potential for water cooperation is great. Evidence indicates that good examples of water cooperation greatly outshine water-related conflicts.

Water cooperation between different social groups, economic sectors, regional governments, countries, and present and future generations, is crucial not only to ensure the sustainable and equitable use of water but also to create and maintain peaceful relations between people. Water cooperation requires the integration of all relevant interests and perspectives, fostering innovation, building trust, developing capacities and making decisions that are acceptable and understood by all. In this context, water cooperation needs to embrace multiple perspectives, be informed by a variety of disciplines and extend to all levels, from the local to the national to the international level, and across all socioeconomic sectors.

## KEY MESSAGES

Access to water can be a source of a conflict, but it is also a catalyst for cooperation and peace building. Cooperation on such a practical and vital issue as water management and drinking water supply and sanitation services can help overcome cultural, political and social tensions, and can also build trust and social peace between different groups; genders, communities, regions or states.

Universal access to efficient drinking water supply and sanitation services is the foundation for the fulfillment of basic human needs and contributes to the achievement of all the Millennium Development Goals. Inclusive, participatory and gender sensitive governance of water and cooperation between different stakeholders can help to overcome inequity and prevent conflicts in access to water and thus contribute to poverty eradication, socioeconomic development and improve the living conditions and educational chances, especially of women and children.

All economic activities depend on water. Cooperation can lead to a more efficient and sustainable use of water resources, e.g. through joint management plans creating mutual benefits and better living conditions, and gender sensitive water governance.

Water cooperation makes possible and promotes the exchange of scientific knowledge, including gender disaggregated data and information, management strategies and best practices, which is fundamental for the protection of the environment and to achieve sustainable development.

## CONCLUSION

The profile of India's population for the year 2030 will be roughly 1.5 billion people. India will still be a rather youthful country, with 8%–9% of its population 65 years of age or older and a median age of 31–32 years (compared to roughly 13% and 37 years, respectively, for the United States today). About 68% of India 2030's population will comprise men and women of working age (conventionally defined as the 15–64 group), compared with 65% today. This means that the working-age manpower is set to grow more rapidly than overall population in the decades immediately ahead, by about 1.3% per annum on average. This aspect while helping in improving the economic condition of the country will lead to additional pressure on the requirement of water. Furthermore by 2030, UNDP anticipates India's life expectancy will reach 70 years, and by its projections, the India of 2030 will be about 40% urban, up from an estimated 30% today which will further accentuate the problem for water and hasten the need for water cooperation.

To highlight this aspect it is necessary that the process should begin by targeting the children who will primarily be responsible for implementing policies and strategies of the country in future. It is in this context that the National Science Seminar, primarily aimed at students in which more than 30,000 students have directly taken part in the seminar and thousands of others have witnessed the seminar at different levels all across the country, is a step in the right direction. The primary objective of the International Year of Water Cooperation as declared by the UN will greatly be fulfilled by this event.

This article has been compiled by the organizers by sourcing information and content from various UN publications and other reference material.



**Prof. P. P. Mujumdar**  
KSIIDC Chair Professor  
Dept. of Civil Engineering, Indian Institute of Science, Bangalore

It is now well accepted in the scientific circles that, at the global scale, the atmospheric temperatures will continue to increase over the coming decades, and as a result, the precipitation patterns are likely to change and sea levels will rise.

These three prominent signals of global climate change result in regional modifications in water availability, evapotranspirative water demands of crops and vegetation, extremes of floods and droughts, water quality, salt water intrusion in coastal regions, groundwater recharge and other related processes. Visible impacts of global climate change will be felt mainly through the medium of water in the coming years.

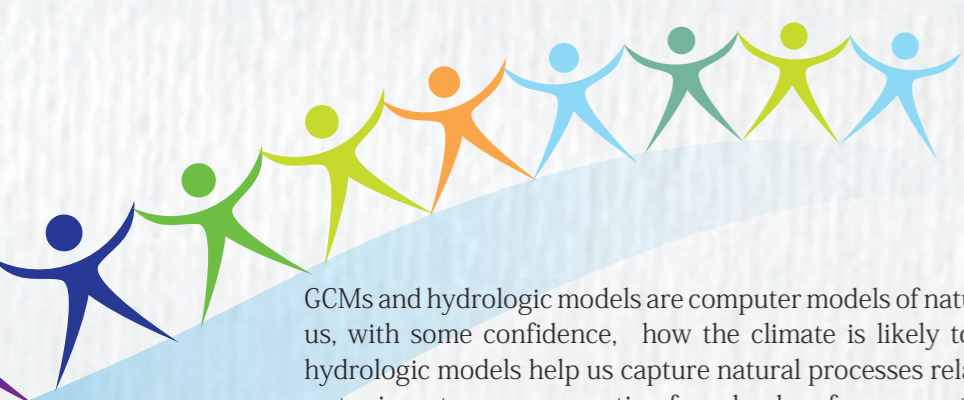
Even without the likely adverse impacts of climate change, we are already living on the edge as water crisis gets more pronounced every year. Consider these facts: several of our rivers are polluted beyond acceptable levels; groundwater is contaminated in many regions of the country because of both natural and anthropogenic causes; safe

drinking water is fast becoming an economic commodity rather than a resource to fulfil the basic human need; indiscriminate exploitation of ground water has put that resource in stress in many regions of the country; water is often transported over large distances with huge pumping involving enormous energy, for supply to cities; unplanned urban growth encroaching upon natural water bodies and drainage pathways has resulted in frequent and intense flooding of cities; we face severe water shortages in the summer months almost every year, and immediately after, intense floods during monsoon months causing huge loss of property and life. Climate change is likely to only exacerbate this situation.

We must accept that urbanisation and development in the country are an irreversible reality and are essential to improve the overall quality of life. An unprecedented growth of urbanisation in the country in a short time, however, has posed the biggest challenge for the urban water managers. An immediate impact of climate change on urban water systems is through altered surface and ground water resources, because of possible reduction in streamflow and rainfall. Additionally, increasing intensities of rainfall along with unplanned development of cities aggravate the already critical urban flooding problem and stress the urban water infrastructure. Urban floods are caused by short duration high intensity rainfall, which are projected to increase in many regions – but the overall water availability is governed by the seasonal rainfall, which may decrease. A challenging problem is to convert the urban floods into a resource, by innovative technologies to recharge ground water or otherwise store the floodwaters for subsequent use.

An accurate assessment of how the water scenario is likely to evolve in a region is not possible with the current available knowledge. Additionally, there are serious disagreements among the policy makers and even among the scientists on the authenticity of climate change itself and on the possible impacts it may have on regional water scenarios. The water managers are thus faced with the challenge of evolving adaptive responses and action plans in the face of not only a large uncertainty associated with the projected impacts but also a sense of perplexity and confusion that the issue of climate change seems to have created because of conflicting views, opinions and even scientific projections on the impending regional water scenarios. Such a sense of confusion is particularly pronounced in India, where the capacity to understand the different aspects of climate change as it affects the water systems is extremely limited among water managers.

How can science help the policy makers in resolving the many critical issues related to water, in the face of climate change? A major science question that we need to address in this context is on how river flows are likely to change in future because of climate change. Other important questions to resolve are: whether the frequencies and magnitudes of floods and droughts are likely to increase, and how do the agricultural and other water demands respond to climate change. We use hydrologic models along with global climate models (GCMs) in our attempt to answer these questions. Both



GCMs and hydrologic models are computer models of natural processes. The GCMs tell us, with some confidence, how the climate is likely to evolve in future while the hydrologic models help us capture natural processes related to water such as flow of water in a stream, evaporation from land surface, evapotranspiration from crops and vegetation, ground water movement and recharge, soil moisture and sediment and pollutant transport in streams. We use projections of future climate provided by the GCMs in the hydrologic models to assess the water situation in a region. With this knowledge, inexact though it may be, action plans for future may be examined. It is the responsibility of the scientific community to reduce uncertainties in the projections and to communicate the results in a manner useful for the policy makers.

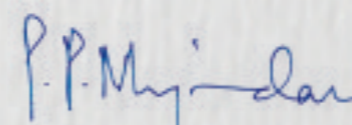
Whether science is, at this stage, geared up to provide an accurate assessment of impacts of climate change at regional scales or not, it is important to acknowledge that water crisis is likely to be accentuated by climate change, and we must prepare ourselves to face abnormal conditions more frequently than we are used to. The water systems must be rendered shock-proof and resilient to a great extent. Current emphasis on creation of large scale water infrastructure in the country must be augmented with well-formulated adaptive policy options. Indeed, the issue of climate change offers an enormous opportunity to apply corrections to the poorly managed water systems in the country. In building resilient, adaptive responses, out-of-the-box solutions synthesising the Gandhian and the Schumaker 'small is beautiful' perspective with that of large scale engineering interventions will be necessary. Measures such as reviving village tanks, rejuvenating lakes and water bodies in urban areas, adopting small-scale, local rainwater harvesting and recycling of waste water should be integrated into the large scale engineering and management solutions of improving water use efficiencies - particularly in irrigated agriculture -, increasing reservoir storage and allied physical infrastructure, harnessing flood waters as a resource, changing the cropping patterns and desalination of seawater, to build resilience into water management systems. The response of groundwater to climate change is likely to be much slower and less critical compared to that of surface water. The ground water reservoir should therefore be recognised as an insurance against climate change. Emphasis should be placed on evolving conjunctive use policies of surface and ground water as an option for resilient response to climate change.

