ENVIRONEWS

INTERNATIONAL SOCIETY OF ENVIRONMENTAL BOTANISTS

Newsletter

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IN THIS ISSUE

President ISEB's New Year Message

EnviroNews is the quarterly newsletter of CSIR-NBRI-based International Society of Environmental Botanists (ISEB). Founded on 3rd December 1994, ISEB completed

21 years of its existence only last month. Over 450 members strong ISEB has earned worldwide recognition and acclaim for its enormous contributions for the cause of environmental protection, biodiversity conservation and sustainable plant wealth utilization. From 1996 to 2015 ISEB has organised five International Conferences on Plants and Environmental Pollution (ICPEP) in collaboration with CSIR-NBRI. Delegates from nearly 50 countries participated in these highly successful conferences.

ISEB maintains a highly informative and educative website which has been accessed by nearly 60,000 individuals from more than 140 countries across the globe. ISEB is publishing this quarterly newsletter (EnviroNews) since January 1995 with an aim to bring latest and complex scientific information on plants and environmental sciences to the reach of specialists and non-specialists, in a simple and non-complicated language, from different parts of the world. The present issue is the 85th issue of EnviroNews which is being published without a single interruption.

CSIR-NBRI rededicates itself to provide all moral and material support and encouragement to ISEB and EnviroNews in promoting the cause of environmental protection, biodiversity conservation and sustainable plant wealth utilization and in facing the onslaught of climate change. I am happy to note that ISEB is also doing some useful work for CSIR-NBRI by informing interested individuals about the researches carried out by our scientists through its newsletter, conferences and website.

On behalf of ISEB and, on my own behalf, I wish to extend my warmest greetings and best wishes to all members of ISEB and readers of EnviroNews for the New Year 2016.

Dr. Chandra Shekhar Nautiyal
President ISEB & Director
CSIR-NBRI, Lucknow, India

HAPPY NEW YEAR 2016

President and Members of the Executive of International Society of Environmental Botanists Wish a Very Happy, Fruitful and Prosperous **New Year** to all Members of ISEB and readers of **E**nviroNews.

With this issue, EnviroNews enters the 22nd year of its publication

LETTERS

We are hosting the "International Conference and Exhibition on Marine Drugs and Natural Products" (Natural Products 2016) along with external scientific associations with the researchers, academicians, medical professionals, department managers and market leaders around the globe, scheduled on **July 25-27, 2016 at Melbourne, Australia**. We would like to invite you for the scientific collaboration with the Natural Products 2016 event, and honor you by offering the position of Organizing Committee Member (OCM) for the Conference. We would like to offer a platform for the interactions between experts around as an Organizing Committee Member; Natural Products 2016 is glad to offer you the privileges like an opportunity to be the keynote/plenary speaker at Natural Products 2016 Conference, an honorable position as the chair/co-chair for the session of your interest, an opportunity to launch your Book/Chapter/Research work at the event, an opportunity to conduct a workshop/ symposia of your University/ Lab/ Organization at the Conference

Sushma Reddy
Gull Ave., Foster City, **Australia**
naturalproducts@pharmaceutical conferences.com

The current situation with Indian forest cover is quite alarming. A recent survey of Indian states by Rediffmail.com [http://www.rediff.com/news/report/rediff-labs-are-indias-wildlife-sanctu-aries-on-the-decline/20150602.htm] studying the change in the patterns of Indian forest cover between December 2006 – November 2014 reveals that majority of the Indian states are showing signs of depleting forest cover in spite of average increase in the number of protected areas and sanctuaries across the nation. Only three Indian states, Punjab, Tamil Nadu and Mizoram showed positive increase in the percentage forest cover while all the remaining states have varying negative percentages of reduction in forested areas. Tamil Nadu is the only state that demonstrates substantial increase in forest cover during the period of analysis. But most worrisome has been the finding that the highly biodiverse regions of the nation represented by states in north, west, east and north east are showing rapid loss of forest cover. Although the report does not provide details of methods of the study; however, an indication of forest loss seems to be apparent along the length and breadth of the nation in spite of several long term conservation programs running in India. It is, therefore, important to have an unbiased introspection of the outcomes of current forest conservation practices across the nation and the nature of their successes. In addition to conservation of virgin forested areas and premier eco-environmental habitats of the nation; social and agricultural forestry need to be promoted to the best of the ability. India with substantial human population and in need for expansion of industrial belts for economic sustenance of the nation will possibly not be able to generate big forests in the future; and there is even possibility of partial destruction and degradation of local forests for infrastructural development.

Hence, alternative and innovative eco-environmental approaches have to be considered. In addition to the conversion of unsuitable agricultural lands, reclaimed lands, abandoned industrial and/or mining areas into artificial forests; emphasis must be placed on forest and water body developments in the highly crowded municipalities, corporations, metros, district towns and small cities across India. Expansion of tea and coffee plantations and other agronomic activities as well as new mining enterprises has to be carefully designed from an eco-sociological perspective to balance the rising economic need for the nation to be integrated with the long term eco-environmental benefits. Highly fragile and diverse ecosystems need to be kept isolated as much as possible from the realms of rapid socio-economic developments. The anthropogenic impacts on virgin forest areas due to the heavy dependence of remote rural and tribal communities, forest fringe dwellers and forest residents for food, fuel, fodders, forages and fertilizers need to be seriously addressed by making these communities important stakeholders in local forest conservation. The daily needs of these forest dependent communities must be catered by developing artificial forest farms on abandoned lands, forest fringes, along highways, mining areas and village fringe areas. Sustainable and judicious use of local forests resources must be encouraged. The central and state governments need to cooperate and collaborate with one another to develop a comprehensive forest conservation policy for the nation with an emphasis on conversion of every available and unused land parcels into artificial forests over the next two decades. Highly biodiverse areas need to be conserved with top priority. India should target in allocating ~25% of her land surface exclusively to forests.

