ENVIRONEWS

INTERNATIONAL SOCIETY OF ENVIRONMENTAL BOTANISTS

Newsletter

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IN THIS ISSUE

ISEB FELLOWS - 2018

The Executive Committee of ISEB which met on 9th October 2018 considered the recommendations of ISEB Fellowship Committee and unanimously approved the same. Prof. S.K. Barik accorded his approval to the recommendations. The award certificates will be duly presented to the awardees by the President ISEB at the inaugural function of ICPEP-6 on 27th November 2018 at CSIR-National Botanical Research Institute, Lucknow.

1.	Prof. Erwin Grill	Department of Botany, Technical University of Munich, Germany
2.	Prof. Lena Q. Ma	Soil & Water Sciences Department, University of Florida, Gainesville, Florida, USA
3.	Dr. Debasis Chakraborty	CSIR-National Botanical Research Institute, Lucknow
4.	Prof. Kusum Arunachalam	School of Environment and Natural Resources, Doon University, Dehradun
5.	Dr. Rajesh Bajpai	Lichenology Laboratory, CSIR- National Botanical Research Institute, Lucknow
6.	Dr. Sanjay Dwivedi	CSIR- National Botanical Research Institute, Lucknow
7.	Dr. Seema Mishra	DDU Gorakhpur University, Gorakhpur
8.	Prof. Shashi Bhushan Agrawal	Department of Botany, Banaras Hindu University, Varanasi
9.	Prof. Surya Kant	Department of Respiratory Medicine, KGMU, Lucknow
10.	Prof. Uma Shankar	North-East Hill University, Shillong, Meghalaya

ISEB Young Scientist Award

Dr. Amit Kumar	Dept. of Botany, Lucknow University, Lucknow

NEWS FLASH

Dr. Nandita Singh, Joint Secretary, ISEB, visited China from 2nd to 9th October 2018, to deliver three invited lectures at Forum of the Environment, School of Environment Sciences, Nanjing University; Institute of Soil Sciences, Chinese Academy of Sciences, Nanjing; and College of Ecology and Soil and Water Conservation, Southwest Forestry, Kunming. The lectures were related to Arsenic Phytoremediation.

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Assessment of ecosystem services from sacred groves of India

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Introduction

Sacred groves are forest ecosystems maintained by traditional communities on the ground of religious beliefs. The pan-India presence of sacred groves is a testimony to the religious belief-based biodiversity conservation practice among the traditional communities across the country. The rich diversity of cultural practices and biodiversity conservation interface manifested in the form of sacred groves that exist in India since time immemorial is indeed an important natural heritage. Each community has a unique set of deity, belief system, and rituals associated with sacred groves that helped conserving diverse plant, animal and microbial species in different eco-regions of the country. Most often, sacred groves represent the original floral and faunal diversity of a particular eco-region. Although sacred groves did exist in the past in many other countries including Japan, Korea, Vietnam, Laos and many African and South American countries, today most of these nations have lost these islands of biodiversity due to modernity, weakened belief systems and developmental pressure. Fortunately, in India despite these pressures, an estimated three lakh sacred groves still exist, although a large portion of these sacred groves are partially or highly degraded and disturbed. It is realized that in the present day scenario, religious belief alone can no longer save these vanishing sacred groves. Unless the people who manage these groves are convinced of the value of these ecosystems it would be difficult to protect them. In addition to the biodiversity and cultural values, ecosystem services (*i.e.*, the benefits derived by the humans from these ecosystems), are the greatest benefits that sacred groves provide to the society.

Ecosystem services as defined in Millennium Assessment(MA)-2003, include, "provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling; that maintain the conditions for life on Earth". Unfortunately, most ecosystem service assessment studies in India have not used rigorous scientific methods for quantifying various ecosystem services provided by different ecosystems. Therefore, there is a need to standardize the field data collection protocols and methods for quantifying different ecosystem services in different ecosystems. Keeping these twin objectives in mind *viz*., (i) quantifying ecosystem services so that the people who are custodian of sacred groves realize and appreciate the tangible and intangible benefits that sacred groves provide, and (ii) standardizing field data collection protocols and methods for a robust quantification of ecosystem services, an all India coordinated project was undertaken during the period 2012-2017 in 15 eco-regions of the country involving 15 different institutions/universities (Box 1) with a goal to achieve sacred grove conservation through realization/appreciation of ecosystem service values by the conserving communities.