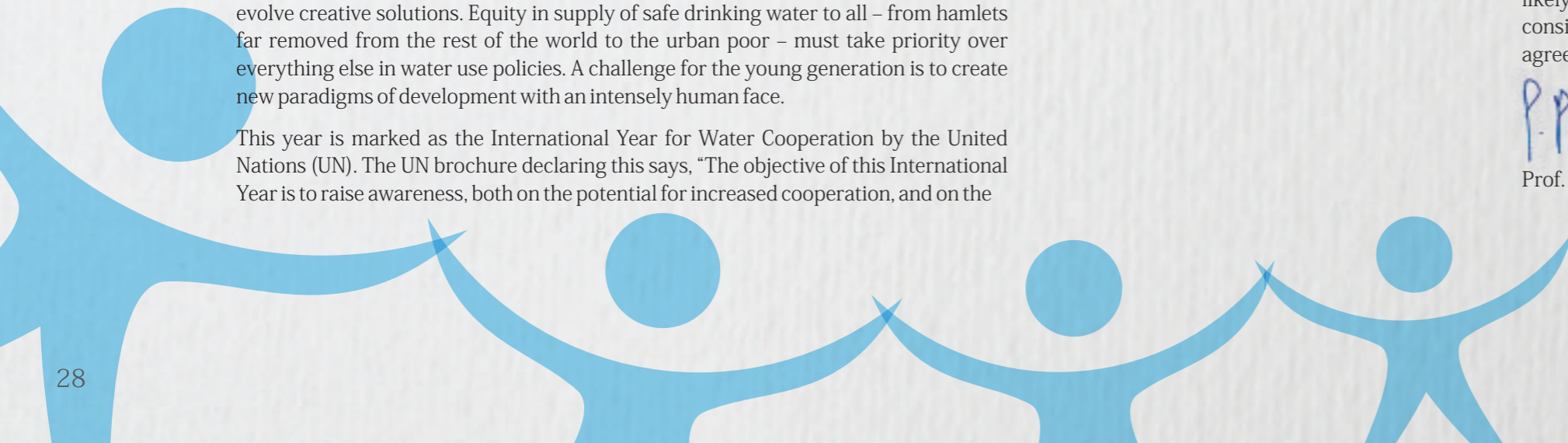
As young, brilliant students of science interested in water issues, the participants of this seminar are urged to see the impending water crisis as an opportunity for them to evolve creative solutions. Equity in supply of safe drinking water to all – from hamlets far removed from the rest of the world to the urban poor – must take priority over everything else in water use policies. A challenge for the young generation is to create new paradigms of development with an intensely human face.

This year is marked as the International Year for Water Cooperation by the United Nations (UN). The UN brochure declaring this says, "The objective of this International Year is to raise awareness, both on the potential for increased cooperation, and on the

challenges facing water management in light of the increase in demand for water access, allocation and services". An excellent example of international cooperation on water sharing is the famous India-Pakistan Indus Water Treaty, where the two countries agreed on some well laid principles of water sharing and have adhered to them in spite of frequent political and military tensions between the two countries. It is a great credit to both India and Pakistan that even during the three wars between the two countries (in the years 1965, 1971 and 1999), the water treaty was never broken. The water treaty has benefitted both the countries immensely in building drought resistance. India and Bangladesh, on the other hand, share more than 50 rivers between them and long standing conflicts on water sharing are yet to be fully resolved, although a few temporary agreements have been put in place between the two countries. Recently, an agreement on sharing of the Teesta river waters between India and Bangladesh was nearly arrived at but unfortunately could not be effected finally. The Colorado Compact, which governs sharing of the Colorado river water among seven states in the United States of America, has functioned extremely successfully for nearly 90 years now, and is treated as an ideal agreement to emulate in a federal structure of governance. In India, too, there are a number of water agreements among states, which despite political differences among the states, have worked very well. These agreements are effected through water tribunals, with legal authority, in most cases. The Narmada Water Disputes Tribunal (NWDT), for example, awarded a decision on the sharing of the Narmada river water among Madhya Pradesh, Gujarat, Rajasthan and Maharashtra. Similarly, the Cauvery Tribunal and the Krishna Water Disputes Tribunal awarded decisions on sharing of water between Karnataka and Tamilnadu in the case of Cauvery river and between Maharashtra, Karnataka and Andhra Pradesh, in the case of Krishna river.

A basic governing factor in arriving at water sharing agreement for a river among countries (or states) is the water available in that river at one or more specified locations. Often, the agreements are based on an estimated amount of water available with a certain degree of confidence. A deficit year or an excess year is defined depending on whether the actual flow in the river is less or more than this estimated amount of water. The water sharing principles are generally worked out for all the three situations: normal, excess and deficit years, with due accounting of water demands in the regions concerned. It is in this context that the issue of climate change becomes critically important, as both water available in a river and water demand are likely to be affected by climate change. Building clauses on climate change impacts - considering explicitly the uncertainty associated with the impacts - into water sharing agreements is indeed a challenge but will soon become inevitable.

  
Prof. P. P. Mujumdar







**Mr. Achim Steiner**  
Executive Director, UNEP

Our planet is more than two-thirds water. Water is such an integral part of our lives—not only for our own drinking and washing, but also in industry, sanitation and agriculture—that we can easily regard it as an inexhaustible resource.

However, this is far from the truth. The United Nations Environment Programme (UNEP) has urged a cooperative approach to water management since its inception more than four decades ago. And while no-one should doubt the potential for water competition to cause conflict—there have been at least thirty-seven cases of reported violence between states over the last half century—the urgent need to cooperate over this precious resource can also be a force for good. In the same period, more than 200 water treaties were negotiated between countries. On the subcontinent, The Permanent Indus Water Commission survived and functioned during two major wars between India and Pakistan: a clear recognition of the importance of cooperation in this most vital regard.

Similarly the eleven countries of the Nile Basin have in many ways in their own national interest often worked together, and often in the face of deeply-held differences. A new UNEP report on how conflict, development and climate change are impacting the Nile Basin has identified six potential hotspots, as far apart as the Mediterranean and the Rwenzori mountains of Uganda, where water competition could cause ecological, social and economic turmoil. But there is also cause for optimism in the relative success of the Nile Basin Initiative as a forum for discussion and agreement with the potential to provide a model for trans-boundary water cooperation in other regions of the world.

2013 is the UN “Year of Water Cooperation”. A recent UNEP survey of 130 countries revealed the urgency of this issue. Over 80 per cent of nations have overhauled their water laws in the past twenty years as a response to growing pressures from expanding populations, urbanization and climate change. In many cases, these reforms have had a significant impact on development, including improvement to drinking water access, human health and water efficiency in agriculture.

But global progress has been slower where irrigation, rainwater harvesting and investment in freshwater ecosystem services are concerned. UNEP’s research also shows that more progress is needed in implementing internationally-agreed approaches to water use, known as Integrated Water Resources Management, which looks at domestic, agricultural, industrial and environmental needs as a whole, rather than considering each demand in isolation.

And this approach will be essential amid increasing and conflicting demands on the world’s water supply. UNEP’s development specialists have demonstrated how a Green Economy, which decouples economic growth from environmental deterioration, can prevent water shortages from dragging nations into economic stagnation and increased socio-economic inequality. Indeed, our technical experts have shown how waste water can be transformed from a major health and environmental hazard into a clean, safe and economically-attractive resource. Together with governments and partners around the world, UNEP is working to implement these kind of initiatives on both a policy and a practical level.

Admittedly, such a macro view can seem far removed from our own daily experiences with water, when brushing our teeth or washing our car. But UNEP’s message is that by an awareness of our own usage, we all have the opportunity to contribute to a culture of valuing water. The theme of our World Environment Day this year was Food Waste. Simply by reducing wasted food we can save as much fresh water as ten times the flow of the Nile: surely a demonstration of how the changes we make in our own lifestyle need not be merely a drop in the ocean.



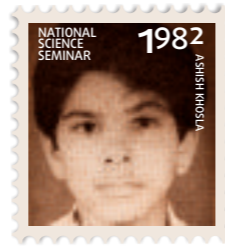
nostalgia

Fond memories from  
past NSS winners



**Ashish Khosla**  
Vice President, Union National Bank  
Abu Dhabi, UAE | AKhosla@unb.ae

WINNER



It's been more than 30 years to the day I participated in the 1st National Science Seminar, and I am pleasantly surprised to see it's still going strong. Clearly the future of science in India is in safe hands!

I was then a student in a small town in Himachal Pradesh, and participating at various levels of the seminar (on "Space and Mankind"), being awarded the 1st prize which was a trip to the Smithsonian Institution, Washington DC - and meeting with distinguished leaders, scientists and astronauts, some of whom I'd only read about before - was an eye opening experience. I was (& still am) extremely thankful to NCSM for providing this unique platform.

At the awards ceremony on that occasion, M. Hidayatullah - former Vice President of India, who was the Chief Guest, said "The true winners in this contest are all those participated with dedication. For winning in life not about prizes - but about self-improvement through knowledge; and participating in this seminar is bound to give one a step up in his or her knowledge."

