



# ENVIRONNEWS

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## Dr. Girish Sahni – New DG CSIR

**D**r. Girish Sahni, a renowned Indian Scientist and Director of CSIR-Institute of Microbial Technology, Chandigarh has been appointed **Director General of the Council of Scientific and Industrial Research (CSIR)**, which is a premier research and development organization of India.

Born on 2nd March 1956, Dr. Sahni is a PhD from Indian institute of Science (IISc), Bengaluru. His post PhD career included a stint each in University of California, Santa Barbara, CA, USA; Postdoc Trainee 1984-86; Rockefeller University New York, USA; Sr. Research Associate and Adjunct Faculty 1986-88; and Albert Einstein College of Medicine, New York: Sr. Research Associate 1987-91, before he joined CSIR-IMTECH in 1991. He became Director of the Institute in 2005.

Dr. Sahni, having specialization in Protein Engineering, Molecular Biology, and Biotechnology, has contributed significantly in the area of protein cardiovascular drugs especially 'Clot Busters' and their mode of action in the human body. The team led by him is responsible for producing technology for India's first Indigenous Clot Buster Drug, natural streptokinase.

He is Fellow, Indian National Science Academy, New Delhi; Indian Academy of Science, Bengaluru, and NASI, Allahabad; Fellow, Association of Microbiologists of India; and Member, Guha Research Foundation.

Amongst many awards he has received for his contributions, the most important ones are: National Biotechnology Product Development Award 2002, CSIR Technology Shield 2001-2002, The Vasvik Industrial Award 2000, Ranbaxy Award in Pharmaceutical Sciences 2003, Vigyan Rattan Award 2014, Shri Om Prakash Bhasin Award 2013, and CSIR Technology Award for Business Development and Technology Marketing 2014.

**Dr. Sahni is a Patron Member of International Society of Environmental Botanists, Lucknow (ISEB).**



Members of ISEB are requested to immediately intimate any change in their contact address including postal, email, fax, and telephone to ISEB office. All correspondence should be addressed to: The Secretary, International Society of Environmental Botanists, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow 226001, India. Tel: +91-522-2297821, E-mail: [isebnbrilko@gmail.com](mailto:isebnbrilko@gmail.com)/[isebmail@gmail.com](mailto:isebmail@gmail.com); Website: <http://isebindia.com>

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## LETTERS

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The electronic database of Indian flora as developed by the Botanical Survey of India (BSI) is greatly appreciated (India's first e-flora). This will not only help in the process of popularizing plants among the general public, students and kids; but, would also contribute significantly in making people aware of the need for successful plant conservation. The electronic database generation also has far reaching impacts as this will be available to researchers and plant enthusiasts across the nation and overseas. Future cooperation and collaboration with botanical researchers, academics, universities, research institutes and botanical gardens across the nation and the globe will be well facilitated through such initiatives. Furthermore, quick check and references would be possible for doubtful identification of plant species in legal cases by the BSI, the customs and forest departments and the judiciary for preventing illegal trade on vulnerable ornamental and medicinal plant species. Commercialization of several potential plant species could also be explored by referring to the database and the current status of the plant resources of the megabiodiverse country could be estimated by the simple click of the mouse without spending hours in the library and botanical archives. In short, the e-flora opens up new opportunity for plant research and conservation in the nation; and should be appropriately funded and supported in future to develop into a premier global resource showcasing plants from the entire Indian subcontinent representing divergent plant habitats and ecosystems.

**Saikat Kumar Basu**  
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I leave for Australia tomorrow (20 September) and will return on 5th or so of October.

This time Dr. BalKrishna, my colleague will be with me and we will study activities of the Small Tree Research Project on mango being carried out by the Australian scientists at Mareeba. They had visited our 'ultra high density project' of mango at Udumalpet (Tamilnadu) last November or so. We will be collaborating on a joint research project on this subject that includes

many other aspects with the objective of high productivity of mango from trees that are maintained small and the planting density is as high as 700 plants per acre (vs about 70 plants per acre). The collaborative project will be supported by Jain Irrigation and Horticulture Innovation Australia Limited (HIAL) with field and lab studies in Australia and India. The project is in its final stages for consideration by HIAL.

We will after this visit attend the International Mango Symposium being held in Darwin where we will be presenting our work on identification of flowering related genes namely FT that induces flowering, TFL that suppresses flowering and Constans that stimulates expression of FT in Alphonso and Ratna. Another study we carried out is on overcoming alternate bearing by the use of a chemical called Cultar that induces profuse flowering every year. We have studied the mechanism of its action in relation to the flowering related genes of mango. Incidentally what we used to call florigen is a compound (protein encoded by the FT gene) synthesized in leaves and moves to the meristem that converts vegetative buds to reproductive buds. My group in Jalgaon is working on this florigen and related genes in mango, banana, pomegranate, onion and some other tropical fruit crops. We have 5-6 PhD students working on these aspects.

This is what I am doing in Jalgaon. Of course this is just one aspect I am working on. There are several others that I am involved in.

**Dr. P. V. Sane**  
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The recent news across the subcontinent regarding smuggling of several economically important plants (different timber yielding species and several sandalwood species) is alarming. These plants have huge commercial demands in China and other Far Eastern and South-East Asian nations. As a result several international plant and plant products smuggling routes have been opened via the states of Himachal Pradesh, Uttarakhand, Uttar Pradesh, Bihar, West Bengal and North East India that share international boundaries with Nepal, Bhutan, China, Bangladesh and Myanmar. Unless strict monitoring and surveillance is maintained

by the Forest Departments across the Indian states; several of the rare and highly endangered species of the plant resources of the subcontinent may be lost before even we could realize the total potential of the danger. The problem has a much deeply penetrating socio-ecological and anthropogenic challenge that could be fathomed at the surface superficially.

Poor economic opportunity in the remote, rural corners of the subcontinent rich in highly endemic and endangered flora and fauna is the root cause of the problem. The anthropogenic crisis has been left unattended for several decades post independence in these remote, rural pockets; and as a consequence, insurgency, illegal trade and poaching of wildlife and forest resources, non-judicious harvest of medicinal and other economic plants, over exploitation of local resources and heavy dependence of the extremely poor, local, human population on the adjoining forests for their daily sustenance is surely going to have long term, devastating impact on the local biodiversity. While the nation is making rapid development and progress in several realms including high industrial production and year round agricultural productivity, progress in nanotechnology, medicine, pharmaceuticals, biotechnology, information technology and space technology; the forest resources of the nation is undergoing slow but steady degradation. Particularly with new smuggling routes being discovered across several northern, eastern and north eastern states; the challenges for protecting the bioresources (plant resources in particular as they grossly neglected) of the subcontinent is indeed a monumental challenge.