Saikat Kumar Basu
UFL, Lethbridge AB **Canada**
saikat.basu@alumni.uleth.ca

We have launched an E-magazine on Environment Management and Sustainable Development. It is a quarterly magazine. We need your articles, news clippings and photographs for next issue.

Kindly circulate it in your contact list, members of ISEB and readers of EnviroNews.

Seema Mishra,
SIES Indian Institute of Environment Management,
Navi Mumbai, **India**
Seema.mishra03@gmail.com

We are a well known press service in Algeria. We are interested in receiving some information documents and printed literature of your prestigious organization. In addition, please subscribe me to the newsletter and journal published by your organization.

Abderrahmane Ben Brahim
B.P 215 Star Melouk
07005-Biskra, **Algeria**
abd.errahmane@rocketmail.com

ISEB FOUNDATION DAY GREETINGS

Prof. Sharad Chaphekar, Mumbai; Prof. Muhammad Iqbal, New Delhi; Dr. Nikhil Kumar, Lucknow; Prof. Arun Arya, Vadodara; Mr. Rama Kant Dubey, Varanasi; Dr. A. Arunachalam, New Delhi; Prof. Javed Ahmad, New Delhi; Mr. Arvind Kumar Dubey, Lucknow and Dr. P. B. Rastogi, New Delhi sent their greetings and good wishes on the 21st Foundation Day of ISEB (3rd November 2015).

WELCOME NEW LIFE MEMBERS

Dr. Nelesh Agrawal, Managing Director, Earth Protection Group Environmental Consultant Pvt. Ltd., Lucknow.
epgec@yahoo.co.in, thepollutionwatch@gmail.com

Prof. Dibyendu Talukdar Associate Professor, Department of Botany, Raja Peary Mohan College, Uttarpara, Hooghly West Bengal
dib_tal@rediffmail.com, dibyendutalukdar9@gmail.com

Dr. Chandra Shekhar Seth, Assistant Professor, Department of Botany, University of Delhi, Delhi.
seth_bhu@yahoo.co.in

Ecotoxicology and remediation of agricultural soils polluted with lead in Argentina

Rodriguez, J.H., Salazar, M.J., Vergara Cid, C., Blanco, A., *Pignata, M.L.
Pollution and Bioindicator Section, Multidisciplinary Institute of Plant Biology,
National University of Córdoba, Córdoba, Argentina.
<*pignata@com.uncor.edu>

Introduction

Heavy metal pollution of soils is a problem of considerable concern worldwide due to the potential toxicological risk to the environment and food safety. In many developing countries, agricultural areas are frequently affected by industrial emissions since they are often located in peripheral areas to urban agglomerations. These sites experience progressive environmental degradation as a consequence of their rapid development, when it is not accompanied by effective environmental and land use regulations. Consequently, large areas of farmland have been contaminated by metals owing to anthropogenic input from mining, smelting, fossil fuel burning, phosphate fertilizers and sewage sludge.

Heavy metal pollution has a harmful effect on biological systems and does not undergo biodegradation, as heavy metals which lie in soils have residence time of thousands of years and during which it accumulates in living organisms. Thus, once soil has become polluted, it remains a long-term source of metal exposure, affecting crop growth and the quality of agricultural products, as well as a serious threat to human health through contamination of the food chain, due to the potential toxicological risk from the consumption of crops that are grown under these conditions.

Many studies, have been carried out worldwide in industrial areas near agricultural soils, and have reported toxic metal concentrations in crops above permitted levels. Regarding lead (Pb), it has been shown that this metal is a highly toxic element, even at low concentrations, leading to serious consequences in human health and ecosystems. The harmful effects on human health include neurological damage, neurotoxic diseases and anemia. For this reason, remediation of soils polluted with this toxic metal is necessary in order to reduce the associated risks, make land safe for agricultural production and enhance food security.

Toxicological risk of crops growing in contaminated soils

Studies about the potential enrichment of heavy metals in soils as a result of antropogenic activities and their subsequent transfer to crops have been performed in the main crop production area of Argentina (Córdoba and Buenos Aires), with results indicating that Pb concentrations in some agricultural soils of Córdoba have exceeded the permitted maximum levels according to national and international laws. Moreover, in these sites, an effective translocation and bioaccumulation of Pb in the principal crop soybean was observed, and it is important to note that accumulation of Pb above the permissible levels was also reported in soybean and wheat growing in soils which did not reach high levels of pollution. In fact, the uptake of heavy metal by plants, with soil–plant transfer of metals, is a very complex process governed by several factors (both natural and anthropogenic) such as environmental conditions, soil heavy metal content, and the sorptive capacity of soil, redox conditions, organic matter and pH.

These parameters are known to control the processes of mobility and availability of metals in soils. Moreover, in sites highly polluted with Pb in Córdoba, there is evidence that an enrichment of soil by Pb can modify the bioavailability of other toxic elements, such as Cd, which although only present at low concentrations in soil, was observed at higher concentrations in soybean seeds, a process known as "concomitant bioaccumulation" of contaminants in the plants.

To assess the toxicological risk of consuming crops exposed to heavy metals, an index named "target hazard quotient" has been developed, which considers the concentration of contaminants in food and some consumer characteristics (age, origin and weight). Another index called "hazard index" summarizes the effects of different pollutants. Both the indices are considered as lifetime risk.