Somehow this struck a deep chord within me (possibly because I was nervous, and not expecting to be amongst the winners at all) and over the years it has held me in good stead. Let me assure you that by becoming one of the hundreds of thousands of students who have taken part here over these years, and by sincerely putting in efforts to understand the topic assigned for your seminar - you are taking a step forward to becoming a winner in life.

About Ashish:

Ashish works as Vice President at a Bank in Abu Dhabi. He is also a co-founder of the Shoolini University of Biotechnology & Management Science, Solan, H.P.



**Divya Baduvanda**  
Bangalore | divyabaduvanda@yahoo.com

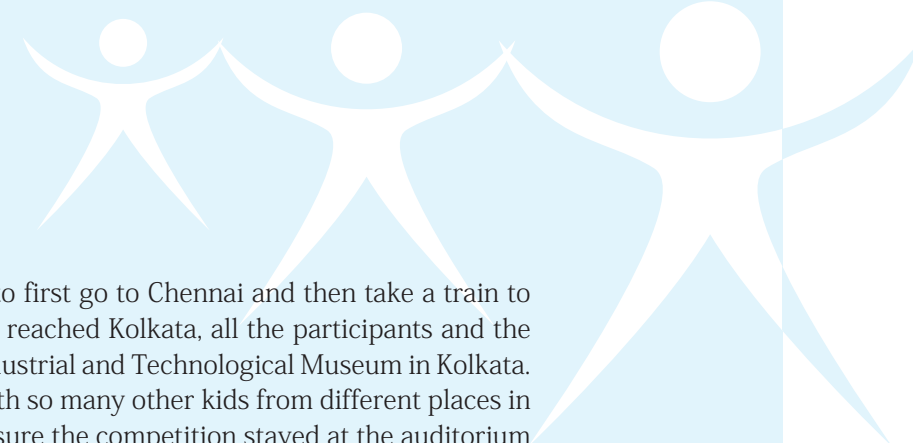
WINNER



It has been 23 years, but I still remember the excitement as if it was yesterday. Then, I was in 10th Standard, a crucial year.

Early during the term that year, my teachers, Mrs. Shanthakumari and Mrs. Valli asked me to prepare a paper on "Natural Disasters: Man-a Slave or Master?". It took me some time and a lot of help from my parents to prepare this paper and present it to my teachers. That was the start of this exciting journey. I was selected from my school to participate in the district level science seminar. Additionally, the teachers also modified my paper and helped me with preparing charts. You have to remember this was before the advent of computers and internet; hence, all our information was from books, which as per present standards had outdated information. Preparing slides for a projector was very expensive and there were no "ppts", hence all supporting props for the paper was in the form of charts which were manually prepared. Only after reaching the state level and then winning it, did I realize the depth and importance of what I had achieved. To see my picture in the newspapers the following day, made me feel very important and my school and parents were really proud of me. But then the journey had just begun, our target was to win the National Level. We prepared new charts and added more information to the paper. My teachers ensured that I practised every day after school and my parents ensured I was there on time and picked me back from school at whatever time may it be. My Diwali vacations were spent at school preparing for this. The seminar was scheduled for December and we wanted to be completely prepared for it. One day while preparing, we thought we should make the charts more interesting and innovative. We thought we could make sliding charts and then also use magnets for the props to attach to the charts. This involved extra work, but then, my teachers, parents and I were all for it. Initially it was a failure, but then with a few modifications it turned out just perfect. Finally the day arrived for me to leave for Kolkata where the seminar was held that year. My teachers, parents and I set out on the

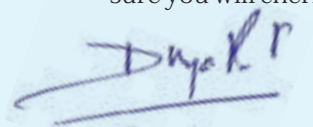




long journey from Bangalore to Kolkata. We had to first go to Chennai and then take a train to Kolkata. The journey took all of 4 days. Once we reached Kolkata, all the participants and the teachers were given accommodation at the Birla Industrial and Technological Museum in Kolkata. It was quite a learning experience for me to stay with so many other kids from different places in India. However, we all had a great time and made sure the competition stayed at the auditorium and rest of the time, we were just kids having a good time. The day of the competition dawned on us, all of us were quite nervous and there was a lot of scrambling around making sure our charts was OK, our uniforms were ironed and neat, our shoes were polished, etc. The competition as such went on the whole day and all of us were eagerly listening to the other speakers to pick out the WOW factors in their presentation and the mistakes in others. There was one girl who presented the entire paper in the form of a poem which I found quite interesting. Evening arrived and it was time for the winners to be announced. They started with consolation prizes and then the second prize, which went to Rituparno Goswami from Bihar. It was then time to announce the winner, and the announcer called out for "Dibo from Kornatoka". I was sitting in my chair without moving and wondering why the winner was not going on to the dais. It was after the third time that my name was called and when people around me pushed and prodded me, I realized it was my name being called and I had won. It was an extremely happy and exciting moment for me, my teachers and my parents. Following this win, I presented the paper at the Youth Science Congress in 1991 at Indore and then also represented India in the International Science Camp held at Huntsville, Alabama.

Representing India at the International Space Camp was prestigious for me and I must thank the National Council for Science Museums for giving me this opportunity. This forum helped me to understand the different cultures of the World, display what India stood for; remember this was a time when India was not as visible as today on the World map. It also was an eye opener to the latest development work being done in the field of Space and Technology. The confidence that the National Science Seminar gave me went on to help me in participating in various competitions in my college days. Just to name a few, I had won in various science seminars in college and while doing my BSc, I again won the first prize in a seminar organized by the Indian Academy of Sciences and was awarded a Summer Research Fellowship at Indian Institute of Science, Bangalore during my summer vacation.

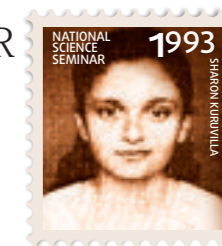
Today, I work as a Medical Writer for a leading Clinical Research Organization and the experience of researching and preparing for the National Science Seminar helps me even today. Whenever I write I keep in mind that what I am working on will eventually impact some patient somewhere in the world and hence I make sure, I research properly before writing. I also ensure what I write is legible and correct. This achievement has also helped me in my personal life. Today, I have a 9-year old son and instead of making him learn things by heart, I make him understand the concepts. Of course I have the benefit of internet and iPad now which did not exist then. My personal message for the students participating in this year's science seminar would be, GO FOR IT. Prepare to your best ability and let the rest follow. Take this opportunity as a learning experience and I am sure you will cherish it for the rest of your lives, just like I still do.



Divya Baduvanda



WINNER



**Sharon Kuruvilla**  
sharonkuruvilla@yahoo.com

Let me first start by congratulating the people behind this wonderful endeavour. I was truly thrilled for having been contacted by someone with regard to this event after so many years.

National Science seminar is truly one of the best organised events I've attended. I participated in 1993 which is 20 yrs back, a time where there was no advanced means of communication that we have today. But still the organisers succeeded in conducting the seminar in an excellent manner. It was a unique experience to meet candidates from all over India. The facilities provided for all the participants were great. I'm glad that National Science Seminar is still being conducted in an outstanding manner and providing a platform for students to showcase their talents & enhance their skills.

Participating and winning the National Science seminar was truly a turning point of my life. It was the first time I was taking part in an event outside my state and that too at the National level. The exposure I got from participating in this was extensive. The research techniques we used to gather the information pertaining to the subject of the year "Are we alone in the Universe?", the efforts put into preparing all those info into a concise presentation and finally rehearsing my 5 minute speech with improved oratory skills, all this contributed into making this a life changing experience for me. It paved the way for moulding me into the confident and competent public speaker that I am today.

I'm now based in Dubai. Married and working as Treasury Controller in a Multi- National Company. Though I did not pursue a career related to science, this experience was the foundation for most of my future activities. It gave me the confidence to accept challenges in life and strive to excel in whatever I do.