The Ministry of Environment, Forest and Climate Change, Government of India, sponsored this mega-project with the following objectives:

- To identify and characterize ecosystem services provided by sacred forest ecosystems of the country;
- To develop a framework, set of indicators, and methods for quantification of sacred forest ecosystem services including the mapping of flow of ecosystem services;
- To assess the quantity and quality of various ecosystem services attributable to sacred forest ecosystem;
- To identify and characterize various drivers impacting ecosystem services in sacred forests;
- To study the change in quantity and quality of ecosystem services due to varying degree of product extraction and other disturbances in sacred groves; and
- To value ecosystem services and suggest practical recommendations for their inclusion in conservation decision making process.

Box 1: Participating institutions/universities in the All India Coordinated Project on "Sacred Grove Ecosystem Services Assessment"

1. North-Eastern Hill University, Shillong, Meghalaya (Coordinating Institution)
2. Manipur University, Imphal, Manipur
3. North-Eastern Regional Institute of Science and Technology, Itanagar, Arunachal Pradesh
4. Goa University, Goa
5. Pondicherry University, Pudducherry
6. Andhra University, Vishakhapatnam, Andhra Pradesh
7. Jiwaji University, Gwalior
8. GB Pant National Institute of Environment and Sustainable Development, Kullu Centre, Himachal Pradesh
9. Transdisciplinary University (FRLHT), Bengaluru, Karnataka
10. Sambalpur University, Sambalpur, Odisha
11. Kerala Forest Research Institute, Nilambur, Kerala
12. CPR Environmental Education Centre, Chennai
13. HNB Garhwal University, Srinagar, Uttarakhand
14. Indian Institute of Science, Bengaluru, Karnataka
15. Abasaheb Garware College, Pune, Maharashtra

The following ecosystem services under four categories as per MA classification, were quantified:

- Provisioning: Fresh water
- Cultural: Recreation/Spiritual
- Regulating: Carbon sequestration and local hydrological balance
- Supporting: Biodiversity and Nutrient cycling

In total, six ecosystem services viz., biodiversity conservation service, cultural services, water quality and improved hydrology, carbon sequestration, and nutrient conservation provided by more than 100 sacred groves located in different ecological regions of the country were quantified.

The eco-regions were: Central Himalaya (Kullu, Himachal Pradesh), Western Himalaya (Srinagar, Garhwal), North-eastern India (Meghalaya and Manipur), Eastern Himalaya (Arunachal Pradesh), Central India (Madhya Pradesh), Eastern Ghats (Odisha and Andhra Pradesh), Western Ghats (Kerala and Karnataka), Deccan plateau (Tamilnadu), and Coastal Tamilnadu/Pudducherry. Ecosystem services were assessed along the size of sacred groves and disturbance gradients as well as under different management regimes. Disturbances in sacred groves were characterized, and impact of disturbance on sacred grove ecosystem services was assessed. A uniform method for quantification of each of the ecosystem services was developed and was followed for all the sacred groves. The quantification exercise was undertaken in close collaboration with the people associated with the sacred grove management. This helped them realize the importance of sacred grove conservation.

Results

The amount of data collected through this initiative on six ecosystem services from 100 sacred groves was enormous. The magnitude of data varied based on geographic location, size, management regime and disturbance level of sacred groves. Although all the identified ecosystem services got depleted with increased level of disturbance, and decreased size of sacred groves throughout the country, the management regime did not show any definite trend, which varied according to the management structure that is in place in different states/regions. The data pertaining to selected sacred groves of Meghalaya in respect of certain ecosystem services are presented in this article as a case study.