No easy solution or quick fix is available and the problem could not be resolved overnight. The most important and tentative solution will be to address the challenge at its basic root and to deal with the humanitarian crisis lurking in the remote, forest covered rural areas of the nation. Unless, we are successful in generating stable income, minimal education and health care facilities in the remote, rural belts of the nation very little success could be achieved in terms of forest and wildlife conservation. Unless we are able to resolve the socio-ecological crisis

and reach the poorest communities; the challenges of illegal trade and poaching of natural resources is almost impossible to tackle. The huge economic demand will make its push through the system and degrade the bioresources of the nation unless the anthropogenic issues are primarily addressed. Once this is successfully addressed, poaching and smuggling of natural resources could be better and more efficiently handled. Furthermore, stronger coordination will be necessary among the several stakeholders

including various government departments such as central and state forest and environment conservation units, different state police forces, borders security forces, local and border intelligence agencies, local administration, social and political workers and activists, educators, ecologists, local rural communities, indigenous communities, forest inhabitants and fringe dwellers, several non-government organizations; all need to work together on a common platform both for social and economic development as well for forest

protection and conservation. The issue is complex, multi-layered and multi-dynamic in nature. However, if we are sincere enough, it is not impossible to resolve; if comprehensive policies and strategies are successfully adopted and executed efficiently.

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## WELCOME NEW LIFE MEMBERS

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## NEWS FLASH

**Prof. Rana Pratap Singh** Professor, Department. of Environmental Science, former Dean, School for Environmental Sciences, Babasaheb Bhimrao Ambedkar (A Central) University, an a member of the Executive council of ISEB has been nominated as a member Advisory Board of UP State ENVIS Centre of Directorate of Environment UP under the Plan of MoEF, New Delhi, Government of India for Environmental Information System.



**Prof. R.S. Tripathi**, Advisor, ISEB and Editor, EnviroNews, will continue as the Chairman of the Programme Advisory Committee for Ecosystem Research Programme of the Ministry of Environment, Forest & Climate Change for a fresh term of another three years (5 October – 4 October 2018) as per the Office Memorandum of the Ministry dated 30th September 2015.



**Dr. Kamla Kulshreshtha**, Principal Scientist CSIR-NBRI and Executive Councillor of ISEB attended an international conference “Who are we working for” organized by the Bristol-Myers Squibb Foundation at Princeton, New Jersey, U.S.A. during 24 September to 4 October 2015. She represented Hope Initiative Patients Support Network Programme and acted as a panelist for global partners and patients. She also visited New York during her stay in U.S.A.



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## Resurrection Plants and Drought Tolerance

Farah Deeba and Vivek Pandey

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On a global basis, about one-third of potential arable land suffers from inadequate water supply, and the yields of much of the remainder are periodically reduced by drought. The responses at various levels are modulated by the intensity, duration, and rate of progression of imposed drought. Droughts have a wide range of effects on the masses in a developing country like India. The impact of droughts is specifically conspicuous in view of the tropical monsoon character of the country. Rainfall by the south-west monsoon is notorious for its vagaries. Indian agriculture still largely depends upon monsoon rainfall where about two-thirds of the arable land lack irrigation facilities and is termed as rain fed. The effect is manifested in the shortfalls of agricultural production in drought years. History is replete with examples of serious shortfall in cultivated areas and drop in agricultural productivity. It is worth mentioning that the shortfall in agricultural production may be the direct impact of meteorological droughts but the succeeding hydrological and agricultural droughts have a long range and far reaching impact on agriculture. Severe shortage of food-grains had been felt and the country had to resort to import of food-grains to save the poor people from hunger and starvation. However, India has been able to build a buffer stock of food-grains and threat from droughts is not as serious as it used to be before the Green Revolution. It is anticipated that yields from rain-fed farming in some south Asian countries could fall by up to 30% by 2050 (IPCC, 2007).

Under both natural and agricultural conditions, plants are frequently exposed to water stress. The phenomenon of desiccation tolerance is found throughout the microbial, fungal, animal and plant kingdoms. In the plant kingdom, it is mainly seeds and non-tracheophytes, such as mosses, that commonly display tolerance to desiccation. Almost every plant process is affected directly or indirectly by water stress. Water stress may range from moderate, and of short duration, to extremely severe and prolonged drought that strongly influence plant growth and function.

The physiological responses of plants to water stress and their relative importance for crop productivity vary with species, soil type, nutrients and climate. Plants perceive and respond rapidly to alterations (even small) in water status via a series of physiological, cellular, and molecular events developing in parallel. These events can contribute to coping with drought stress, either increasing its ability to avoid damage (avoidance mechanisms) and/or maintaining its metabolic functions under water limiting conditions (tolerance mechanisms). Most seeds are termed 'orthodox' because they can survive dehydration to an air-dry state, whereas a minority is called 'recalcitrant' because they show a marked sensitivity to such severe dehydration. Many mosses, lichens and ferns can survive dehydration of their vegetative organs, whereas this is uncommon in tracheophytes. Although there are no gymnosperms that show vegetative desiccation tolerance, there are several angiosperm families that contain desiccation-tolerant members. These individual species are collectively referred to as 'resurrection plants'. Upon dehydration, resurrection plants shrivel up and fold their leaves until water is available, whereupon these plants revive in a remarkable manner. Plants adapt to drought by a number of physiological and morphological mechanisms. Leaf movements are common adaptive responses to drought stress in plants. One of these movements, leaf rolling is a hydronastic mechanism that reduces light interception, transpiration and leaf dehydration. In desiccation-tolerant plants also, curling or folding are the most obvious response to desiccation stress. The leaves of *Xerophyta humilis* are flat and grass like. Upon dehydration the leaf blades fold in half along the midrib and only the abaxial surfaces are exposed to the light which is thought to serve to reduce light absorbed by the leaf in the desiccated state. In fully hydrated *Craterostigma wilmsii* plants, the leaves are green and expanded. As the plant dries, leaves progressively curl inward and become tightly folded with only the abaxial surfaces of the outer whorl of older leaves

exposed to sunlight. It is thought that a number of morphological modifications associated with dehydration are adaptations of resurrection plants to minimize damage from light (and consequent free radical stress) in the dry tissues. Water loss is minimized by reducing light absorbance through rolled leaves. Immediate responses and slower adaptation responses can be distinguished. One of the first physiological responses is stomatal closure, governed mainly by the plant hormone abscisic acid (ABA). Stomatal closure is modulated by a number of factors, including ion channels, protein kinases and phosphatases, lipid messengers, reactive oxygen species (ROS), and positive and negative transcriptional regulators. This is followed by down regulation of photosynthesis, which also serves to minimize ROS production. Osmoprotectants such as late embryogenesis abundant (LEA) proteins, polyols, proline, sucrose, and other sugars rapidly accumulate in many tissues. Aquaporins play an important role for water redistribution among different tissues and cellular compartments. Functional antioxidant systems are also essential for protection against excessive ROS production under drought. Much slower responses include biochemical alterations in the cell wall and changes in root architecture. However, proliferation of the root system in response to water deficit is often coupled with reduced above-ground plant growth. Signalling events that lead to these responses involve activation of ion channels, Na<sup>+</sup>/H<sup>+</sup> antiporters, Ca<sup>2+</sup>-binding proteins such as calmodulin and calcium-dependent protein kinases, receptor-like kinases, and mitogen activated protein kinases. These early signalling events eventually regulate transcriptional factors and coregulators that govern the global transcriptional re-programming necessary for the execution of the above-mentioned physiological and morphological changes, resulting in adjustment to drought stress.