Thanks & regards,

Sharon Kuruvilla





**Deepa Chari**  
Dublin, Ireland | deepu.chari@gmail.com

WINNER

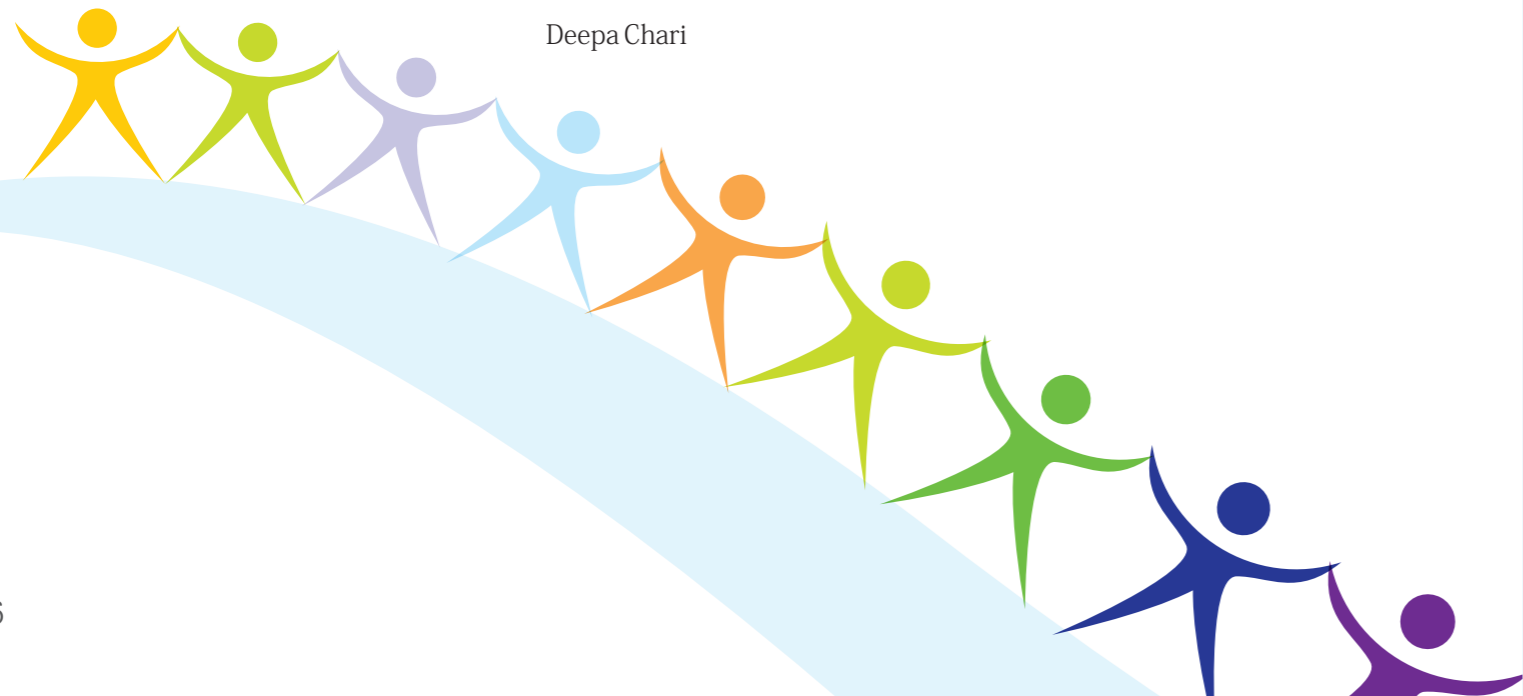


## I participated in NCSM seminar competition in 1995

The seminar was an important event in enhancing my interest to undertake higher education in science discipline. I found the competition as a dynamic stage to make many friends from all over India. Talking to the students, their mentors and organisers was a great experience which I would never forget. I enjoyed the social get together and field trips during the event. The whole event was very motivating.

I encourage all young students to participate in NCSM activities and enjoy the beauty of science through these activities. My best wishes for your future endeavours.

Deepa Chari



**Anupama Kondayya**  
Knowledge Management & Innovation Catalyst at Oracle  
Bangalore | anupamakondayya@gmail.com

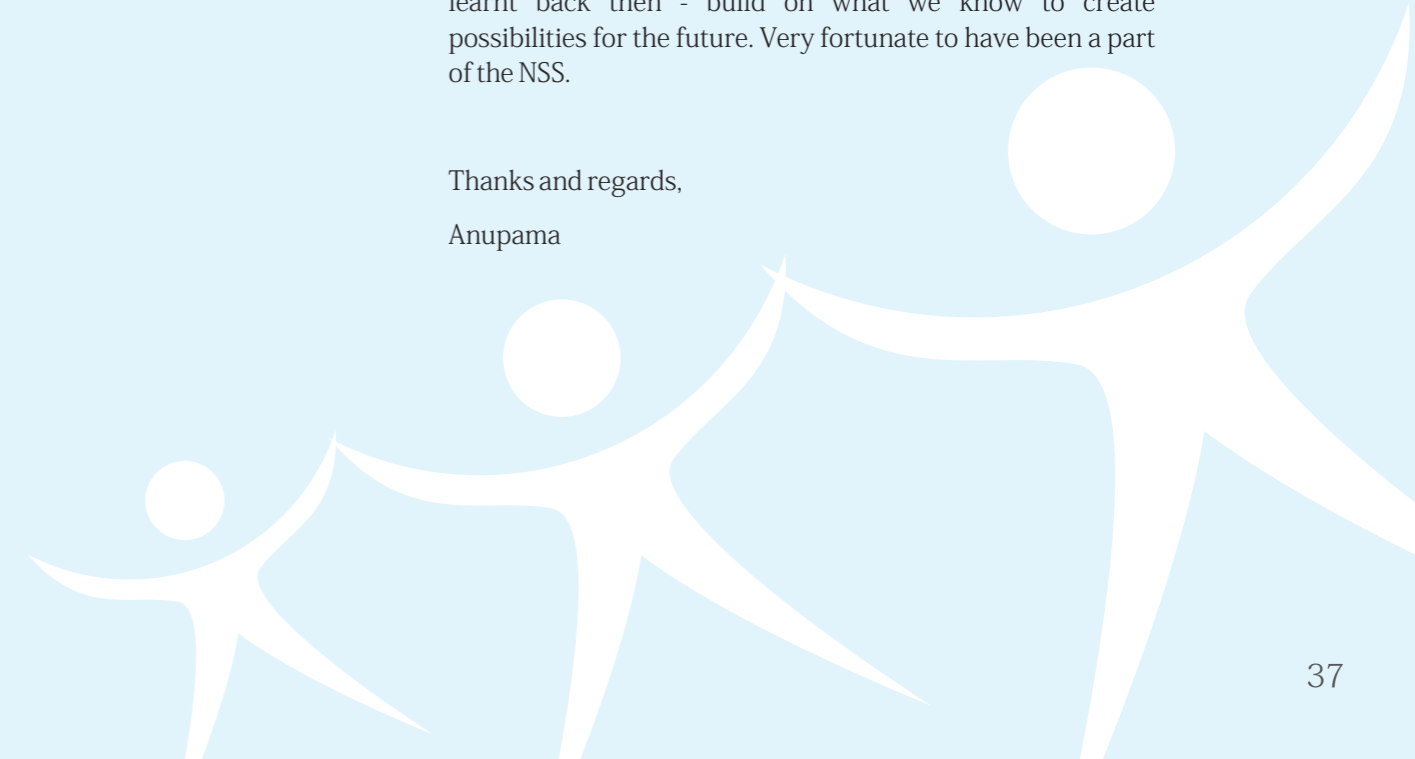
WINNER



## How NSS Helped Me : NSS 1999 is by far one of the most enriching and memorable experiences in my life.

Apart from giving me lifelong friends and an immensely broad cultural exposure through meeting participants from all the other Indian states, it gave my love for science a further boost by making me research, explore and imagine possibilities on a scientific topic at the verge of the millennium. That exercise of building on present scientific advances to peep into the future reinforced a love of ideas in me. It is no wonder that I work in the field of Knowledge Management and Innovation today, which combines what I learnt back then - build on what we know to create possibilities for the future. Very fortunate to have been a part of the NSS.

Thanks and regards,  
Anupama





**Purva S. Dholakia**  
Senior Research Assistant  
LDC-IL, Central Institute of Indian Languages,  
Mysore, Karnataka | purvadholakia@gmail.com

WINNER



It's my privilege and honor to jolt down and share my memories of National Science Seminar.

Well, some event in life meant to be the landmark . and National Science Seminar has been one of its kind in my life experience, a journey from no one to be 'the ONE'. It came to me as a casual competition and I took part in it with all my passion , knowledge and past experience. I didn't realize the glory of the title "the winner" when it was achieved back in 2000, it came with recognition and responsibility. Later through life stages that glory unfolds its value and proved that National science seminar was not mere a competition but a path breaker event , and larger than life portray for me. As per my knowledge , this competition has taken up its course since 1986, and I am the one till now who brought the title back to my region Gujarat.

National science seminar stands out from other competitions as it's being a knowledge sharing event rather than just a contest for ranks and position. Here, all the participants are winner themselves as they get the platform to share their opinions and views about crucial issues related to science and get knowledge in return. It's all about analytical, thoughtful aptitude towards the given issue, your reasoning and resolutions about the topic. Look at the twist and turn- the "chakravyuha" of the competition as you have to clear written test, your presentation and the Questionnaire. You have to be so equipped with the knowledge about the topic, here your real test is, in the presentation time whether you are voicing others view by mugged up script or your own views and knowledge about the topic are spoken out loud. Winning is not so easy here! You have to be real "Abhimanyu" by meticulous study research, then only u can cross successfully the "the chakravyuha" of NSS. For me, it consisted of 4-6 hours of study everyday before sculpting a presentation, Intense discussion with teachers and keeping yourself updated with general knowledge scenario. Here, at the end not any individual or any state body wins but a correct aptitude, a new and reformative thought process wins.

National science seminar has been continuing to ignite the spirit of scientific approach and analysis in young generations, and through this way it teaches students to contribute to society by being responsible and adapting knowledge to conquer with socio-scientific challenges. It's not about only taking up science stream and being doctors or engineers , but it's all about to develop your skills , and cultivate your aptitude towards challenges may it be science then to society and then to life. I am not a doctor or an engineer , I am proud to say that I am a Linguist , a researcher , we work for uplifting Indian languages in the scenario of their extinction . we produce software for Indian scheduled languages and endangered languages. The world is bound to take notice of our work. I had been face to face to my researcher spirit through NSS, and it led me upto here. National Science Seminar is all about do the best as a human being for the society and be the best where you are. I am proud to say that me including all achievers are still part – the fruit bearing branches of the unshakeable tree called 'National Science Seminar'. It would not have been possible without the efforts of my teachers Geeta Dholakia and Jyoti Chandvani, blessings of my parents and the support of my school Matruchhaya Kanya vidyalaya. Hereby, I am extending my gratitude to all whose seen and unseen support has made me creating the history by achieving the glorious title and also made me "Apurva – (never seen before, the victorious) from "Purva".