Sacred groves of Meghalaya selected for the study

The study was conducted in six sacred groves viz., Mawnai sacred grove, Nongkrem sacred grove, Mukhla sacred grove, Nongbah sacred grove, Muthlong sacred grove and Ialong sacred grove situated in different districts of Meghalaya. Out of the total six sacred groves studied, four are located in Jaintia Hills district viz., Ialong sacred grove, Mukhla sacred grove, Muthlong sacred grove and Nangbah sacred grove. Ialong sacred grove, managed by *Raid* (community management under *Elaka* Chief) is located about 9 km from Jowai, the headquarters town of Jaintia Hills district (latitude 25°27.45'N, longitude 92°15.21'E). Mukhla sacred grove, managed by *Lyngdoh* (priest) is located about 15 km from Jowai (latitude 25°29.84'N, longitude 92°11.34'E). Muthlong sacred grove (latitude 25°27.80'N, longitude 92°19.00'E), managed by *Lyngdoh* is located 17 km from Jowai, and Nangbah sacred grove (Figure 1; latitude 25°31.58'N, longitude 92°15.26'E) managed by *Doloi* (*Elaka* chief of Jaintia Hills), is about 13 km from Jowai. The sacred groves managed by *Doloi* and *Raid* are called as *Khloo Blai* (literally meaning 'forest of the God') and those by *Lyngdoh* or priest are known as *Khloo Lyngdoh*. These groves are well protected for a long time based on strong religious beliefs of the Jaintia tribe and they generally represent the climax vegetation of the region.

The other two sacred groves are located in East and West Khasi Hills districts of Meghalaya. Both these forests are known as *Law Lyngdoh* (forest taken care by the *Lyngdoh* or Priest). Mawnai sacred grove is located in West Khasi Hills district of Meghalaya (latitude 25°34.95'N, longitude 91°36.00'E) at a distance of about 65 km from Shillong, the capital of Meghalaya state. The other sacred grove is known as Nongkrem sacred grove and is located in East Khasi Hills district (latitude 25°29.67'N, longitude 91°52.65'E), which is about 23 km from Shillong.

Plant diversity in sacred groves under different management institutions

Sacred groves managed by *Lyngdohs* (priest clan) had greater species richness than those managed by *Raid* (*Elaka* chiefs in Khasi Hills district) and *Dolois* (*Elaka* chiefs in Jaintia Hills). The species richness as well as the number of endemic and threatened plant species was far greater in the sacred groves than the adjoining unprotected community forests (Figure 2). All the plant community attributes likewise, were adversely affected due to disturbance.

Tree biomass/carbon in sacred groves and adjacent unprotected community forests

Tree biomass values, an expression of carbon stock in the three sacred groves *viz*., Mawnai, Nongkrem and Nangbah, and their adjacent unprotected community forests

Figure 1: A view of Nangbah sacred grove in Jaintia Hills, Meghalaya along with the adjacent crop fields.

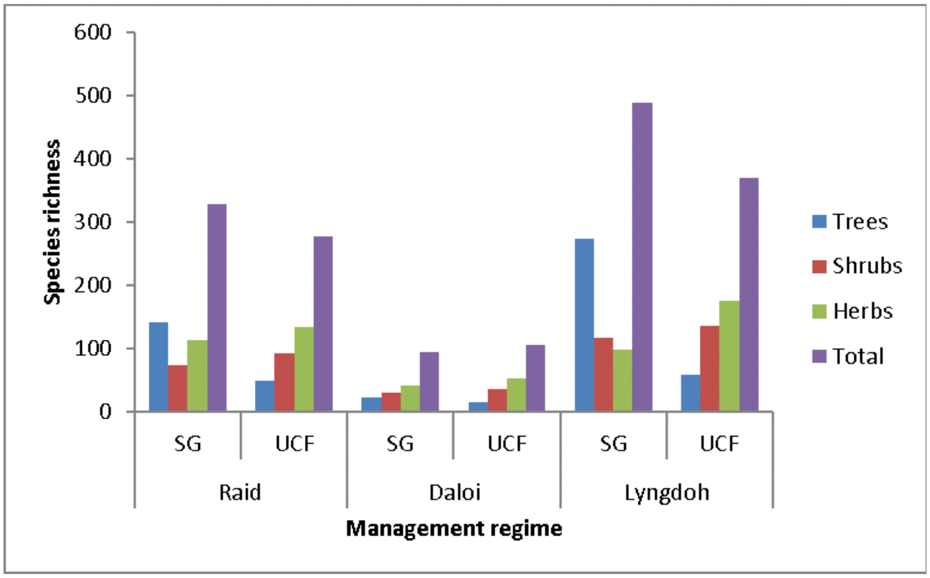

Figure 2: Species richness of sacred groves (SG) and adjacent unprotected community forests (UCF) under different management regimes in Meghalaya.