In a study performed in Pb polluted soils in Córdoba, by applying this above mentioned indices we reported an effective toxicological risk for potential Chinese consumers, due to the high consumption of soybean in comparison with Argentina or Europe (taking into account that they are the main recipients of this export product). In addition, regarding the quality of crops, it is expected that the accumulation of toxic elements causes physiological damage affecting their productivity and quality. However, an optimal quality of soybean crops has been reported, which presented toxic levels of metals in their seeds. Thus, these results suggest the importance of monitoring agricultural soils and metal transfer to crops.

Remediation of heavy metal contaminated soils

As mentioned above, taking into account the residence times and poor degradation of heavy metals in soil, with consequent damage to the environment and human health, it is necessary to develop environmental friendly remediation methodologies.

Traditional remediation methodologies, which are based on engineering processes, generally involve the removal of the contaminated soil and its physico-chemical treatment. However, traditional remediation involves the loss of fertile soil as an agricultural resource. Thus, taking into account that the loss of fertile soil in the world is about 24 billion tons per year, and it requires 500 years for the natural formation of 2 cm of fertile soil (a process which can not be artificially reproduced), it is pertinent to replace this remediation methodology by a more environmental friendly techniques. Therefore, in this context, phytoremediation is an attractive alternative as it is a biotechnological process that involves the use of plants and associated microorganisms to remedy the contamination of the environment (soils, sediments, and water). This harnesses the physiological or mechanical processes of plants to alleviate pollution, through degradation, extraction and stabilization. Regarding heavy metal contaminated soils phytoremediation is limited to the immobilization of metals in roots and the rhizosphere (phytostabilization) or metal accumulation in aerial parts (phytoextraction).

Focussing on the potential use of phytoremediation, we performed a screening study of native plants, growing in Pb-polluted soils in the province of Córdoba, Argentina and identified two species (Bidens pilosa and Tagetes minuta) with a high capability of extracting Pb and accumulating it in their aerial tissues. In addition, a useful phytostabilizator species (Sorghum halepense) has been reported. It is noteworthy that the ability of these phytoextractor species depends on many factors that interact in complex ways, thus making it difficult to standardize this method for different cases. For this reason, we carried out studies about the influence of factors such as the content of other elements in soil and their interaction with Pb, the presence of natural rhizosphere microorganisms and agricultural implications, and the application of phytohormones plant growth promoters. As the results indicated a strong intraspecific variability, we are currently performing investigations about acclimation and adaptation of different populations of these species, in order to isolate and select individuals with higher phytoextractor efficiencies for reproduction and employment. Once these individuals are identified, the study of their genetic profile will allow general parameters applicable to different phytoremediation projects to be established.

Remediation of lead and economic profit.

In emerging economies the implementation of remediation programs in contaminated agricultural soils has encountered opposition when addressing the interests of the different social sectors involved. For example, the control authorities do not have sufficient influence on producers and landowners, who often perceive remediation as a negative concept since the entails a loss of productivity during the period required to attain permitted metal concentrations. However, the latest advances in science in this context can offer alternatives which include the possibility of obtaining financial gains during the remediation process.

Below, we relate three different remediation studies in which our research group works:

1- Phytoremediation: a case study of Tagetes minuta

The aim of combining phytoextraction of metals with the ability to provide a return in investment was attained through the use of aromatic crops associated with essential oil production, Tagetes minuta was one of the species identified in the screening study for its ability to accumulate Pb. This is an annual aromatic plant that belongs to the Asteraceae family, originally from the temperate regions of South America, it has been recently introduced in several regions of the world for medicinal purposes. The plant has a rich chemistry for obtaining natural products and also yields volatile essential oils, which can be extracted by hydrodistillation, and are widely used in cosmetics, perfumery (with its aroma being classified as sweet and similar to citrus fruits), as a food flavoring and in beverages and medicine. It has antioxidant and anti-inflammatory effects, antibacterial and nematicidal properties, and it can be used in repellents for mosquitoes, ticks and mites, as well as in insecticides against the family Psychodidae and vectors of diseases such as leishmaniasis. This extensive potential usage makes T. minuta an optimal candidate for Pb phytorremediation with a view towards obtaining economic profit, thus we decided to concentrate our investigation on this species in Córdoba, Argentina. We found that when this species accumulated Pb in its harvestable organs, this metal was not present in its essential oil, which was therefore a safe product of good quality. It was also observed that the Pb concentration in leaves affected the production of some minor oil components, which are involved in the plant response against stress. These components may explain the high Pb tolerance of T. minuta, and further study might reveal important clues for the enhancement of Pb uptake by other accumulator species.

2- Phytoremediation: a case study of co-cropping.

As mentioned above, phytoremediation is a favorable alternative from the environmental perspective in agricultural soils polluted with toxic metals. However, this methodology is generally time-consuming and requires the cessation of agriculture for a number of years, which represents a non-economical alternative for agricultural producers. To circumvent this

problem, co-cropping systems have been recently applied that involve the growth of a metal hyperaccumulator plant associated with a low metal accumulating crop, in order to improve the remediation of heavy metals. In contrast to mono-cropping, co-cropping can enhance the growth and metal uptake of the hyper-accumulating plant. This is done by producing a synergistic effect between the species through the sharing of their rhizospheres,. Furthermore, it may be possible to use hyperaccumulators to alleviate the metal uptake of conventional plants by depletion of the potentially toxic metals within shared rhizospheres, which has been given the name 'phytoprotection'. However, a better understanding of the rhizosphere interactions of co-cropped species is still required in order to be able to optimize phytoremediation technologies. Thus, the purpose of our study was to evaluate two potential phytoextractor plants (the native species Bidens pilosa and Tagetes minuta) co-cropped with agricultural species growing on lead-polluted soils in Córdoba, Argentina. The concentrations of Pb, as well as those of other heavy metals, were investigated in the phytoextractors, crop species and soils, with the potential risk to the health of consumers also being estimated. The soil parameters pH, EC, OM% and bioavailable lead showed a direct relationship with the accumulation of Pb in roots. In addition, the concentration of Pb in roots of native species was closely related to Fe, Cu, Mn and Zn. Our results indicate that the interaction between rhizospheres increased the phytoextraction of lead, which was accompanied by an increase in the biomass of the phytoextractor species.