For participants, I would like to say, have faith in yourself, be humble enough to acquire all sorts of knowledge , and have the "go get it ..." attitude as nothing is impossible to achieve, sky is the limit... Best of luck.

*P.S. Dholakia*

WINNER



**Biswanath Patel**  
Co-founder & Director | biswapatel@gmail.com

It is a great privilege to write to the participants of the National Science Seminar (NSS) 2013. It brings back fond memories of the year 2001 when I too was one of you, a participant at the final lap of the competition at Nehru Science Centre, Mumbai. I was filled with ample excitement and tension in equal measure.

I had a deep inclination towards science and mathematics, since my childhood. Never being able to cram stuff easily, I was always drawn to these subjects as they were based on sound logic, formulae and involved minimum rote memorization. So, the National Science Seminar was a natural step and I was encouraged to participate by my parents and schoolteachers, especially my Biology teacher, Mr. Bibekanand Mishra who was also my escort during the competition. I had never imagined in the beginning though, that the journey that I embarked on would lead so far!

The topic of the National Science Seminar-2001 was on "The Biotechnological Revolution", a very nascent field in India at that time. Worldwide, there had been great strides in biotechnology – from genetic engineering, mapping the human genome to developing genetically enhanced strains of food crops. Monsanto had started field trials of Bt-cotton in India. It was thus a very relevant time for a debate on the potential benefits and pitfalls of the new technology. It was very interesting to research for and read about state-of-the-art technologies, debate various points-of-view, and then assimilate and present the conclusions concisely in under 6 minutes – which was then the stipulated length of a seminar presentation.

As a science student, it was my first foray into research and literature review. It taught me a lot about the scientific process – how an idea is hypothesized, developed, tested and then its results debated. By keeping the topic open-ended, the seminar organizers challenged every student to think about both sides of the issue and not get stuck with one viewpoint. I appreciate the fact that most of the seminar topics that I have heard about, including this year's topic "Water Cooperation – Issues and Challenges" are open-ended and lead to an open discussion. The analytical and scientific reasoning that I developed at the end of the process later helped me in my courses, projects and internships during my career which was inevitably steeped in science.

The benefits of participation weren't just limited to development and continuance of an interest in science, though. I belong to a small place called Burla in Western Odisha, considered one of the most underdeveloped regions in a poor state of India. The NSS was the first major country-level competition that I took part in. Though I was good at academics and topped my class in school, I had never had the chance to prove my mettle at a bigger stage. The reach of NSS even at that time was astounding – by having so many levels of competition, down to the block level, it was ensured that every willing student was given a chance. The NSS gave me immense confidence and self-belief

about the fact that education is the biggest leveller and I could compete with the best in the country. The final stage held at Mumbai was especially a great learning experience. I met and interacted with the best and the brightest students from across the country. In those days, the Internet wasn't as ubiquitous as it is today and it was indeed difficult to interact across geographies – the NSS helped bridge those distances. For quite a few of us, it was our first pan-Indian competition, so it was interesting to talk to so many students from different backgrounds, yet a common cause.

The feeling after winning the competition was of course beyond words. Being declared the best in India for the first time gave me a boost in self-confidence that shaped my career. I was presented the trophy by Dr. Ashok Mishra, the Director of IIT Bombay, and as luck would have it, IIT Bombay later became my alma mater with Dr. Mishra still the Director in his second stint at the institute.

As I mentioned, science and mathematics have remained my calling in life till today. I cleared IIT JEE 2005 and decided to pursue Computer Science and Engineering at IIT Bombay. During my undergrad, I explored research opportunities through internships at two prestigious universities – the Max Planck Institute of Biological Cybernetics, Tubingen, Germany and the National Institute for Computers and Automation, Sophia-Antipolis, France. After graduation, I worked for 3 years at Nomura, an investment bank, in Mumbai and New York. I was a quantitative analyst and later an equities trader, and we used statistical techniques, mathematical modelling and computer algorithms to design and execute trading strategies based on real-time market data.

Wanting to make a bigger impact using technology, I founded and am currently running my own start-up <http://buyt.in> with a few colleagues from Nomura. We are using technology to simplify online shopping in India. With a burgeoning young population, increasing internet penetration and steady growth in economic standards, e-commerce is the next big thing. However, a plethora of websites and bombarding of information has made finding the best product or deal, a complicated task. We aim to become a one-stop shop for e-commerce where we aggregate and curate information about products, deals, reviews, etc and provide a simple search interface so that the user can quickly and easily find anything that is available online, at the best price. What India needs today is technology solutions to a lot of problems, and we aim to take a step in that direction – by becoming the Google of e-commerce.

I hope you guys are motivated by my journey. Having reached this far, you have already proven that you have a scientific bent of mind and a dedication towards science. I hope the experience with NSS 2013 propels that dedication further, so that you go ahead, pursue meaningful careers in science and research. The biggest takeaway from a competition like this is that science had always assisted humanity and continues to be a great tool to solve most problems. All the countries in history that have been able to develop, gain power and rise above others, be it England or Europe in general during the Industrial Revolution, Germany in the post-World War II years, the "Asian Tigers" (South Korea, Taiwan, Singapore, Hong Kong) in the second half of the 20th century, or the United States currently, have done so on the back of science and technology. If you put your minds to it, one day, you can definitely contribute back to the country by tackling some of the multifarious problems that plague India, through the use of technology.

I wish all of you all the best for the competition and for your future. I would like to reiterate the slogan coined by our former Prime Minister Atal Behari Vajpayee, "Jai Jawan, Jai Kisan, Jai Vigyan".

Jai Hind.

*Biswanath Patel*



**Gunjan Jhunjunwala**

Bangalore | [jhunjunwala.gunjan@gmail.com](mailto:jhunjunwala.gunjan@gmail.com)

WINNER



My career so far : I completed economics honors, from Shri Ram college of commerce, Delhi. Worked with Google for 3 years and then did MBA from ISB, Hyderabad. Post that, worked with Airtel as a Young Management Leader for 1.3 years and now launching a startup.

Message on how the seminar has helped me : It has helped me tremendously - from 11th standard to getting admission to my dream MBA college, ISB Hyderabad. For example: I missed my 11th standard admission season deadlines in Pine Mount School, Shillong (one of the premier schools there). Solely, because of the trophy, the principal considered me as a special case and said "you are welcome with open arms" and I was admitted. I owe a lot to this competition!

Regards,

Gunjan



**Devangana Kalita**  
Assam | devangana.kalita@gmail.com

WINNER



## The National Science Seminar was an incredible experience for me and I will always cherish it.

Over a period of 3-4 days, I had so many enriching conversations and exchanges, and forged many friendships from across the country. I did not go on to pursue science in my graduation and post-graduation, even though I continue to engage in scientific debates. The NSS experience in retrospect, was one of the platforms from which my interest for what I am doing today arose. I am an activist working on issues of social change. My most recent association has been in solidarity with the struggle of the Dongria Kond tribals in Niyamgiri Orissa against the horrific and corrupt mining corporation of Vedanta Plc.

My NSS presentation theme was about science and its potential for social change. In my activist work, I often encounter 'science' -- be it debates about policy introducing Genetically Modified crops or nutrition or community participation in ecological conversation or utilities of massive dams or nuclear power or HIV vaccines or illegal pharmaceutical testings or climate change. Science, therefore is not neutral, its highly political and has an impact on people's lives across the world. The unfortunate thing today is that science is often constructed in public discourse as monolithic and the so-called legitimacy of science is used to bring in policies and projects that have devastating impacts on the lives of the marginalised. Scientists today are often paid my huge multinational corporations to produce dubious research for legitimising their vested interests. As scientists, I hope the participants of NSS will not just stay cocooned in their science labs, but make dedicated and concentrated efforts to contribute to the fight for justice and equality in the world, through the knowledge they have been privileged to gather. It is important that scientists work in the labs, as well as with people, to understand the real impact and influence of their work. Activist scientific research in collaboration and interaction with marginalised people is a crucial need in the world today and a sincere hope of mine.

I am currently pursuing a second Masters in Modern History from Jawaharlal Nehru University (JNU) in Delhi. I have an MA in Gender and Development from the Institute of Development Studies, Sussex University England and a BA (Hon) in English Literature from Miranda House College, University of Delhi. I studied Science till my Class 12th. I also work part-time as a Research Assistant for University of Sussex on a project called "Food Riots and Food Rights: A Moral and Political Economy of Accountability for Hunger".