Several resurrection plant species, including *Myrothamnus flabellifolia*, *Craterostigma plantagineum*, *Craterostigma wilmsii*, *Xerophyta viscosa*, *Xerophyta*



humilis, *Eragrostis nindensis* and *Sporobolus stapfianus*, have been intensively studied with the goal of identifying the mechanisms responsible for their remarkable desiccation tolerance. Desiccation tolerance seems to not necessarily require the presence of novel molecular structures; however, the developmentally triggered re-activation of established pathways and processes seems to be crucial in conferring tolerance. Research on desiccation tolerance has generally been conducted using discipline-specific approaches, focusing exclusively on the physiological, metabolic, molecular, genetic, biochemical or ultrastructural changes that occur in resurrection plants during dehydration and rehydration. We believe that, for tolerance to emerge, these fundamental processes, constituting cellular information regulation, energy metabolism and structural organization, must be integrated through coordinated metabolic and signaling events.

#### Resurrection plants: Overview

Resurrection plants are unique in that they are able to lose more than 95 % of the water in vegetative tissues, fall into anabiosis for long periods, and regain full functions after rehydration. Vegetative desiccation tolerance is more common in lower plants such as bryophytes, rare in pteridophytes and angiosperms, and absent in gymnosperms. It has been estimated that the total number of desiccation-tolerant

plants is at least c. 1,300 (1,000 pteridophytes and 300 angiosperm plants). While the mechanisms of desiccation tolerance in bryophytes are mainly related to cellular repair, the more complex tissues in angiosperms require mechanisms that prevent desiccation-induced cell- and tissue damage in the first place.

The small group of angiosperm resurrection plants displays remarkable habitat and geographic diversity throughout both the northern and the southern hemispheres. Resurrection plants can be found among both monocots and dicots. Most occur in dry and desert areas or in more temperate areas with sufficient rain precipitation but periods of drought or/and cold winters (like the European resurrection plants *Haberlea rhodopensis* and *Ramonda serbica*). A resurrection plant, *Lindernia brevidens*, was even discovered in the tropical rainforests of Africa, where humidity is always high. Most of the resurrection species are herbaceous plants.

The resurrection plants are interesting not only because of the desiccation tolerance and as a source for gene discovery but also because they have unique metabolites, some of which have potential uses in biotechnology and medicine. For example, the South African woody resurrection species *Myrothamnus flabellifolia* has long been known for its medicinal properties. Its extracts, rich in

polyphenols and essential oils, are used to treat various disorders, including influenza, kidney diseases, and gingivitis. The predominant polyphenol 3,4,5-tri-O-galloylquinic acid has been shown to inhibit M-MLV and HIV-1 reverse transcriptases. Myconoside, a glycoside abundantly present in extracts of *H. rhodopensis*, can strongly stimulate antioxidant skin defenses and extracellular matrix protein synthesis. Extracts from *H. rhodopensis*, which are also rich in polyphenols, can stimulate the synthesis of elastin in a dose-dependent manner and also possess radioprotective, anticlastogenic, and antioxidant effects on rabbit blood samples exposed to gamma radiation in vitro. These results suggest that the strong medicinal properties of some resurrection plants should be the aim of further extensive experiments which could provide strategies and solutions in combating various human diseases.

Resurrection plants are interesting potential sources for desiccation tolerant genes to be used in crop improvement. Furthermore, using a systems biology approach (transcriptomics, genomics, proteomics, metabolomics) will lead to a significantly improved understanding of the mechanisms associated with plant desiccation tolerance. This is important for improving the application of genetic-engineering approaches in enhancing drought tolerance in valuable economic crop species.

## Garbage to gold: An untapped approach towards sustainability

Garima Dixit<sup>a</sup>, Amit Pal Singh<sup>a</sup>, Amit Kumar<sup>b</sup>, Atul Upadhyay<sup>a</sup>, Rudra Deo Tripathi<sup>a</sup>

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What is waste? Is it really discardable or unused from any point of view? Let's give it a thought "A waste is not waste until it is wasted". The problem of solid waste is worldwide; some countries have managed it while others are trying to cope up with the problem.

#### Problem around the world

Problem of solid waste is very prominent in urban areas. The world is hurtling towards its urban future. The amount of municipal solid waste (MSW), one of the most important by-products of an urban lifestyle, is growing even faster than the rate of urbanization. World cities generate up to 1.3 billion tonnes of solid waste per year. This volume is going to

increase approximately 2.2 billion tonnes by 2025. Globally, solid waste management cost is \$205.4 billion annually and it's going to increase up to \$375.5 billion in 2025. This increase in cost will affect more severely the low income countries (more than 5-fold increases) and lower-middle income countries (more than 4-fold increases).

#### Solid Waste Problem in India

Urban India generates 188,500 tonnes of solid waste per day and 68.8 million tonnes per year. About 20% of this waste is recovered by informal entities (local people) in large cities and this percentage is less in small cities. Remaining 80% of waste reaches to open dump sites and causes

damage to public health deteriorating the environment. These dumpsites are already handling more waste than they can hold in nearly every city and it is hard to find land fill space around urban areas.

**Table 1: Chronologically increasing waste per capita and urban waste**

Year	Per capita waste generated (g/day)	Total urban municipal waste generated (Mt/year)
1971	375	14.9
1981	430	25.1
1991	460	43.5
2000	500	48.8
2010	600	~ 70.2

Source: NPTEL

**Table 2: Typical composition of municipal solid wastes in India**

Components	Mass % range	Moisture % typical	Density % range
Food wastes	6-26	14	50-80
Paper	15-45	34	4-10
Cardboard	3-15	7	4-8
Plastics	2-8	5	1-4
Textiles	0-4	2	6-15
Rubber	0-1	0.5	1-4
Leather	0-2	0.5	8-12
Garden Trimmings	0-20	12	30-80
Wood	1-4	2	15-40
Misc. Org. Sub.	0-5	2	15-40
Glass	4-16	8	1-4
Tin cans	2-8	6	2-4
Non ferrous metals	0-1	1	2-4
Ferrous metals	1-4	2	2-6
Dirt ash bricks	0-10	4	6-12

Source: Ramachandra, 2003

The amount of waste generation is so huge that municipalities struggle to collect the waste and give less importance to disposal. Municipalities do not have sufficient funds for the salaries of the staff. These municipal corporations are ineffective in managing the waste due to various reasons including the lack of political will and limited fund for solid waste management.