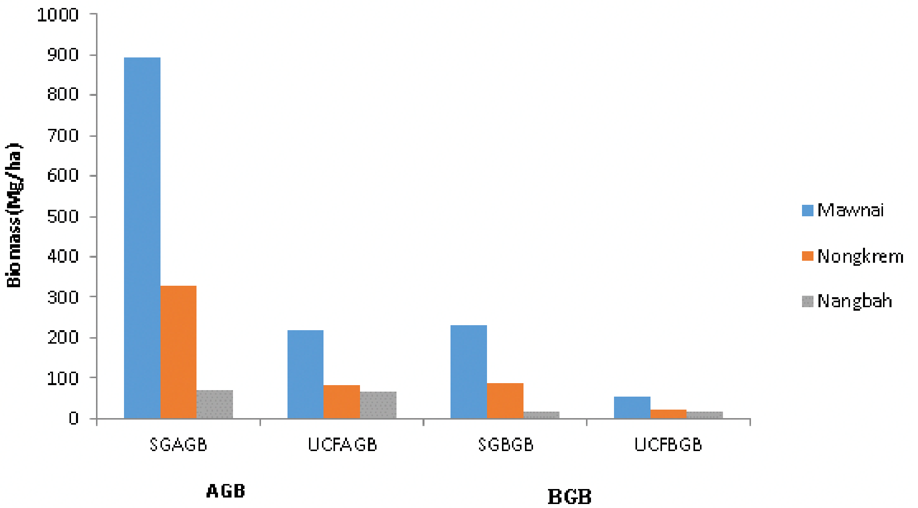

Figure 3: Tree biomass in sacred groves and adjacent unprotected community forests in three study sites of Meghalaya.

revealed significant ($p<0.05$) variation in biomass content among the groves as well as between the sacred groves and adjacent unprotected community forests (Figure 3). The adverse effect of disturbance was evident from the lower tree biomass values as obtained in adjacent unprotected community forests compared to the undisturbed sacred groves.

Other ecosystem services

Although data is not presented here due to space constraint, water quality in the undisturbed sacred forests was far better than the disturbed community forests. Water-use data showed that more households draw water from the undisturbed sacred forests for different purposes as compared to the disturbed community forests. The soil nutrients showed significant decrease in concentration with disturbance. There was a flow of nutrients from the sacred forests to the adjacent agricultural fields, which contributed towards the soil fertility in the adjacent agricultural field. This contribution of nutrient flow towards the soil fertility in the agricultural fields resulted in increase in the annual crop yield of the agricultural fields adjacent to the undisturbed sacred forests as compared to the agricultural fields adjacent to the

Figure 4: Rituals at Mukhla sacred grove.

disturbed community forests. The data on tree biomass carbon validated the hypothesis that undisturbed sacred groves with dominance of higher girth class trees are better carbon sinks than the disturbed forests. Cultural importance of each sacred grove was also documented. Level of cultural importance and religious belief associated with the sacred grove was a major determinant of disturbance intensity in the sacred grove (Figure 4).

Management of grove did vary among the sacred groves, and the ecosystem services varied with management regime. Large sacred groves provided greater ecosystem services per unit area than the medium and small sized groves.

Multiple ecosystem service-based conservation area prioritization

Remote sensing imageries and geographic information system duly supported by adequate field sampling were used to map the spatial distribution of these ecosystem services. The flow of different ecosystem services was mapped and areas providing maximum ecosystem services in a landscape were identified for future protection (Figure 5).