3- Organic amendments: a case study of biochar.

Phytoremediation is not effective where heavy metal contamination in soils is very high. Thus, in these cases, in situ remediation in order to reduce the availability of metals is the most appropriate alternative. Heavy metal immobilization technology often uses organic and inorganic amendments to accelerate the attenuation of metal mobility and toxicity in soils. Among those used to treat heavy metal contaminated soils are municipal solid waste, compost, cattle manure, sewage sludge, red mud, lime and beringite, zeolites, charcoal coal, and biochar. However, it is important to consider the effects of these amendments on the environment, such as the incorporation of new pollutants by the use of municipal waste. Moreover, currently there is a lack of information on emissions of greenhouse gases (GHG) that these amendments may generate, which is very important to consider when evaluating the cost benefits of applying a soil amendment. Thus, in recent years some studies have been performed in relation to the use of an effective amendment such as biochar, which is the incomplete pyrolysis of the biomass, with the characteristics of biochar depending on other factors such as the biomass used and the physicochemical characteristics of the production process. The original aim of the use of biochar was to obtain C sequestration in soils, due to its recalcitrant characteristics. However, numerous other potential applications have been recently reported as a result of its effects on soils, such as liming of acidic soils (increase pH) and increasing the cation exchange capacity. Moreover, these features can decrease the heavy metal availability of soils.

Other studies have evaluated the potential effects of the amendment of biochar to soils and GHG emissions, and have reported a net decrease of these emissions by reducing the availability of N for nitrification and denitrification through adsorption (microbial or physical). However, few studies have been performed about the evolution of metal bioavailability with the aging of biochar.

Considering the above mentioned findings, we conducted preliminary studies with the purpose of assessing different biochar (BiC) amendments in Pb polluted soils with respect to the bioavailability of the metal and food security, and evaluating the effects on the N cycle and potential GHG emissions. Our first study was performed using various contaminated Pb soils from Córdoba according to a pollution gradient, which were amended with two different quality biochars using various woods as the biomass and in the pyrolysis process, with the effect of the biochar amendment in polluted soils being evaluated on the amonification and nitrification rates. These results indicated a direct relationship between the amendment contents in soils and the water retention capacity (WHC), which was dependent on hydrophobicity, surface area and improvement of the soil structure. Furthermore, for the purpose of assessing the ammonification and nitrification gross rate, we analyzed the content of NH_4^+, NO_3^-, TNb and TOC extractables of amendment soils. Our partial results reveal a direct relationship between Pb content in soils and extractable nitrogen, especially nitrates, as well as a direct relation with the content of soil organic matter. Thus, in soils contaminated with metals where phyto-remediation has been applied, some studies have employed nitrogen fertilizers such as urea and ammonium nitrate in order to provide nutrients to the hyper-accumulator plants in addition to the fact that they can accumulate heavy metals through soil acidification and a greater bioavailability of metals.

As mentioned above, the incorporation of BiC in Pb contaminated soils reduces the bioavailability of this metal, which is reflected in the amount of total extractable nitrate. Consequently, in the second phase of these studies, we evaluated the effect of an amendment of organic carbon (charcoal) on the bioavailability of Pb in soils and assessed bioaccumulation in soybean, as well as GHG emissions. Especially in the case of N_2O, we observed an increase of its emissions in soils with a natural content of Pb without amendment and cultivated with soybean at the maturity growth stage, which was the result of the senescence process that increased the organic matter on decomposition. Furthermore, our results indicated that the application of this charcoal to the soil was particularly toxic for the plant at a 10% W/W amendment concentration. Finally, the soils amended with 5% charcoal reduced N_2O emissions in comparison with soils without an amendment for both lead polluted (700 ppm) and natural soils.

Therefore, we conclude that the N cycle in soils with an agricultural history is modified in the presence of elevated levels of Pb, and that the immobilization efficiency of Pb after an amendment depends on characteristics such as biomass and the pyrolysis process, as well as on soil processes such as ammonification and net nitrification, and ultimately, the potential N_2O emissions.

Construction of mega dams on the upper reaches of Brahmaputra has serious ecological and economic implications for the Indian subcontinent