#### Solid Waste Problem in Lucknow

Lucknow, a metropolitan city, nestled on the banks of the Gomti River, is flanked by Barabanki District on the east, Unnao on the west, Raebareilly on the south and Sitapur and Hardoi districts on the north, respectively. Lucknow is a major city and capital of Uttar Pradesh State. Its population is of 2.186 million which generates 1365 tonnes of solid waste per day. It has been observed that city disposes the waste within few kilometer distances from the city in open dumping places without following scientific techniques of land filling and without caring about its impact on human health. MSWM is a major problem being faced by municipalities. The problem of waste is not only technical but also occurs due to lack of awareness, political, legal, socio-cultural and environmental factors and paucity of available resources for solid waste management. For The municipalities and NGO's related with municipalities are responsible for collection of segregated waste from door-to-door (DTD) according to MSW Rules, 2000. Sweepers collect the MSW from the roads/streets and carry it to the nearest collection points. Solid waste

produced from individual households is taken to the collection point or deposited on the adjacent roadside from where it is collected when the roads are being swept. Despite this, solid waste is a real problem for the urban environment due to improper management at individual and institutional level.

**Table 3: MSW sources in Lucknow**

Sources of waste	Percentage
Households	42
Restaurants	28
Street sweeping	6.8
Market	8.3
Shops and workshop	7.5
Offices	4.2
Hospitals	1.7
Hotels	1.5

By Rahul Charles Francis, L.P.Singh,  
Earnest Vinay Prakash

#### Solution for the solid waste problem

It is all about garbage; let's start thinking to convert this garbage in gold (money, employment, women empowerment, health and clean environment). How this garbage can be converted in gold? Garbage is a social problem; we need to solve it socially with the help of members of our own society.

#### Around the world:

In ancient cities, wastes were thrown onto unpaved streets and roadways, where they were left to accumulate. The organized waste collection was associated only with state-sponsored events such as parades. Disposal methods were very crude, involving open pits located just outside the city walls. As populations increased, efforts were made to transport waste farther out from the cities. Efforts have been made to cope up with the increasing waste problem around the world.

#### Reduce, Reuse, Recycle

This is the most useful technique in sector of waste management. It involves reduction, reuse or recycling in order to minimize the amount that ends up in landfills. Methods of waste reduction, waste reuse and recycling are the preferred options when managing waste. There are many environmental benefits that can be derived from the use of these methods. They reduce or prevent green house gas emissions, reduce the release of pollutants, conserve resources, save energy and reduce the demand for waste treatment technology and landfill space.

#### Switzerland: Waste Recycling

The Swiss Environment Protection Law stipulates that the producers of waste should bear the cost of solid waste disposal. Waste management is financed through tariffs e.g., unit based pricing system, charging for each bag. This pay-per-bag scheme applies to residual waste. Waste bags for this residual waste can be purchased at large retail stores and are available in different sizes (for example, 17, 35, 60, and 110 liters). The waste bags are picked up at the curbside on a fixed weekday.

#### Germany: Recycling Policy

Waste separation at the household level is a prominent feature of German waste management systems, which are organized on a municipal level. Households separately dispose of paper and cardboard; glass; biodegradable waste; light packaging (plastics, aluminum, and tin); and the residual household waste. Residual waste, organic waste, and paper are collected in designated wheeled bins; packaging materials are collected in yellow bags or in a yellow bin. The waste is picked up at the curbside every week or every two weeks. Glass and sometimes paper have to be brought to community collection sites.

#### The Philippines: A New Solid Waste Management and Recycling Concept

The system contains a managed landfill, a recycling center, and a composting site for green waste at the landfill site. The recycling is done by trained and authorized waste workers (former informal waste pickers) at the well-managed landfill site. The waste workers are allowed to sort the waste before it is compacted and covered in the landfill site. The workers have a storage room for the sorted materials and can sell it in bulk either to intermediaries or directly to the recycling industry. Green waste from markets, parks, and gardens is collected separately and composted. The recycling activity reduces the waste amount in the landfill by up to 20 percent. Diverting the green waste from the landfill site saves another 10 percent of the total waste to be disposed of in the landfill site. Littering of juice wrappers was a major problem in the town. A women's cooperative started to collect these wrappers (mainly at ceremonial places); clean them; and produce bags, hats, covers, and other handy equipment for the national and international market.

#### Bangladesh: Composting in Dhaka

An organization called Waste Concern promote the concept of the 4 Rs—reduce,



reuse, recycle, and recover waste—in urban areas. It is based on the idea that the organic content of Dhaka's household waste, which accounts for more than 70 percent of total waste, can be efficiently converted into valuable compost. This practice reduces disposal costs and prolongs the lifetime of landfill sites. It also reduces the harmful environmental impact of landfill sites, because organic waste is responsible for groundwater contamination and methane gas emissions. When organic waste is turned into compost, the soil in urban areas is improved.

#### **Argentina: Improvement of livelihoods of recuperates**

Various initiatives exist to improve the livelihoods of the waste recuperates. For instance, the White Train I is a child care center that hosts children of waste collectors during the typical working hours (4:00–11:00 p.m.). The center also supports the enrollment of children in school. Though the center was a neighborhood initiative, the municipality now provides the financial support. Another program, project recuperar, is a microcredit system that aims to help migrant waste collector families' access credit and start small businesses or regularize their migratory situation.

#### **Europe: Recycling System for Refrigerators and Cooling Devices**

As refrigerators and other cooling devices pose a serious threat to the environment and the global climate, Switzerland and the European Union introduced a directive that regulates the safe recycling and disposal of cooling devices. Households are obliged to bring old devices back to the shops. All shops selling these devices are ordered to take back old refrigerators for free and must organize their safe recycling and disposal. The cost of such a system is covered by a prepaid recycling fee that is added to the price of the products. This levy must be paid by the purchaser of the device. In 2005, more than 82,500 tons of electronic waste was collected in Switzerland, 75 percent of which could be recycled.

#### **Solid waste management tax in the United Kingdom**

In the United Kingdom, waste management is financed through the council tax, which is raised by local authorities to pay for local services, such as providing police and security, providing support to the elderly and vulnerable, maintaining parks and open spaces, cleaning streets, and collecting and disposing of waste. The tax is based on the property value and is set in an amount to cover the budgeted expenses for the year.