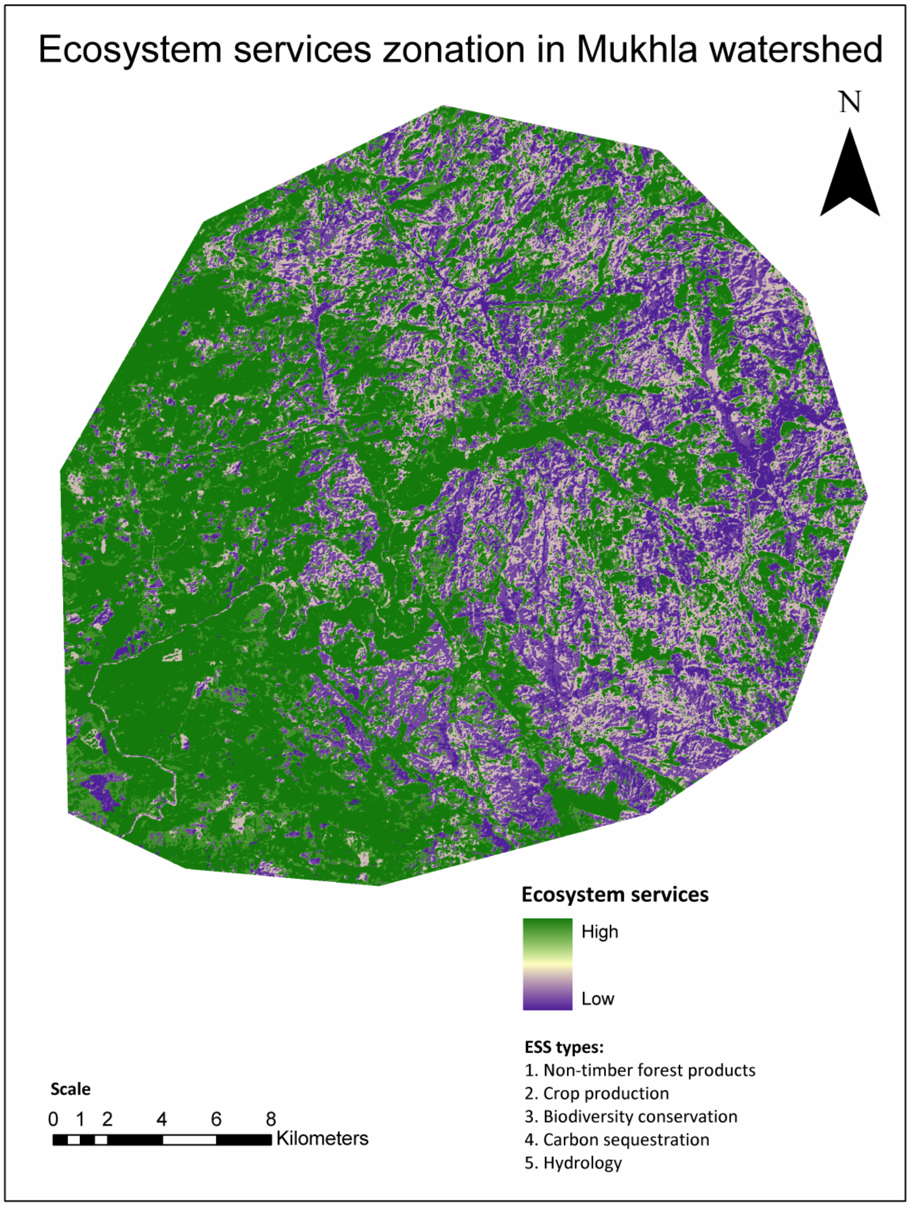

Figure 5: Prioritization of conservation area based on multiple-ecosystem services in Mukhla watershed, Meghalaya.

Conclusion

The sacred groves are the remnants of climax vegetation of the region, and have been protected by the tribal communities and their traditional institutions since time immemorial on religious ground. They provide several benefits to the people. They maintain clean environment, protect water sources and offer suitable ecological niches to a number of endemic and threatened species. However, the decrease in number and size of sacred groves, and their degradation caused by erosion of religious beliefs, and increasing anthropogenic pressures are a matter of grave concern. The quantitative data collected on ecosystem services will generate added interest in the tribal communities to conserve these forest patches. The realization of immense value of ecosystem services that these sacred groves provide,is expected to enhance conservation efforts by the local communities, which in turn, would ensure continuous flow of ecosystem services. Thus there is a strong need to undertake quantitative assessment of ecosystem services provided by the sacred groves representing diverse ecosystems in order to convince all stakeholders to protect these groves from disturbance.