Saikat Kumar Basu
UFL, Lethbridge AB **Canada**
<saikat.basu@alumni.uleth.ca>

The construction of mega dams on the upper catchment areas of the Brahmaputra River in Tibet by China is a serious future concern for India and Bangladesh sharing the lower riparian catchment areas from both economic and ecological perspectives. The construction of such massive reservoirs will certainly have serious consequences with respect to the steady flow of the trans-boundary river in the middle (NE India) and lower (Bangladesh) catchment areas while traversing across Tibet and NE India and joining the Ganges (Padma) in Bangladesh; and finally draining into the Bay of Bengal. The less availability of water in the dry summer season will impact irrigation potential as well as hydro-electricity generation capacity of the river and its several tributaries in Arunachal Pradesh; and the vast, fertile, alluvial, Brahmaputra River valley of Assam. Similar and worsening conditions are also expected for Bangladesh, further down in the lower catchment areas. The local agriculture and power generation of the middle and lower catchments areas will be severely impacted with negative implications for the regional economy. The reduced flow of the river due to massive dams in the upper reaches will have serious ecological consequences for the ecologically sensitive Ganges-Brahmaputra Delta system which is traversed by numerous distributaries bringing fresh water to the estuarine zone with long term impact on the world's largest mangrove forest, the Sunderbans. The Sunderban mangrove ecosystem has been already hit hard by severe anthropogenic pressures beyond the carrying capacity, repeated cyclonic disturbances causing mass destruction of the protective forest belt, depletion of significant portion of the original mangrove forest and creation of numerous, large salt pans within the once densely vegetated forests. The alternation in riverine flow and imbalance in the amount of fresh water reaching the estuarine zone will result in rapid salination of significant portion of the forest; as well as enhance the annual rate of bank erosion resulting in serious threats for the future of this unique global ecosystem spread across India and Bangladesh. It will, therefore, be important for both India and Bangladesh to discuss a mechanism for establishing joint management of the trans-boundary river with China following international norms and regulations. It will be necessary for the three countries to sit on a dialogue table and discuss the establishment of a Joint River Commission between China, India and Bangladesh similar to that of Mekong River Commission jointly operated by Cambodia, China, Laos, Myanmar, Thailand and Vietnam. The issue is extremely sensitive and critically important for the virtual survival of the life line of NE India and Bangladesh and unless dealt with immediate effect and through proper diplomatic channel, may result in a dark future for the eastern half of the Indian sub-continent.

Heavy metals and food security

[1]Ashita Sharma, [2]Simran Kaur and [1]Avinash Kaur Nagpal*
[1]Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, **India.**
[2] Department of Biological Sciences and Geology, Queensborough Community College, Bayside, New York - 11364, **USA**
<*avnagpal@rediffmail.com>

Introduction

The Sustainable Development Goals (SDGs) as framed by the United Nations focus primarily on reducing global hunger and providing food for all. There has been an exponential rise in the chronically hungry population around the world with approximately 800 million people suffering from chronic undernourishment, according to UNFAO (United Nations Food and Agriculture Organization). With the world's human population estimated to be reaching an enormous 9.1 billion in 2050 (UN data), the need to make substantial change in the current agricultural systems to feed the already suffering hungry millions and the additional 2 billion people expected by 2050, is the challenge facing humanity. According to recent FAO projection, the agricultural outcome is expected to increase by a phenomenal 70% to feed the ever expanding human population. Food security, which includes continuous availability of "safe" food and its access to all, is a condition that poses a big problem not only for developing countries but for developed nations too. In the efforts to increase the global food production new agricultural practices (often wrong, short term solutions with long term negative consequences) are being introduced. To meet the land requirement for sufficient crop growth, shifting landscape policies are being adopted which again are not the best practices. The recent surge in the usage of urban, industrial or the polluted land, which is certainly not suitable for agriculture as it may lead to the addition of toxins to food-crops, is a practice that needs serious reconsideration. The growing irrigation demands and insufficient water availability as a result of change in rainfall patterns and decrease in water level is another serious problem challenging food security. To meet the irrigation demands, waste water from industries is being used for crop production. Though this practice has increased crop output, but the use of industrial waste waters or other similar inappropriate resources produce a crop,

which generally cannot be considered as "safe" food. Various research investigations conducted world-over have found significant concentrations of heavy metals in crops cultivated through the use of such inappropriate resources beyond acceptable daily intake. It is quite evident that there can be an increase in crop production by adopting certain agricultural and irrigational practices (as a few mentioned above) but they don't necessarily help in attaining global food security. According to a statement made by Dr. Manmohan Singh (former Prime Minister of India), "if I don't have enough food in my country how can I think of saving the environment", the issue of food security is nevertheless deeply linked with the environment and "safe food".

Heavy Metals: What are they?

Naturally occurring metals with density higher than 3.5 g/cm^3 are considered as heavy metals. Some heavy metals are essential for normal metabolism of most living organisms, unfortunately, the term "heavy metals in soils" has almost become synonymous to "toxic elements in soil". A few elements categorized as heavy metals and of concern are: mercury (Hg), cadmium (Cd), arsenic(As), chromium(Cr), thallium (Tl), Zinc (Zn) and lead (Pb). Mercury (density14.6 gcm^{-3}); lead (density 11.4 g cm^{-3}) and cadmium (density 8.65 g cm^{-3}) are known as the "big three" heavy metals due to their highly toxic behavior with no known essential biological function. Mercury, essentially released in the environment through mining, coal combustion and burning of fossil fuels, is popularly used in thermometers, dental fillings, and batteries. Lead is usually found in nature in combination with other elements like sulfur and oxygen and particularly used in construction of plumbing essentials, lead storage batteries and in an alloy form with other metals. Cadmium is predominant in all types of soil, rocks and released primarily as a by-product of lead refining. It is used extensively in batteries, utensil coating, PVC and many electrical components. Select heavy metals are also known to move along with fertilizers, detergents and many petroleum products as an impurity.

Sources

Heavy metals exist naturally in the Earth's core. Due to natural weathering processes and catastrophic events like floods, tsunamis and volcanoes these metals accumulate and increase in concentration in the biospheric zone as well. Anthropogenic activities that lead to soil disturbances like mining, drilling and extraction of fossil fuels, leakage through discarded products in improperly protected landfills, use of leaded gasoline and lead based paints, indiscriminate use of fertilizers, mismanagement of industrial wastes, combustion of fossil fuels, metallurgy technology, electroplating and production of sewage sludge and industrial and automotive emissions (to name a few among innumerable practices adopted by humans to sustain civilization) further increase the concentration of heavy metals in biosphere beyond the general background level. These metals are then translocated between biotic and abiotic components of any ecosystem and undergo various types of chemical transformations into different ionic states. Soil pH and oxidation conditions, microbial activity, temperature fluctuations and various other environmental geochemical factors are responsible for this heavy metal speciation

Table 1 provides a brief description of sources that contribute to the increase in the concentration of heavy metals in soil.