Waste management authorities also receive money from a central grant. Waste collection authorities do not receive any financial compensation from the Packaging Waste Recovery Notes system. Accordingly, it is becoming common to charge for the waste amount that exceeds the volume of the storage receptacle and lies next to the bin.

These are some solid waste management practices followed around the world. Now let us consider what practices are followed in India for the waste management.

#### **Solid waste management in India**

Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep urban centers clean. However, it is among the most poorly rendered services in the basket. The systems applied are unscientific, outdated and inefficient; population coverage is low; and the poor are marginalized. Yet several approaches are being practiced in India for waste disposal.

#### **Integrated Solid Waste Management Approach**

Integrated solid waste management refers to the strategic approach to sustainable management of solid wastes covering all sources and all aspects, such as generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency.

On daily basis we throw a full of dustbin outside our home and also litter here and there on public places. In our buildings or society we have a gardener, a gate keeper; do we have a waste manager? This waste manager can separate the waste, can sell non-biodegradable waste to the manufacturer (for recycle) and convert biodegradable waste to compost, or we can plan for a biogas plant. The increase in community size necessitated a more organized form of waste management to minimize the environmental impacts as the quantity of pollutants exceeded the system's threshold.

#### **Waste-to-Energy Approach**

Waste-to-energy technologies, such as anaerobic digestion, gasification, incineration, pyrolysis, and pelletization, are often pushed by vendors of waste treatment technologies. However, they have yet to be proven under Indian conditions. Two waste-to-energy plants based on refuse-derived fuel were set up in Andhra Pradesh in 2003. Each of those plants produces 6.5 megawatts of power. Some small biomethanation (anaerobic digestion) plants

are working successfully in Andhra Pradesh and in Maharashtra, where methane energy is produced from kitchen waste and green waste.

#### **Best Practices of waste management in India**

Suryapet in Andhra Pradesh, North Dum Dum and New Barrackpore in West Bengal, and Vejalpur in Gujarat are good examples of storage of waste at its source. Through an effective public awareness campaign, including public meetings and student rallies, citizens have been motivated to store the waste at its source in two separate bins for bio-degradable and non-bio-degradable waste. The system is working well.

#### **Solid waste management in Lucknow**

The entire operation of solid waste management (SWM) system is performed under these major categories: collection, segregation & storage, transportation, compost plant and other plants. Lucknow Nagar Nigam has provided several depots for the temporary storage of solid waste, which are scattered throughout the city. These depots are in good condition but waste is scattered toward the road and animals are also found there in search of food. The solid waste is directly collected from the collection points by the collection vehicle to the disposal site. Since the solid waste is collected again from the collection points to the disposal site, it is termed secondary collection. The hauled container, stationary container, manually loaded dumper and mechanically loaded dumper systems are used during secondary collection, transportation and disposal of solid waste.

#### **Major Drawbacks of the SWM Transport System**

Trucks and tractors have open beds. During transport, waste spills from the truck, thereby causing nuisance.

Practiced manual loading of waste without use of protective gears is dangerous to the health of waste workers.

The transport system is not synchronized with the secondary storage system. Problems arise when a transport fleet is modernized, because waste at the secondary storage system is still dumped on the ground. If the secondary storage system is modernized without an adequate fleet of modern vehicles, similar problems arise

#### **Processing of solid waste**

Solid waste is being processed in several ways in Lucknow Municipal Corporation area.



## Composting

Composting is nature's process of recycling decomposed organic materials into a rich soil known as compost. Anything that was once living will decompose. Basically, backyard composting is an acceleration of the same process that occurs in nature. By composting your organic waste you are returning nutrients back into the soil in order for the cycle of life to continue. Finished compost looks like soil—dark brown, crumbly and smells like a forest floor.

Currently, solid waste management system has no facility of composting. In the cattle colony near River Gomti where cattle produce dung has not been collected by the Lucknow Nagar Nigam workers. So, the people are living in unhygienic condition. The population of mosquito, rodents and flies increase to cause several diseases in these areas. Gobar (Dung) also reaches to the river stream on flooding in the rainy season.

## Incineration

According to the EPA, 90% of medical waste is incinerated. Incineration is the controlled burning of the medical waste in a dedicated medical waste incinerator. Among industry folks, these units are often referred to as hospital/medical/infectious waste incinerators (HMIWIs). The waste generally passes through the incinerator on a belt, and because most medical waste can be incinerated, the waste is not sorted or separated prior to treatment. Incineration has the benefit of reducing the volume of the waste, sterilizing the waste, and eliminating

the need for pre-processing the waste before treatment. The resulting incinerated waste can be disposed of in traditional methods, such as by bringing it to a landfill. The downside of incineration is potential pollution from emissions generated during incineration. The EPA has stringent requirements on emissions from medical incinerators. The incineration process can be applied to almost all medical waste types, including pathological waste, and the process reduces the volume of the waste by up to 90%.

The largest concern associated with incineration is air pollution from emissions. The EPA says that at least 20% of medical waste is plastic. The biggest concern is that the incinerator may create toxic compounds. Dioxins and furans can be produced when these plastics burn. Older medical waste incinerators included no pollution control equipment. As new federal and state emission regulations are instituted that have more stringent requirements, medical incinerators are often not being replaced at the end of their service life. Over time, the amount of waste being incinerated will be reduced as other technologies replace on-site incinerators.

This equipment is only used for hospital waste. About 500 Kg waste is incinerated per day in the hospital. Clinic dumps their waste in open dump which is collected by Lucknow Nagar Nigam.

## Recycling

Recyclable waste paper, card board, plastics, polythene, glass, metals, rubber, leather and textiles etc. are collected and

segregated by waste pickers and collectors. This collected wastes are daily transferred to dealers who are living in slums near the residence of waste workers. The waste collector and waste pickers are generally illiterate and work without safety equipment such as boots and gloves although they contribute to the improvement of environment.

## Energy Generation

Energy-from-Waste (EfW or waste-to-energy) facilities offer a safe, technologically advanced means of waste disposal while also generating clean, renewable energy, reducing greenhouse gas emissions and supporting recycling through the recovery of metals. On Sitapur Road an electricity generation plant has been established. But it started without any proper management plan in place. So it stopped before electricity generation and without giving any output. At present there is no electricity generation from solid waste.

## Conclusion

Solid waste is a curse to modern society. It is a global problem but developing countries are facing this problem more seriously as they do not have any integrated approach towards solid waste management. In this scenario we can learn from the countries having proper system for solid waste management. The most effective passage goes through three R's: Reduce, Reuse and Recycle. Solid waste may prove a source of livelihood if we could apply few of the above mentioned proposals such as energy generation.