Acknowledgement

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Strategies to reduce arsenic uptake by rice

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Arsenic is a known carcinogen and it has been reported that it is a cancer promoter rather than an initiator. It has epidermological as well as serious health effects like cancer, hyperkeratosis on human beings. Arsenic in human beings enters through contaminated food and water. In food arsenic is found in those areas where there is contamination in soil or irrigation water. The vegetables and crops grown there are source in human beings. Arsenic contamination has become a major problem in many parts of the world. Rice is the staple food for the people of arsenic contaminated areas of South and South-East Asia. Rice grains have higher arsenic levels than other cereals like wheat and barley. In India, West Bengal is most affected where rice is the major crop grown. The arsenic contaminated water has been extensively used for paddy irrigation which has resulted in high deposition of arsenic in topsoil and uptake in rice grain, increasing threat to the sustainable agriculture in this region. The arsenic concentration in rice varies with the rice varieties. The selection of suitable rice genotype is essential to limit As concentration in rice. There is a need to breed rice cultivars with high tolerance to As in the soil and which prevent its partitioning into grain. But the problem arises due to continuous addition of arsenic in soil through the contaminated water.

Paddy rice is characterized by iron plaque on root surfaces. Ferrous ions form from the reduction of ferric ions under the reducing conditions such as paddy fields. Paddy rice roots can release oxygen and oxidants into the rhizosphere, thereby oxidizing the ferrous ions transported to roots from paddy soils into ferric irons with the precipitation of iron oxides or hydroxides. Under field conditions, iron plaque has also served as a restraint on the uptake of metal(loids) such as As by plants. This is probably due to its adsorption or co-precipitation processes. At the same time, the sink-like characteristic of iron plaque leads to the concentration of metal(loid)s in the rhizosphere. In some cases, iron plaque may release these metal(loid)s and subsequently enhance uptake. For example, iron plaque can diminish the inhibition effect of phosphate on paddy rice's arsenate uptake. The experiments with Fe/Mn plaque formation on root and As uptake in different genotypes, showed that root oxidation significantly influences As mobility in rhizoshphere. Genotype with higher radial oxygen loss (ROL) induces more Fe plaque formation and sequesters more As in iron plaque and rhizoshphere soil, leading to the reduction of As accumulation in rice plants. The Fe/ Mn plaque formation on the root surface play a crucial role on the genotypic variations in As uptake. The differences in iron plaque formation among rice genotypes have been noted. Specifically, the interactions between genotype, environment, and environment x genotype affect the uptake and accumulation of As. Furthermore, Hu and his group have reported that both As and phosphate concentrations in iron plaque had a strong positive correlation with the amounts of Fe in iron plaque (DCB-extractable) for three rice cultivars. The degree of ROL has been used to evaluate root aeration and has been found to have a strong correlation with As tolerance and accumulation in rice.

Development of efficient, cost effective and environment friendly remediation method is needed for As removal from contaminated soil and water. Phytoremediation, the use of plants to clean up pollutants, is steadily gaining acceptance. *Pteris vittata* (Chinese brake fern) is a well-known As hyperaccumulator. The plant possesses an exceptional ability to take up, translocate and tolerate As. When grown in As-contaminated soils, *P. vittata* accumulates As in fronds often more than 10 times the concentration in the soil. In glasshouse pot experiments, *P. vittata* removed between 0.1 and 26% of the soil As, depending on soil As concentration and bioavailability, and other soil factors. In a small scale field trial, Ma and her group from University of Florida, reported that the mean concentration of soil As was decreased from 190 to 140 mg kg^{-1} after three harvests of *P. vittata*. However, many plants have been reported as As hyper-peraccumulators. Xie and his group have listed ferns as naturally evolved As accumulators, and the majority of them are members of the Pteris genus. Beside these, efforts have led to the identification of other potential As-accumulator aquatic and terrestrial plants. However, there is a need to screen more plants to find the best suited option for a particular area. The use of indigenous plants with high tolerance and accumulation capacity for As could be a very convenient approach to As phytoremediation. From phytoremediation perspective, plants should display, (i) high uptake rate; (ii) tolerance to high concentration of As; (iii) high translocation to shoot system; (iv) efficient system to tolerate high As level in plant parts.