Table 1. Sources of Heavy Metals

Type of Sources	Examples
Point (Localized) Sources	Industries: Effluent from Alloy industries, Tanneries, Paper mills, ore extraction sites, refineries etc.
	Automobiles: Tyre dust, lubricating oils; erosion from metal frames etc.
	Fuel extraction and Combustion: Mining; drilling, processing and burning of fossil fuels (coal, oil, & natural gas) etc.
	Agricultural chemicals: Pesticides and fertilizers
	Municipal Waste: sewage and garbage disposal
Diffuse Sources	Atmospheric Deposition of heavy metals through rain and wind.
	Run off and Leaching of heavy metals to distant locations.

Heavy Metal Toxicity

Soil contamination from various sources (as identified above) leads to an imbalance between essential metals (required as micronutrients for normal cellular functioning) and non-essential metals that are harmful for life. Trace elements like Zinc, Chromium, Boron, Copper, Manganese, Iron, Molybdenum, Selenium and Cobalt are required for normal functioning of plants. Boron aids carbohydrate transport while manganese, iron and zinc participate in chlorophyll formation. Deficiency of copper and iron leads to chlorosis in plants. Natural metabolic processes allow heavy metals present in biosphere to enter the food chain through producers. Once absorbed, they exhibit toxicity at all trophic levels and thus their increasing and persistent presence in soil is of concern. Absorption of heavy metals from soil or water is through the root zone and from air through stomata (openings in the epidermis of leaf tissue). Uptake of metals is related to size, concentration, mobility and its ionic state. The toxicity associated with heavy metals can be classified as both physical and chemical toxicity. Dependent upon size of metal ion it can reach up to the organ, tissue

Table 2. Toxicological effects of Heavy Metals

Trophic Level	Mode of Entry	Toxic Effects
Producers	Roots, Stomata	Chromosomal Alterations Reduction in Mitotic Index Increase in Antioxidant activity Reduction in Photosynthesis Decrease in Germination Rate
Consumers (Humans studied most extensively)	Food, Inhalation, Dermal Contact	Skin damage Breathing Problems Decrease in white blood cells Carcinogenicity Mutagenicity Cytotoxicity
Decomposers	Absorption	Impact on metabolic activities of fungi and Bacteria: Fungi are relatively more tolerant Imbalance in Bacteria-Fungi ratio Effect on detritus food chain

and cellular level. Physical toxicity is the result of clogging of cellular channels, which in turn inhibits water transport. Chemical toxicity results due to binding of heavy metals with essential biomolecules leading to inhibition of catalytic activities, disruption in cell membrane functions, damage to nucleic acid structure and production of reactive oxygen species. Toxicological effects of heavy metals are known at all trophic levels and shown in table 2.

Human-The Consumer: Humans are continuously exposed to heavy metals through the food we ingest, air we inhale or through the pollutants we touch. The Minamata Bay (Japan) tragedy that involved toxicity due to high mercury content in food resulted in neurological disorders and death of large number of people. Mercury was slowly creeping (from 1932-1968) through industrial wastewaters into marine ecosystems and accumulating in shellfish popularly consumed by local communities living around the bay. The astronomical accumulation of arsenic (due to natural geochemical processes) in the ground waters of the Hoogly region (West Bengal, India) is linked to number of cases of arsenic toxicity in the eastern states. Seafood is staple diet for most of West Bengal and arsenic in the food chain is reason for much concern. It is reported to cause skin damage, decrease in production of white blood cells and irregular heart rhythm. Cadmium, another toxic metal, considered as potential carcinogen by US Environmental Protection Agency is used in many agriculture fertilizers. The consumption of this metal with food crops leads to renal and gastrointestinal failures. The chemical homology of cadmium with zinc and copper ions has been reported to hinder metabolic functioning leading to breathing problems and recently cadmium has been linked to degenerative diseases like lung and stomach cancer.

In India, the practice of using industrial waste waters for irrigation purposes and growing food crops on land that is not appropriate for agriculture has increased the incidence of exposure of Indians to toxic levels of soil heavy metals. The hazard quotient calculated on the basis of concentration of metal ingested through food and body weight of individual, exceeded the acceptable limit in food crops from many areas in India, including, Varanasi, Andhra Pradesh, Rajasthan and many other parts of north India. The main source of heavy metals in these food crops has been reported to be wastewater irrigation and cultivation on contaminated land.

Though generating sufficient food to satisfy global hunger is the major issue facing both developed and developing nations, using inappropriate resources and practices to do so is not the solution. Moreover anthropogenic activities which have led to major disturbances in the delicate elemental and mineral composition of soil is not only harming human health but is proven to be detrimental to the well-being of all forms of life inhabiting Earth.

Remedial Measures:

The reduction in heavy metals in food chain for attaining food security can be a two-pronged approach. This is discussed as follows.

1) The prevention of further deterioration of land by using the following practices:

- Use of treated waste-water (if used for irrigation purposes).
- Prohibiting use of agricultural chemicals with heavy metal content.
- Sealing landfill sites to prevent the leaching of heavy metals in surrounding areas.
- Management of solid waste (municipal, household, industrial, biomedical etc.)

2) Make amendments to soil: Amendments (change or addition) to soil can be done to restore agricultural land in order to improve its physico-chemical properties. Amendments reduce the mobility and availability of these metals and in turn decrease the transfer of metals to plants and food chain. Mobility can be decreased due to pH alterations, chemical bonding of metal ions with substrate to form less mobile complex or by physical adsorption of metal ions on substrate. Both inorganic chemicals and organic products are used as soil amendments.