Warm Regards

Devangana

proud  
winner  
2012

# Winner National Science Seminar 2012

## Topic: Mathematics in India: Past, Present & Future

Urbi Datta  
Shishu Bihar H.S. School  
Agartala, Tripura



# Best deliberation 2012

## INTRODUCTION:-

Mathematics is "incapable of being restricted within assigned boundaries or being reduced to definitions of permanent validity, as the consciousness of life, which seems to slumber in each monad, in every atom of matter, in each leaf and bud cell". The famous Bertrand Russell said that it is "the subject in which we never know what we are talking about nor whether what we are saying is true". And mathematician is, said Charles Darwin, a "blind man in a dark room looking for a black cat which isn't there". Be it Aristotle's "science of quantity" or August Comte's "science of indirect measurement", mathematics indeed is one of the essential emanations of the human spirit, a thing to be valued in and for itself like art or poetry. For me, logic is maths and maths is my passion. From the past to present and hopefully the future, Indians had expertise in several field of mathematics and its applications. MATHEMATICS has played a significant role in the development of Indian culture for millennia. In fact everything in the world do happens mathematically. By Laplace, "The idea of expressing all quantities by nine figures whereby is imparted to them both an absolute value and one by position is so simple that this very simplicity is the reason for our not being sufficiently aware how much admiration it deserves." And once we violate this very logic of mathematics, we invite disarray in every single sphere of life.

## PRE-VEDIC AND VEDIC ERA IN INDIAN MATHEMATICS:-

The farthest possible past of Indian mathematics can be traced back to the Pre-Vedic period of around 3000B.C and Vedic period of around 2500-1000B.C where excavations at Harappa, Mohenjo-Daro and other sites of INDUS VALLEY CIVILIZATION threw light on the

evidence of use of "practical mathematics" like the manufacturing of bricks whose dimensions were in the proportion of 4:2:1, construction of buildings with decimal measurements, usage of cone and cylinder shaped potteries, thus, demonstrating the knowledge of basic geometry. In the Baudhayana Sulbha Sutra, it is mentioned that the domestic fire-altars of the Vedic Era required to have a square base and be constituted of five layers of bricks with 21 bricks in each layer. The Baudhayana Sulba Sutra, Apastamba Sulba Sutra and Katyayana Sulbha Sutra had mentioned about the Pythagoras theorem and have given examples of simple Pythagorean triples e.g. (3,4,5), (5,12,13), (8,15,17), (7,24,25), (12,35,37). They too introduced the concept of irrational numbers, decimal numbers that are non-repetitive or non-recursive. For example, the square root of 2 is one such number. Baudhayana gives the formula for the square root of two as:-

$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{4 \cdot 3} - \frac{1}{(3 \times 4 \times 34)} = 1.4142156$ . The value is accurate up to five decimal places, the true value being 1.41421297. Our Indian mahamanishis were also able to keep the record of time by using sundials which we





still preserve today in places like Delhi and Jaipur. One among these famous marvels is situated in Delhi, namely Jantar Mantar. The primary purpose of the observatory was to compile astronomical tables, and to predict the times and movements of the sun, moon and planets. A problem like “squaring the circle and circling the square” was too faced by the ancient Vedic mathematicians. However, it was later solved by Aryabhata in the Classical Era. The discussion was ultimately halted in the determination of the value of “pi”. Archimedes proved the value of “pi” to be between  $22/7$  and  $223/71$ . But Aryabhata mentioned the value of “pi” also to be  $6282/20000$ .

### CLASSICAL ERA OF INDIAN MATHEMATICS:-

With Aryabhata in 476 AD the Classical Era of Indian mathematics begins. The great mathematician Aryabhata in calculating a value of pi to 5 significant figures, used the word ‘sanna’ (approaching or approximation), to mean that not only is this an approximation but that the value is incommensurable (or irrational) in his book named ‘Aryabhatia’. He also defined certain trigonometric functions like sine which he mentioned as ‘jya’, cosine as ‘kojya’ and inverse sine as ‘otkram jya’. One of Aryabhata’s discoveries was a method for solving linear equations of the form  $ax + by = c$  which he called as the Kuttaka (or pulveriser) method. Here a, b, and c are whole numbers, and we seeking values of x and y in whole numbers satisfying the above equation. Bhaskaracharya later in his book titled ‘Lilavati’, refined the Kuttaka method of solving linear equation with two variables by Aryabhata. Varahamihir too contributed a lot by adding formulae relating sine and cosine as  $\sin^2x + \cos^2x = 1$ ,  $\sin x = \cos(90-x)$ , etc. Brahmagupta worked a lot in circles, cyclic quadrilaterals and tangents. In 7th century A.D, Brahmagupta gave his famous theorem on cyclic quadrilateral which states that “if a cyclic quadrilateral has diagonals that are perpendicular

to each other then the perpendicular line drawn from the point of intersection of the diagonals to any side of the quadrilateral bisects the opposite sides”. He too introduced his formula of finding the area of a cyclic quadrilateral, in which the mentioned  $AREA = \{(s-a)(s-b)(s-c)(s-d)\}$ . Here, a,b,c,d are the sides of the cyclic quadrilateral respectively, and s being the semi perimeter i.e.  $\{(a+b+c+d)/2\}$  of the quadrilateral. Famous mathematician Sreedharacharya in around 870 A.D gave the formula for finding the roots of the Quadratic Equation in the form of  $ax^2+bx+c=0$  where  $a \neq 0$  as  $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ .

### MODERN ERA OF INDIAN MATHEMATICS:-

With Ramanujan as the pioneer the Modern age of Indian mathematics paves its way. Srinivasa Ramanujan (1887- 1920) though not recognised early, was a genius that India and mathematics can boast of in all times to come. The mathematical genius created history in the fields of approximation to pi, highly composite numbers, number theory, infinite series, Bernoulli’s no, hyper geometric series, partition functions etc and we are also much acquainted with Ramanujan’s number 1729 that has its own specialities. It is the smallest number expressible as the sum of two cubes in two different ways:  $1729 = 13^3 + 2^3 = 9^3 + 10^3$ . The Shanmugha Arts, Science, Technology & Research Academy (SASTRA), based in the state of Tamil Nadu in Southern India, has instituted the SASTRA Ramanujan Prize of \$10,000 to be given annually to a mathematician not exceeding the age of 32 for outstanding contributions in an area of mathematics influenced by Ramanujan. Today many works have also been started focusing Ramanujan’s ‘lost notebook’. Many scientists have commented that Ramanujan’s results opened up vistas for further researches not only in mathematics but in other disciplines also such as physics, computer applications and statistics. Indian Genii, like Harishchandra, R. Balasubhmanium, Sujata Ramdorai and Manjul Bhargava has also added a lot to the field of mathematics. At present institutes like ISI (Indian Statistical Institute), CMI (Chennai Mathematical Institute), HRI (Harishchandra Research Institute), TIFR (Tata Institute of Fundamental Research), The

Mathematics Department of Madras University, now known as the Ramanujan Institute of Mathematics, Allahabad, Agra, Annamalai University and Andhra University, Banaras Hindu University and the Central College of the Mysore University are nurturing talented mathematicians and are having some good mathematical research works too. Students from top nurtured institutions like IISCs, IITs in India under the guidance of their professors have contributed much to applied mathematical aspects in fluid dynamics. At very present, Fuzzy mathematics are being applied mostly in computer games, time-complex computations, subway journeys, elevators, washing machines, microwave, ATM machines, traffic light controllers etc. Many works are also going on fuzzy mathematics in Tripura under the guidance of many experienced faculties. The Department of Science and Technology, New Delhi, has begun a National Mathematical Sciences Initiative; a mathematical biology group has also been formed to work in areas of neuroscience, proteomics and genomics, and of mechanics applied to biological systems. Medicine, from the simplest physiological principles of haemodynamics to the most well developed magnetic resonance dependent imaging machineries, is all about mathematics. ISRO (Indian Space Research Organization), being the pioneer in space research in India has been contributing a lot in the field of mathematical models used in space since 1969 till today. This organization’s main aim is to develop space technologies and its application to various tasks of national and international interest. It has successfully designed two major satellite systems, namely the Indian National Satellites (INSAT) for communication services and the Indian Remote Sensing (IRS) satellites for management of natural resources. It has also developed various launch vehicles, like the Polar Satellite Launch Vehicle (PSLV), the Geosynchronous Satellite Launch Vehicle (GSLV), etc. for launching satellites. In other words, ISRO is opening up the wide horizon of application of maths in Space Research. Besides, DRDO (Defence Research and Development Organisation), is highly concentrating on the mathematical applications to improve our nation’s defence. They are carrying out research in several fields like Robotics, designing hard-to-break encryption algorithms, making UAVs

(unmanned aerial vehicle), architecting remotely controlled vehicles etc. and contributing plethora to our traditionally bright mathematical backbone. Very recently in October 2006 in the National Institute of Advanced Studies (NIAS), Bangalore, a workshop entitled ‘Perspectives and Future Prospects in Higher Mathematics’, was attended by prominent mathematicians of the country as well as other distinguished scientists. Besides this, most of the top ranked institutions in India are actively hosting, sponsoring and participating in different national and international level research based seminars and workshops related to the enhancement of mathematics and its applications happening every now and then.

### CONCLUSION:-

The mathematics which had began in the Pre-Vedic Period in India have occupied the biome of our life in a way that today we have maths from grocery shops to banking, in nature, like hexagonal bee hives to contrasting man made semi octagonal Hawa Mahal windows and lots more. In order to make India self-sufficient in food, clothes and defence, mathematical researches are on speedy progress. Basing on the active research in mathematics in present India, it can be told that future of Indian mathematics is definitely bright be it the digital speech processing programmes for robots or our daily text maths. So it can be concluded with the celebrated English Mathematician James Joseph Sylvester that “Mathematics is not a book confined within a cover and bound between brazen clasps. It is not a mine, whose treasures may take long to reduce into possession. It is not a soil, whose fertility can be exhausted by the yield of successive harvest. It is not a continent or an ocean whose area can be mapped out and its contour defined. It is limitless, as infinite as the worlds which are forever crowding in and multiplying upon the astronomer’s gaze”.