## Economy, progressive culture and support better environmental protection and conservation initiatives for the Indian subcontinent

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The Indian subcontinent region is inter-connected through its spectacular geology and geography, majestic flora and fauna, dynamic socio-cultural diversity and unique history and heritage. The classical definition of the Indian subcontinent has been contested by several scholars over time and several definitions have been provided over the ages from geographical, geological, biological, socio-cultural, anthropological, historical, economical and geopolitical perspectives. However, avoiding all complexities, a broad and holistic definition of the subcontinent could be ascertained as the continuous landmass

of the Indian plate, stretching from the mighty Himalayas in the north to the tip of the peninsular India including all the island chains and archipelagos encircling it in the west, south and east encompassing the Arabian Sea, Indian Ocean and the Bay of Bengal respectively. If we include Afghanistan (also considered to be part of the Central Asian landmass) in the west to the modern day Myanmar (erstwhile Burma) on the east, the majestic subcontinent includes a wide diversity of complex inter mix of numerous ethnicities, socio-cultural diversities, different time and economic zones, rich biodiversity, spectacular

landforms and several micro-climatic regimes. The modern day union of SAARC (South Asian Association of Regional Cooperation) member nations including Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, the Maldives and Sri Lanka uniquely represents the traditional and historical Indian subcontinent with interdependence on one another for various purposes. If in the future, Iran (in the west) and Myanmar (in the east) of this gigantic economic union be successfully endorsed through memberships into SAARC; the economy, trade and commerce, politics, education, environmental and socio-

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cultural enrichment of the so called subcontinent would increase many folds beyond our slightest imagination.

Not only dynamic trade and commerce or geopolitical strategic union between the current and potential future members would be successfully established; but, several perennial issues between the member nations could be easily resolved through engagement and discussion across supportive political environment. Massive roadways, railways and waterways connecting Central Asia via Iran to mainland India; and establishing connectivity to China (in the north) and Thailand and South East Asian nations (in the south) through Bangladesh and Myanmar could economically, socio-culturally and politically connect the entire region for peace and economic prosperity. Several rivers and their numerous tributaries and distributaries cut across the adjoining countries of the subcontinent. For better management of such cross border resources, if treaties are negotiated for joint management of different rivers systems for tackling the challenges of flood and draught control would be great; furthermore, irrigation facilities and water transportation could be revolutionized. If comprehensive arrangement for introducing joint management approaches in reducing environmental pollution, mitigating climate change issues, conserving forests and wildlife, protecting vulnerable and marginal communities settled across porous and unprotected borders be established among the member nations; that would provide long term sustenance and conservation of the rich natural

resources and amazing ecological diversity of the nations comprising this proposed, extended SAARC economic zone.

Comprehensive regional cooperation and negotiations for making multi-party treaties in the realms of economics, trade and commerce, connectivity, environmental protection and wildlife conservation, mitigation of climate change and global warming issues; joint management and sharing of key natural resources such as watershed and river management, management of freshwater, estuarine, marine and energy resources, education, research and training for generating efficient human resources necessary for building the economy and working without restrictions in different member nations of this economic zone; promoting tourism and unrestricted, legal human movement between the different regions can successfully establish long term socio-cultural contact among the communities across this unique and culturally diverse economic zone. This will not only settle several cross border issues among member nations but would help in the long term future and sustainability of both people and environment of this mega economic zone that represents substantial percentage of global human population. Such arrangements will definitely reduce cross border conflicts, illegal encroachments, illegal migrations and insurgent activities along the borders; will put checks on smuggling of contraband commodities, human trafficking, illegal wildlife trade and subsequent poaching of several wildlife species within different pockets of rich biodiverse ecosystems of this

eco-zone. Joint management means added expertise with multiple layers of cooperation between member nations and would certainly benefit issues from successful border management, sharing natural resources sustainably to effectively protecting and conserving the local environment and vulnerable ecosystems better.

Collaboration, cooperation and coordination between different academic and research organizations of the region on jointly developing different space programs; promoting various aspects of the agricultural, industrial, medicinal, pharmaceutical and environmental sectors; developing and sharing different energy and marine technologies would benefit all members. Similarly, collaborations among different socio-cultural institutes and organizations can help boost different business such as tourism and entrainment industry; promote studies about different ethnicities, languages and regional cultures for better understanding and conserving them for future generations; and in bridging the existing cultural gaps can greatly help in uniting numerous communities sharing this huge economic zone. Overall, an extended and enthusiastic membership and cooperation drive between members of the subcontinent sister nations and new potential members along western (Iran) and eastern (Myanmar) frontiers could pay big dividends for the long term political, economic, socio-cultural and environmental sustenance of Central, South and South East Asia significantly.

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## NEWS AND VIEWS

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### Crazy Tree Grows 40 Kinds of Fruit

Sam Van Aken, an artist and professor at Syracuse University, uses "chip grafting" to create trees that each bear 40 different varieties of stone fruits, or fruits with pits. The grafting process involves slicing a bit of a branch with a bud from a tree of one of the varieties and inserting it into a slit in a branch on the "working tree", then wrapping the wound with tape until it heals and the bud starts to grow into a new branch. Over several years he adds slices of branches from other varieties to the working tree. In the spring the "Tree of 40 Fruit" has blossoms in many hues of pink and purple, and in the summer it begins to bear the fruits in sequence. It is both a work of art and a

time line of the varieties' blossoming and fruiting. He has created more than a dozen of the trees that have been planted at sites such as museums around the U.S., which he sees as a way to spread diversity on a small scale.

Source: National Geographic

### Grow plants to curb urban heat

The presence of vegetation in urban areas-along the roads, in the parks and in the neighbourhood - can limit city heat effect to a great extent, according to a NASA study.

Using multiple satellites' observations, researchers found that areas in the US covered in part by concrete surfaces had a summer temperature 1.9 degrees Celsius higher than surrounding rural areas. In

winter, the temperature difference was 1.5 degrees Celsius higher in urban areas.

At the human level, a rise of one degrees Celsius can raise energy demands for air conditioning in the summer from five to 20 percent. This has nothing to do with greenhouse gas emissions. It is in addition to the greenhouse gas effect. This is the land use component only.

The urban heat island effect occurs primarily during the day when urban impervious surfaces absorb more solar radiation than the surrounding vegetated areas, resulting in a few degrees temperature difference. The urban area has also lost the trees and vegetation that naturally cool the air. Anywhere in the US, small cities generate less heat than mega-cities. The reason is the effect vegetation has on



keeping a lid on rising temperatures.