➢ **Inorganic amendments:**

Inorganic amendments include addition of calcium, magnesium, phosphates, and nitrates to the soil. These amendments are known to increase the soil pH thus decreasing the mobility of metals. Apart from alteration in pH, certain amendments also bind with the metal ions. Limestone when added to soil releases carbonate ions (CO_3^{2-}) in the presence of CO_2. These CO_3^{2-} ions can then combine with certain heavy metals forming stable compounds, for example, $CuCO_3$ and $CdCO_3$.

➢ **Organic amendments:**

The amendments like vermicompost, peat, solid waste, biochar and plant residues have significant effect in lowering the concentration of heavy metals in crops. These amendments act as substrate decreasing the heavy metal mobility due to adsorption or precipitation of metals on these particles. They are also known to alter the pH of soil further decreasing the heavy metal mobility.

Human population growth is a threat to food security. To meet the enormous task of feeding the citizens of their countries, nations are implementing inappropriate agricultural and irrigational practices that are inadvertently disrupting the delicate elemental composition of soil. The disastrous situation of continuous buildup of heavy metals in food crop farms needs to be addressed. As explained earlier, either irrigational malpractice should be stopped immediately or low cost amendments should be adopted for the reclamation of land so as to somewhat control the mobility of heavy metals up the food chain. Use of such amendments not only helps in reclamation of land but also proves to be an effective strategy of waste management.

I have become my own version of an optimist. If I can't make it through one door, I'll go through another door - or I'll make a door. Something terrific will come no matter how dark the present.

~ Rabindranath Tagore

A new technology to remove and capture CO_2

The average temperature of the past three decades have each been higher than any decades since records began. This is the result of human activity which has released green house gases, especially CO_2, into the atmosphere. Burning coal, oil and gas produces large quantities of CO_2 making the power generation sector a focus for climate change mitigation strategies.

Power plants are a major source of CO_2 emissions and contributor to global warming. Carbon capture and storage (CCS) technologies can reduce emissions from power plants. A portable technology to remove CO_2 from their combustion exhaust gases has been tested on a coal burning plant in Poland, which captured thousands of kilograms of CO_2 per day. This could be a viable future means of mitigating CO_2 emissions from the power generation sector.

However, these technologies can be expensive due to the large amounts of energy they require. New CCS technologies that require less energy are being researched. One such technology was designed by the Polish Institute for chemical Processing of Coal in collaboration with an industrial partner, TAURON. The plant absorbs CO_2 using a chemical (amine-based) solvent. The scientists claim that this technology is the most effective for coal-fired power plants and can be implemented with existing units. The plant is mobile so it can be tested in various locations, and flexibly designed.

Source: Science for Environment Policy (5 November 2015)

Diesel fumes alter half the flower smells that bees need

In polluted environments, diesel fumes may be reducing the availability of almost half the most common flower odours that bees use to find their food, research has found. The new findings suggest that toxic nitrous oxide (NOx) in diesel exhausts could be having an even greater effect on bees' ability to smell out flowers than was previously thought.

NO_x is a poisonous pollutant produced by diesel engines which is harmful to humans, and has also previously been shown to confuse bees' sense of smell, which they rely on to sniff out their food. Researchers from the University of Southampton and the University of Reading found that there is now evidence to show that, of the eleven most common single compounds in floral odours, five can be chemically altered by exposure to NOx gases from exhaust fumes.

Bees are worth millions to the British economy alone, but we know they have been in decline worldwide. We don't think that air pollution from diesel vehicles is the main reason for this decline, but latest researches suggest that it may have a worse effect on the flower odours needed by bees than we initially thought. People rely on bees and pollinating insects for a large proportion of our food, yet humans have paid the bees back with habitat destruction, insecticides, climate change and air pollution. This work highlights that the pollution from dirty vehicles is not only dangerous to people's health, but could also have an impact on our natural environment and the economy. It is becoming clear that bees are at risk from a range of stresses from neonicitinoid insecticides through to varroa mites.

Our research highlights that a further stress could be the increasing amounts of vehicle emissions affecting air quality. Whilst it is unlikely that these emissions by themselves could be affecting bee populations, combined with the other stresses, it could be the tipping point.

Source: Science Daily

Our days are getting longer due to rise in sea-level: Study

Melting of glaciers near the Earth's poles and the resulting rise in sea level is partly slowing down the Earth's rotation, thereby increasing the length of our days, a new study suggests. In order to fully understand the sea-level change that has occurred in the past century, we need to understand the dynamics of the flow in Earth's core. The connection is through the change in the speed of Earth's rotation. Melt water from glaciers not only causes sea-level rise, but also shifts mass from the pole to the equator, which slows down the rotation.

Over the past 3,000 years, the core of the Earth has been speeding up a little, and the mantle - crust on which we stand - is slowing down. As a consequence of Earth rotating more slowly, the length of our days is slowly increasing. In fact, a century from now, the length of a day will increase by 1.7 milliseconds. This may not seem like much, but this is a cumulative effect that adds up over time. The scientists involved in the study are confident in predicting sea level to the end of the 21st century. This can help to better prepare coastal towns, for example, to cope with climate change.

Source: Science Daily

Climate-friendly meal options in restaurants

Restaurants can influence consumer food choices by offering climate-friendly meals on their menus, a recent study concludes. In a trial at Finnish restaurants, customers and staff were receptive to selecting meals based on the carbon footprints of their ingredients. The research highlights the importance of planning communication strategies and the need for a carbon footprint food database.