**Miss Urbi Datta**  
Class-X  
Shishu Bihar H. S. School  
Agartala, West Tripura.

# Topics of NSS in the past

Following is the list of various important topics on which the National Science Seminar was held from the year of inception.

1982	Space and Mankind
1983	Communication : Today and Tomorrow
1984	Environment and Human Survival
1985	We and the Ocean
1986	Green Revolution and Our Future
1987	Pollute and Perish : Conserve and Flourish
1988	Information Revolution
1989	Atomic Energy : Potentialities and Hazards
1990	Natural Disasters : Man - Slave or Master
1991	Origin of Life
1992	Tomorrow's Habitat
1993	Are We Alone in the Universe ?
1994	Population : A Resource or a Burden ?
1995	Resources from the Earth
1996	Genetic Manipulation : Scope, Potential and Impact
1997	Recycling : A Step Towards Conservation
1998	50 Years of Science & Technology in Independent India : Aspirations and Achievement
1999	Science & Technology in the New Millennium : Prospects & Problems
2000	Health for All : Vision and Reality
2001	Biotechnological Revolution : Benefits and Concerns
2002	Remote Sensing Applications for National Development : Potential & Impediments
2003	Powered Flight : A Century of Innovation & the Future of Aviation
2004	Science Awareness : Needs & Prospects
2005	A Century of Physics : Achievements & Challenges
2006	Conservation of Biodiversity : Prospects & Concerns
2007	Global Climate Change and Its Impact
2008	Water Crisis on Earth : Problems and Remedies
2009	Chandrayaan : Promises & Concerns
2010	India & World Science : Are We There?
2011	Chemistry For Human Welfare : Promises and Concerns
2012	Mathematics in India : Past, Present & Future

# Past Winners

Winners of National Science Seminar since 1982

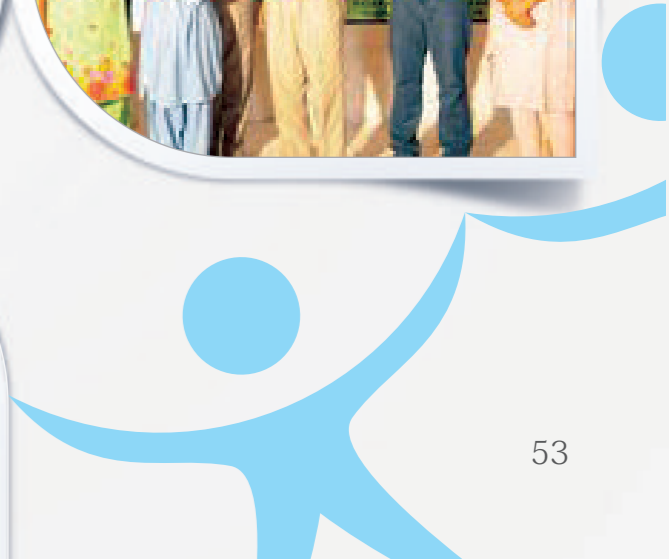
YEAR	NAME	SCHOOL	STATE
1982	Shri Ashish Khosla	St. Luke High School, Solan	HIMACHAL PRADESH
	Ms. Sumita Trivedi	La Martiniere School for Girls, Kolkata	WEST BENGAL
1984	Savitha Murthy	Women's Peace League H. School, Bangalore	KARNATAKA
1985	Kum. Elizabeth Joseph	Mount Fort School Kansbahal	ORISSA
1986	Kumari Sucharita Hota	St. Joseph's Con. H. School, Sambalpur	ORISSA
1987	Kumari Sudipa Banerjee	Jodhpur Park Girls' H. School, Kolkata	WEST BENGAL
1988	Shri Abhinav Taneja	Mt. Fort School, Sundergarh	ORISSA
1989	Shri M. Manoj	K. R. High School, Cannanore	KERALA
1990	Kumari B. P. Divya	Women's Peace League, Bangalore	KARNATAKA
	Shri Rituparna Goswami	Michael's High School, Dighaghat	BIHAR
1991	Shri Jasmeet Singh Sahni	Govt. Model Sr. Sec. School	CHANDIGARH
1992	Shri Maninder Jit Singh	Guru Nanak Public School, Ludhiana	PUNJAB
1993	Kumari Sharon Kuruvilla	G. B. English High School, Kottayam	KERALA
1994	Kumari Shilpa Sharma	St. John High School, Tuensang	NAGALAND
	Kumari Jayanti	Prabhat Tara G.M. School, Muzaffarpur	BIHAR
1995	Kumari Chari D. Nathamuni	S.R. Girls' High School, Sevasadan	MAHARASHTRA
1996	Kumari Suchismita Deb	Holy Cross School, Silchar	ASSAM
1997	Kumari Anu Singla	St. Joseph's Convent School, Bathinda	PUNJAB
1998	Shri Brajesh Ranjan	Ramakrishna Mission Vidhyapith, Deoghar	BIHAR
1999	Kumari Anupama Kondayya	Saraswati Vidyalaya, Nagpur	MAHARASHTRA
2000	Kumari Purva S. Dholakia	Matruchhaya Kanya Vidyalaya, Bhuj	GUJARAT
2001	Shri Biswanath patel	St. Joseph's convent H. School, Sambalpur	ORISSA
2002	Ms. Gunjan Jhunjhunwala	St. Mary's Hr. Sec. School, Shillong	MEGHALAYA
2003	Dharav Sinh M, Solanki	Institute of Our Lady of Fatima, Moti Daman	DAMAN & DIU
2004	Devangana Kalita	Little Flower School, Dibrugarh	ASSAM
2005	Ms. Anwasha Dash	St. Anne's Convent School, Sonepur	ORISSA
2006	Nishant Prabhakar	Ramkrishna Mission Vidyapith, Deoghar	JHARKHAND
2007	Subhajit Dasgupta	Ramkrishna Mission Vidyapith, Deoghar	JHARKHAND
2008	Vikram Aditya	Ramkrishna Mission Vidyapith, Deoghar	JHARKHAND
2009	Kum. Sonam Lhamu Monpa	Ramakrishna Sarada Mission Girls' School, Khonsa	ARUNACHAL PRADESH
2010	Sh. Satyesh Mundra	St. Francis School, Deoghar	JHARKHAND
2011	Sh. Ganeshwar. S	Sri Jayendra Golden Jubilee School, Tirunelveli	TAMILNADU
2012	Miss Urbi Datta	Shishu Bihar H.S. Schoo, Agartala	TRIPURA