The amount and type of vegetation plays a big role in how much the urbanization changes the temperature. As a by-product of photosynthesis, leaves release water back into to the atmosphere in a process called evapotranspiration, which cools the local surface temperature the same way that sweat evaporating off a person's skin cools them off. Trees with broad leaves have more pores to exchange water than trees with needles, and so have more of a cooling effect.

**Source:** NASA/Zee News

### Role of Cyanobacteria in liver diseases

Cyanobacteria — often referred to as blue-green algae — are found in water bodies around the world and can produce toxins with potential health risks. This US-wide study found a significant positive association between cyanobacterial bloom coverage and death by non-alcoholic liver disease. The researchers say their study suggests some evidence of a potential health risk and should be used to generate further investigation into the health impact of cyanobacteria. Cyanobacteria are natural components of marine and freshwater environments and perform roles vital for the health of the ecosystem. However, when the conditions are right, they can multiply rapidly to form dense surface scums called blooms. These blooms, which appear as a green blanket covering the surface of the water, produce dangerous toxins which can be harmful to humans. By contaminating water used for drinking and recreation, these toxins can be ingested and inhaled by people. This problem looks set to increase in the future, as eutrophication and climate change encourages the proliferation of cyanobacterial blooms. This study specifically investigated cyanobacterial blooms and liver damage, for which there is already evidence of a connection. To investigate the risk further, this US-wide study tested the hypothesis that contamination by cyanobacterial blooms is a risk factor for nonalcoholic liver disease.

The researchers started by estimating the spatial distribution of cyanobacterial blooms in the US. Bloom coverage maps were developed. The maps were based on phycocyanin levels determined by the satellite, a pigment found at high concentrations in cyanobacterial blooms and which can be used to infer levels of toxins.

A statistical tool was then used to identify clusters of death from non-

alcoholic liver disease, which were compared to the bloom coverage maps. The initial results showed that cyanobacterial blooms were widespread in the US. Further analysis showed that bloom coverage was significantly related to risk of death from non-alcoholic liver disease. The researchers calculated that for every 1% increase in cyanobacterial bloom coverage, the risk from non-alcoholic liver disease death increased by 0.3%. Although this study found a clear and significant association between the spatial distribution of cyanobacterial blooms and death from non-alcoholic liver disease, the researchers emphasize that their study shows correlation not causation. Therefore, they recommend that their findings should be interpreted with caution and used to generate hypotheses for further testing to establish the connection, and in particular any underlying biological mechanisms.

**Source:** Science & Environmental Policy

### Artificial 'plants'

Los Angeles: Scientists have taken a big step towards creating artificial 'plants' that can use only sunlight to make gasoline and natural gas to run future cars without polluting the environment. A research team has created an artificial leaf that produces methane, the primary component of natural gas, using a combination of semiconducting nanowires and bacteria. It is a major advance towards synthetic photosynthesis, a type of solar power based on the ability of plants to transform sunlight, carbon dioxide and water into sugars. Instead of sugars, however, synthetic photosynthesis seeks to produce liquid fuels that can be stored for months or years and distributed through existing energy infrastructure. Peidong Yang, a professor at the University of California, Berkeley said his hybrid inorganic/biological systems give researchers new tools to study photosynthesis - and learn its secrets. One purpose of this experiment was to show that we could integrate bacterial catalysts with semiconductor technology. This lets us understand and optimize a truly synthetic photosynthesis system, Burning fossil fuels is putting carbon dioxide into the atmosphere much faster than natural photosynthesis can take it out. A system that pulls every carbon that we burn out of the air and converts it into fuel is truly carbon neutral. Ultimately, researchers hope to create an entirely synthetic system that is more robust and efficient than its natural counterpart. To do that, they need model systems to study nature's best designs,

especially the catalysts that convert water and carbon dioxide into sugars at room temperatures.

**Source:** Times of India, Sep 9, 2015,

### CNG-run vehicles emit dangerous nanocarbon

The compressed natural gas (CNG)-run buses are harmful for humans as they emit "nanocarbon" particles which can cause cancer, according to a study conducted by CSIR in Delhi.

The study can change the perception that natural gas is a clean fuel as it does not emit any visible smoke, which is in contrast to smoke emitted by diesel-run vehicles and perceived as harmful for humans. Natural gas is supposed to be a clean fuel when used in internal combustion engines, but, people realize that what they see (smoke) is perhaps better than what they don't see (no smoke from CNG vehicles). They during his address at the Global Green Energy Conclave held here.

A study was carried by CSIR with a professor of Alberta University, who has developed a device to measure and analyze particles emitted by vehicles. The machine was installed on the exhaust of a natural gas-run DTC bus in Delhi.

It was found that nanocarbon particles coming out of from natural gas combustion. These particles are moving around in the atmosphere and going straight into lungs through the nose. It then enters into blood through membranes. These nanocarbon particles are carcinogenic. These nanoparticles are rich in polynuclear aromatic, having huge surface area. They are also carcinogenic. What will be its effect when all the commercial vehicles, such as buses, run on natural gas in Delhi? One can see smoke coming out from diesel engine and tell that it is dangerous. But, nanocarbon particles coming out from vehicles is something we need to look at.

**Source:** Times of India, Aug 6, 2015

### Big hazard to seabirds? One word: Plastics

The problem with plastics in the ocean is increasing as the world makes more of the stuff. In the next 11 years we will make as much plastic as has been made since industrial plastic production began in the 1950s. The problem of plastics in the oceans is huge problem, with one study earlier this year estimating there was 269,000 tons of it in the oceans. As many as nine out of 10 of the world's seabirds likely have pieces of



plastic in their guts, a new study estimates.

The researchers combined computer simulations of locations of the garbage and the birds, as well as their eating habits, to see where the worst problems are. Their data is the latest to highlight the challenges facing seabirds, whose numbers have declined significantly in recent decades. The biggest problem strangely isn't where there's the most garbage. Instead it's where there's the greatest number of different species, especially in the southern hemisphere near Australia and New Zealand. Penguins and giant albatrosses live in these areas. Some species of albatross and shearwaters seem to be the most prone to eating plastic pieces. Birds mistake plastic bits for fish eggs, so they think they're getting a proper meal but they're really getting a plastic meal.

Usually it's tiny pieces of plastic, but far bigger things, such as an entire glow stick and three balloons have been found in a single short-tailed shearwater bird. Researchers have found everything from cigarette lighters to bottle caps to model cars toys. And it's only likely to get worse. By 2050, 99 percent of seabirds will have plastic in them,

Even simple measures can make a difference, such as reducing packaging, banning single-use plastic items. Efforts to reduce plastics losses into the environment in Europe resulted in measureable changes in plastic in seabird stomachs with less than a decade, which suggests that improvements in basic waste management can reduce plastic in the environment in a really short time.