In the EU25, approximately 20–30% of greenhouse gas (GHG) emissions from overall consumption come from the production and consumption of food and drink. One way to reduce emissions could be to make people aware that their food choices affect the environment. Researchers investigated if restaurants in Finland could influence consumer behaviour by offering a choice of two 'Climate Choice' meals alongside conventional meals. The meals offered either a 15% (meat options included) or 30% (vegetarian only) reduction in GHG emissions compared to an average meal. These values were based on the carbon footprints of 200 different ingredients in 105 common lunchtime meals in the restaurants. Carbon footprint calculations were based on published Life Cycle Assessment (LCA) studies and other scientific evidence, and focused on GHG emissions associated with raw material production and the processing of ingredients used in the meals, including packaging, transport and cooking.

Although customers were positive about the idea, they typically chose the climate friendly meal because they thought it would be a healthy choice, rather than for environmental reasons. The researchers therefore suggest that communication should link climate change and health impact. Most restaurant staff were also interested in the concept, despite it involving extra work for them. Only around half of the interviewed customers noticed information about the Climate Choice meals in the restaurants. Information on tables was noticed the most and labels at the buffet the least.

Restaurants cannot currently implement this concept because there is no comprehensive carbon footprint database for food ingredients. Therefore, a list of climate-friendly ingredients could be made available, including most plant ingredients and greenhouse vegetables, grown either in-season or using renewable sources of energy. The researchers say that carbon footprint databases should be created and incorporated with a restaurant's IT system, which already provides the nutritional value of their recipes. Nevertheless, restaurants would still have to determine the origin and production method of ingredients to design truly climate-friendly meals. In order for customers to take note, climate-friendly food should become a long-term concept in restaurants, rather than the focus of short-term campaigns.

Source: Science for Environment Policy

Unbelievable! Glass of water contains 10 million good bacteria

Doctors always insist on drinking lot of fresh water as it is good for health. A new study has come up that has given another good reason to drink water. Even a glass of fresh water contains more than ten million bacteria that are good for health in some way or other, says the new study. These bacteria help in purifying water, making it healthier for drinking.

The researchers have found more than ten million good bacteria in a glass of water. They explained that clean tap water always contain these good bacteria and they grow in the drinking water treatment plant and on the inside of our water pipes, which can be seen in the form of a thin, sticky coating – a so-called biofilm. All surfaces from the raw water intake to the tap are covered in this biofilm.

The new finding suggests that bacteria can play a vital role in purifying the water in pipes than previously thought. The discovery lead to the theory that most of the water purification is done in pipes in water purification process rather than in purification plant.

Formerly, we could hardly see any bacteria at all and now, thanks to techniques such as massive DNA sequencing and flow cytometry, we suddenly see eighty thousand bacteria per milliliter in drinking water."

We have known about the existence of some good bacteria like in our intestine they help in digestion of food and keep us healthy. Maybe they have a much bigger role to play, beyond our imagination and we have to find that.

Moreover, the quality of water might be directly proportional to the amount of bacteria present in water; however, further study is needed to confirm the find.

Source: Kanishk Singh (from Journal of Microbes and Environments)

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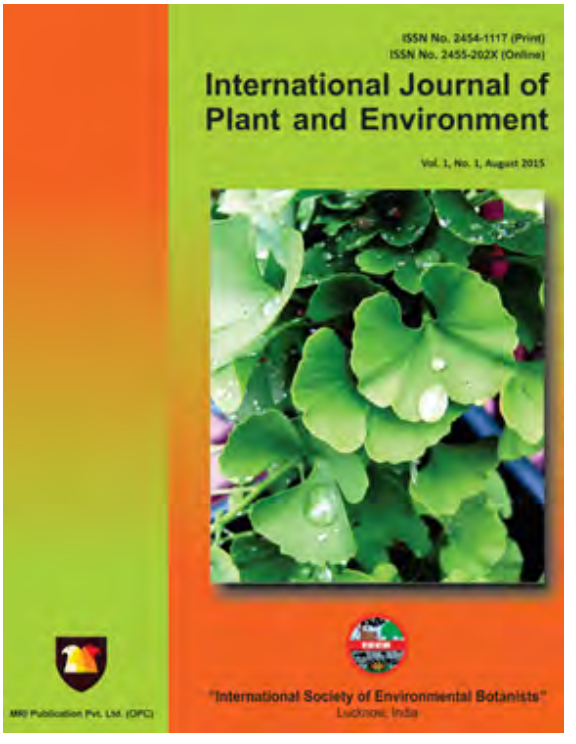

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For editorial matters contact:
Dr. R.D. Tripathi
Editor in Chief, International Journal of Plant and Environment &
Emeritus Scientist (CSIR) & Professor (AcSIR)
Plant Ecology & Environmental Science Division
CSIR-National Botanical Research Institute
Lucknow 226001, INIDA
Mobile: + +91-7376679779
Tel: + +91-522-2297825 Ext: 825 (O); 0522-2721568 (R)
FAX: + +91-522-2297839 / 2297836
Email: ijpeeditors@gmail.com, tripathird@gmail.com; tripathi_rd@rediffmail.com

For subscription contact:
Mr. Pradeep Kumar Tiwari,
Subscription Manager, MRI Publication Pvt. Ltd.
82, Usman Enclave, Near Goel Chauraha, Sec. O, Aliganj, Lucknow – 226024
Mob.: + +91-9696263646

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Contact: Prof. B. D. Joshi,
Director
Institute of Environment & Development Studies
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Tel: +91-522-2297821 (Direct) /
+91-522-2205831 to 2205835 (PBX)
Extn. 821, **Fax:** +91-522-2205836/2205839

E-mail: isebnbrilko@gmail.com /
isebmail@gmail.com;
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