# Participants of National Science Seminar 2013



# Glimpses of State Level Science Seminars

# 2013





# Glimpses of State Level Science Seminars

# 2013



# Objectives and Awards

## STATE SCIENCE SEMINAR-2013 AT A GLANCE

Places where State Seminar was held with number of participants



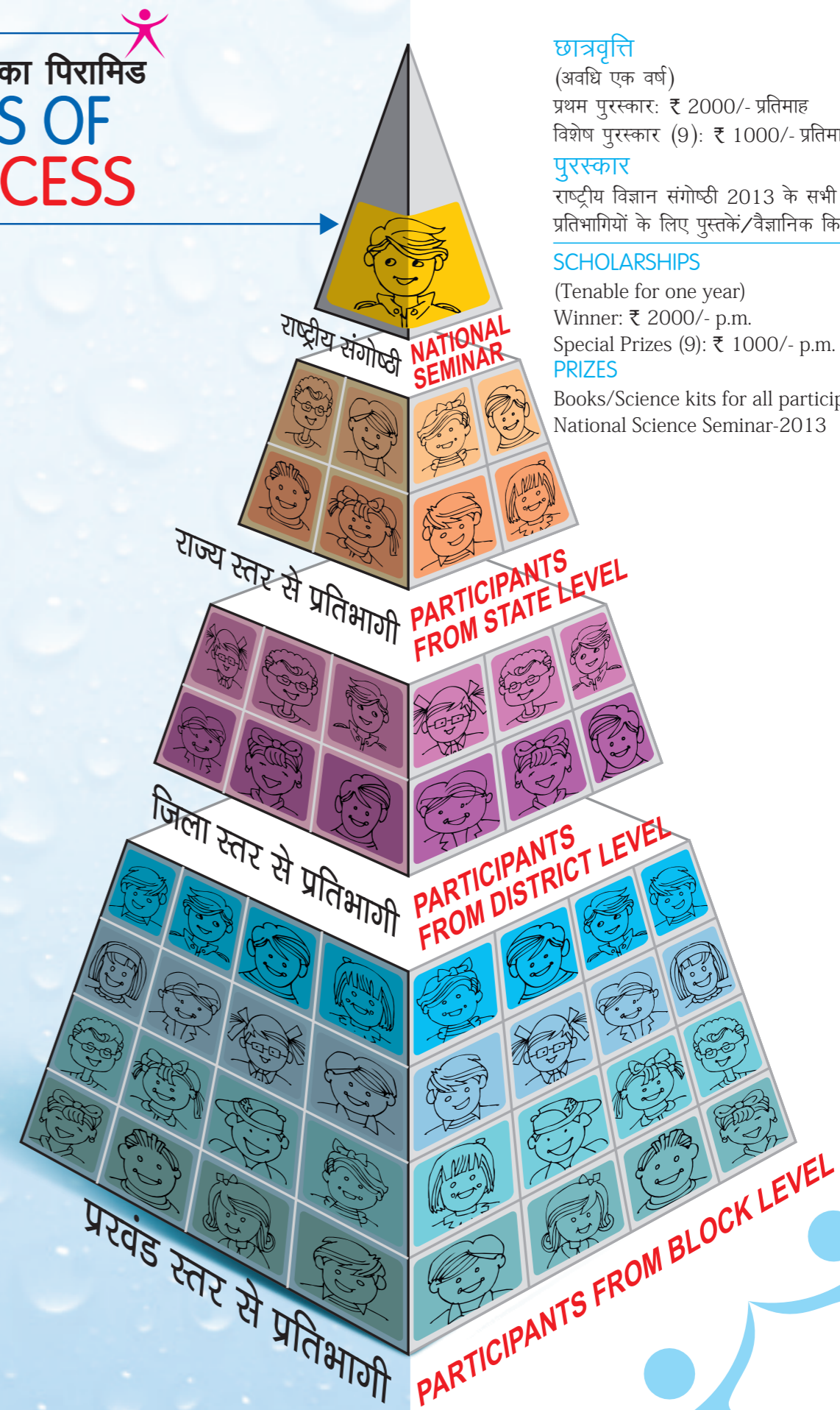
### उद्देश्य

- विद्यार्थियों में वैज्ञानिक खोज के संबंध में रचनात्मक एवं विश्लेषणात्मक प्रवृत्ति जागृत करना।
- उभरते वैज्ञानिकों को विचारों के आदान-प्रदान हेतु मंच उपलब्ध कराना।
- देश भर के विद्यार्थियों में राष्ट्रीय एकता की भावना विकसित करना।

### OBJECTIVES

- To inculcate in the minds of young students a spirit of scientific enquiry and analytical thinking.
- To provide a platform to the budding scientists for exchanging ideas.
- To nurture a feeling of national integration among young talents from every corner of the country.

## सफलता का पिरामिड STEPS OF SUCCESS



### छात्रवृत्ति

(अवधि एक वर्ष)

प्रथम पुरस्कार: ₹ 2000/- प्रतिमाह

विशेष पुरस्कार (9): ₹ 1000/- प्रतिमाह

### पुरस्कार

राष्ट्रीय विज्ञान संगोष्ठी 2013 के सभी प्रतिभागियों के लिए पुस्तकें/वैज्ञानिक किट आदि।

### SCHOLARSHIPS

(Tenable for one year)

Winner: ₹ 2000/- p.m.

Special Prizes (9): ₹ 1000/- p.m.

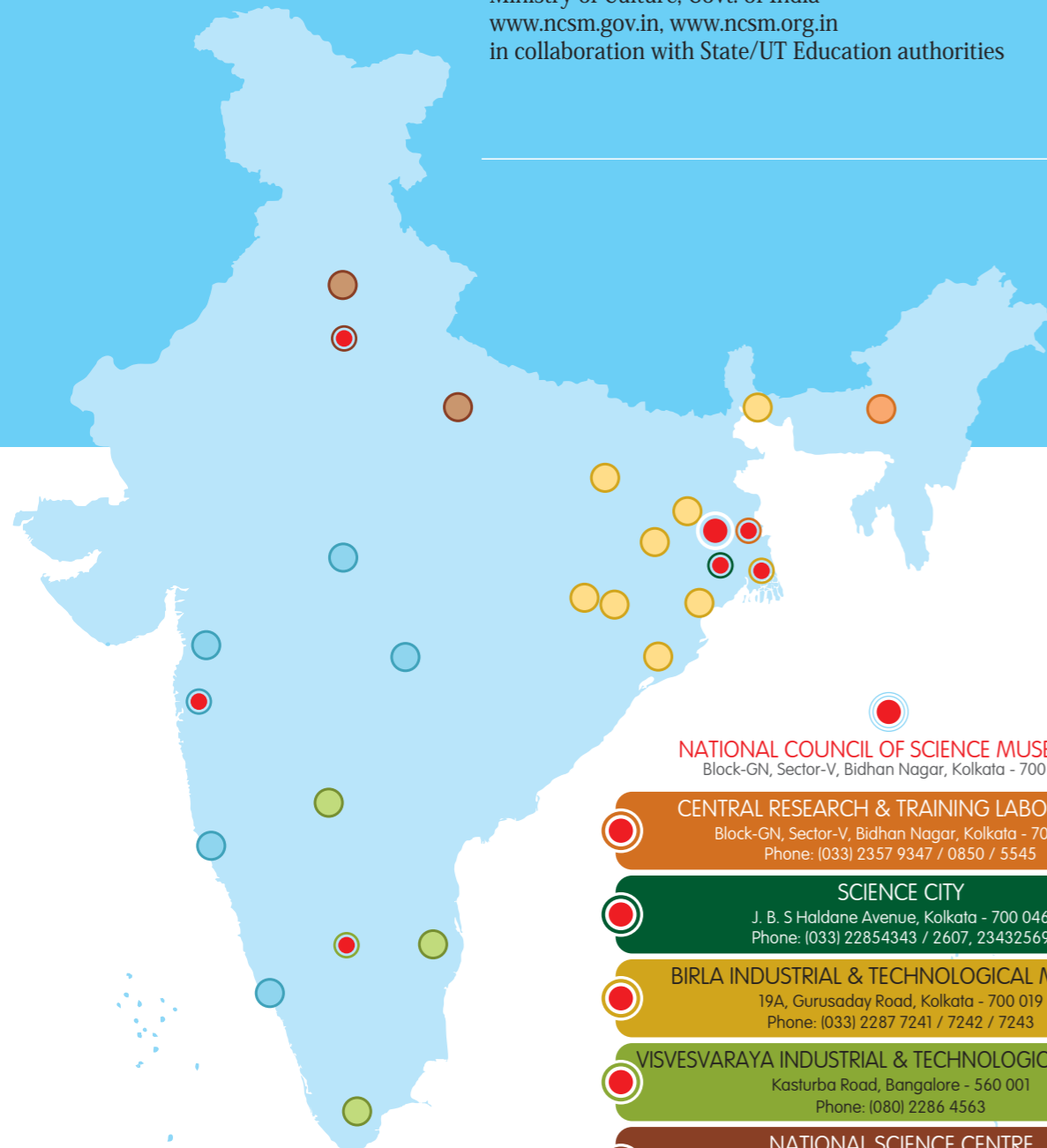
### PRIZES

Books/Science kits for all participants of National Science Seminar-2013

# NCSM Nationwide

## National Council of Science Museums

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in collaboration with State/UT Education authorities



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Bardhaman

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Tirupati

District Science Centre  
Tirunelveli

District Science Centre  
Gulbarga

### National Science Centre

Kurukshetra Panorama & Science Centre  
Kurukshetra

Regional Science City  
Lucknow

### Nehru Science Centre

Regional Science Centre & Planetarium  
Calicut

Goa Science Centre & Planetarium  
Panaji

Regional Science Centre  
Bhopal

District Science Centre & Planetarium  
Dharampur

Raman Science Centre & Planetarium  
Nagpur



# Collaboration

STATE SCIENCE SEMINAR-2013

Organised by NATIONAL COUNCIL OF SCIENCE MUSEUMS in collaboration with:

## EAST ZONE

- Directorate of Secondary Education  
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- Directorate of Education (S)  
Govt. of Manipur
- Directorate of Education  
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- Directorate of Higher & Technical Education  
Govt. of Meghalaya
- State Council of Educational Research & Training  
Govt. of Bihar
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Govt. of Tripura
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Govt. of Mizoram
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Govt. of Odisha

- Directorate of Human Resource Development  
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## WEST ZONE

- State Council of Educational Research & Training  
Govt. of Chhattisgarh
- Department of Science & Technology  
Dadra & Nagar Haveli Administration
- Department of Science & Technology  
Administration of Daman and Diu
- Gujarat Council on Science and Technology  
Govt. of Gujarat
- State Institute of Science Education  
Govt. of Maharashtra
- State Council of Educational Research & Training  
Govt. of Goa
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- Director of Higher Education] Chandigarh Administration  
Govt. of U.T. Chandigarh

- State Council of Educational Research & Training  
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## SOUTH ZONE

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- Department of Education  
UT of Lakshadweep
- State Council of Educational Research & Training  
Govt. of Andhra Pradesh
- Department of State Educational Research & Training  
Govt. of Karnataka
- Directorate of School Education  
Govt. of Tamil Nadu
- Directorate of Public Instruction  
Govt. of Kerala

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- 8) Ms. Sharon Kuruvilla NSS Winner 1993
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- 10) Ms. Anupama Kondayya NSS Winner 1999
- 11) Ms. Purva S. Dholakia NSS Winner 2000
- 12) Ms. Biswanath Patel NSS Winner 2001
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- 15) **Mr. Suresh Goklaney**, Executive Vice Chairman, Eureka Forbes Ltd
- 16) **Mr. R. K. Dubey**, CMD, Canara Bank for their benevolent financial support

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ಆನ್‌ಲೈನ್ ಮೂಲಕ ಸಂಭವಿಸುತ್ತದೆ

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