**Source:** CBS News

### Delhi has world's deadliest air

A recent air quality monitoring survey has found that the deadly PM2.5 levels in Delhi are 10 times higher than the safety limit prescribed by the World Health Organisation (WHO), and four times higher than even the Indian safety limit.

Delhi's air is the most toxic in the world due to high concentrations of PM2.5 — particulate matter less than 2.5 micrometres in diameter — that is believed to pose the greatest health risk because it penetrates deeply into lungs.

The PM2.5 limit prescribed by WHO is 10 microgrammes per cubic metre, and the Indian limit is 40 microgrammes per cubic metre. PM2.5 are minuscule particles in the air that reduce visibility, cause the air to appear hazy, and affect respiratory tracts. Air pollution is killing 3.3 million people a

year worldwide, according to a new study. Farming plays a large role in smog and soot deaths in industrial nations. The study also projects that if trends don't change, the yearly death toll will double to about 6.6 million a year by 2050. About three-quarters of the deaths are from strokes and heart attacks.

Air pollution kills more than HIV and malaria combined. With nearly 1.4 million deaths a year, China has the most air pollution fatalities, followed by India with 645,000 and Pakistan with 110,000. The United States, with 54,905 deaths in 2010 from soot and smog ranks seventh highest for air pollution deaths. What's unusual is that the study says that agriculture caused 16,221 of those deaths, second only to 16,929 deaths blamed on power plants.

In the northeastern United States, all of Europe, Russia, Japan, and South Korea, agriculture is the No. 1 cause of the soot and smog deaths, according to the study. Worldwide, agriculture is the No 2 cause with 664,100 deaths, behind the more than one million deaths from in-home heating and cooking done with wood and other biofuels in the developing world.

The problem with farms is ammonia from fertilizer and animal waste. Ammonia then combines with sulfates from coal-fired power plants and nitrates from car exhaust to form the soot particles that are the big air-pollution killer. In London, for example, the pollution from traffic takes time to be converted into soot, and then it is mixed with ammonia and transported downwind to the next city.

The scientists had assumed that traffic and power plants would be the biggest cause of deadly soot and smog. Agricultural emissions are becoming increasingly important but are not regulated. Ammonia air pollution from farms can be reduced at relatively low costs.

### Azolla fern: A climate change cure?

Azolla is a small algae like fern which blooms rapidly in the same way as algae. This little plant is incredible as it changed the Earth which was overheated by green house gases, into a balmy and hospitable planet some fifty million years ago. In many parts of the world it is regarded as a weed. Behind the change of climate of the past few million years was geological coincidence: The isolation of the Arctic

Ocean. At this critical point in history, the newly enclosed sea became a shallow, tepid, salty and nutrient-rich lake. These conditions proved ideal for a small algae-like fern to flourish and change our atmosphere.

Fifty million years ago this happened on an enormous scale as Azolla plant quickly formed a thick-green carpet covering the entire Arctic Ocean. Nitrogen — and carbon dioxide—were its primary food.

As it changed the weather, rains returned. These rains, in turn, helped the little fern spread over the hard-baked continents. The plant bloomed—and died. Bloomed, and died. Each time depositing a thick layer of sediment. This carbon-laden soil was first discovered under the Arctic Ocean seabed in 2004.

Since the scientists have been trying to determine true power of this little plant and it has been found that in the course of one million years, it pulled out almost half of the carbon dioxide in the atmosphere.

Massive Azolla blooms are believed to have triggered the climate change that created the frozen North Pole. This ice waste went on to bring about even further drops in the level of CO2 by freezing it out of the air and locking it away in deposits known as permafrost.

What is really incomprehensible that previous process of our planet cooling and CO2 dropping took 50 million years to unfold. Now, we may be reversing this process in a matter of centuries.

### Can it do it again?

China has funded a project to map the genome of Azolla and hope to have results within a year. This knowledge will give us control over Azolla in a way we didn't have before. We can increase carbon sequestering and nitrogen fixation, or give Azolla's properties to other plants. We have even found chemicals in Azolla that stop cell division. The question is almost what will we find that Azolla cannot do.

**Source:** Jennifer Huizen & Climate Wire (In Scientific American)

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04-06 November 2015; Nagoya, Japan

E-mail: lsbe@lsbe.org

Website: <http://www.lsbe.org>

### 5th International Conference on Environment Science and Biotechnology (ICESB 2015)

9-10 November, 2015, Jinju, South Korea

E-mail: icesb@cbees.org

Website: <http://www.icesb.org>

### National Conference on Environmental Monitoring, Assessment and Pollution Control

10 - 11 December 2015; Navi Mumbai, India

Organizing Secretary

SIES Indian Institute of Environment

Management

Plot 1E, Sector- V, Sri.Chandrashekharendra

Saraswati Vidyapuram,

Nerul, Navi Mumbai 400 706

E mail: [emapco2015@sies.edu.in](mailto:emapco2015@sies.edu.in)

### 16th International Conference on Environment and Natural Science (ICENS) ?

January 3rd, 2016, in Barcelona, Spain

Website:

<http://iserd.co/Conference/Spain/ICENS/>

### 14th National & 5th International Conference of Climate Change & Phytodiversity: Challenges & Opportunities

15-18 January, 2016, Karachi, Pakistan

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University of Karachi, Karachi-75270, Pakistan.

E-mail: [anjum@uok.edu.pk](mailto:anjum@uok.edu.pk)

Website: <http://www.pakbs.org>

### 5th International Conference on Climate Change and Humanity (ICCCH 2016)

23-25 January, 2016; Pattaya, Thailand

E-mail: [iccch@cbees.org](mailto:iccch@cbees.org)

Website: <http://www.icch.org>

### ICAPC 2016: 18th International Conference on Air Pollution and Control

01 – 02 February, 2016; Rio de Janeiro, Brazil

<https://www.waset.org/conference/2016/02/rio-de-janeiro/ICAPC>

### 5th International Conference on Biodiversity

10-12 March, 2016; Madrid, Spain

Email: [biodiversity@conferenceseries.net](mailto:biodiversity@conferenceseries.net)

<http://biodiversity.conferenceseries.com/#sthash.JAiuNBfw.dpuf>

### International Conference on Pollution Control & Sustainable Environment

25-26 April, 2016 Dubai, UAE –

E-mail: [pollutioncontrol@omicsgroup.com](mailto:pollutioncontrol@omicsgroup.com)

<http://pollutioncontrol.conferenceseries.com/#sthash.tU1nOAY3.dpuf>

### Air Pollution 2016

### The 24th International Conference on Modeling, Monitoring and Management of Air Pollution

20-22 June, 2016; Crete, Greece

<http://www.wessex.ac.uk/air2016>

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