Another possibility is *in situ* arsenic phytostabilization, i.e., using metal tolerant plants for retaining the metal maximally in roots, thus reducing leaching and uptake in plant parts, further preventing transfer to food chain. The field utilization potential of most of these hyperaccumulator plants are very less due to their small biomass and slow growth rate. Rhizoremediation, involving both plants and the rhizospheric microbes, is an efficient bioremediation process for contaminant degradation and/or promoting plant growth in presence of plant growth promoting bacteria (PGPB). Different metal tolerance mechanisms have also been discovered in various microbes: exclusion, active removal, biosorption, precipitation or bioaccumulation, both in external and intracellular spaces. Some bacterial strains are also known to play an important role in the biochemical cycle of As, through its conversion to species with different solubility, mobility, bioavaiability and toxicity. The known mechanism of arsenic resistance in microorganisms requires the ars operon and is based on energy dependent efflux of both arsenate [As(V)] and arsenite [As(III)] from the cell. In this operon the gene arsC is particularly interesting because its product, a cytoplasmic arsenate reductase, catalyzes reduction of less toxic As(V) to more toxic As(III), which may be transported out of the cell by arsAB, As chemiosmotic efflux system and by ATPase membrane system. Rhizospheric bacteria have found to enhance, reduce, or have no effect on the metal uptake. For instance Srivastava and group identified a bacteria *Staphylococcus arlettae* strain NBRIEAG-6, which was able to remove arsenic from liquid media and possesses arsC gene, gene responsible for arsenate reductase activity. The biochemical profiling of the isolated strain showed that it had the capacity of producing indole acetic acid (IAA), siderophores and 1-aminocyclopropane-1-carboxylic acid(ACC) deaminase. The microbial inoculation significantly ($p < 0.05$) increased biomass, protein, chlorophyll and carotenoids contents in test plant. Moreover, bacteria NBRIEAG-6 has the ability to help *B. juncea* to accumulate As maximally in plant root, and can be accounted as a new bacteria for As phytostabilization. Plants from As contaminated soils are generally mycorrhizal, indicating that the symbionts can evolve As-tolerance. However, conflicting results are reported in the literature concerning the role of mycorrhizae (including AM) in the absorption and translocation of metals into the plant, some reports indicating exclusion, some others accumulation.

Arsenic-contaminated irrigation water could increase the As level in soil and its subsequent accumulation in rice grains; however, the arsenic risk assessment of rice based on the total content of As in the soil and irrigated groundwater can be misleading because arsenic accumulation in plants is largely influenced by a variety of factors, including soil physicochemical parameters; other elements such as iron, phosphorus, sulfur, and silicon concentrations; and environmental conditions that control As availability and uptake in the soil-rhizosphere-plant system. Environmental conditions can be managed by changing irrigation practices. For example, the flooding of the paddy soil mobilizes As in the soil solution and can increase As accumulation in rice. Therefore, changing agricultural practices to aerobic rice cultivation throughout the entire season may be a viable strategy to mitigate this problem.

The uptake of arsenite in rice usually occurs through the silicon transport pathway. Therefore, the application of silica fertilizer in soil is suggested to decrease the transfer of arsenic from the soil and irrigation water to rice. Furthermore, phosphate fertilization is suggested to lower arsenate uptake in plants because both compounds enter rice via the same transporters. However, there are arguments in certain cases because under flooding conditions, As is present as arsenite, which cannot compete with phosphate; furthermore, phosphate increases As mobility because it competes with arsenate for the adsorption site on Fe-oxides/hydroxides.

Researchers and practitioners are trying their level best to mitigate the problem of As contamination in rice. However, the solution strategies vary considerably with various factors, such as cultural practices, soil, water, and environmental/economic conditions, etc. The contemporary work on rice to explain arsenic uptake, transport, and metabolism processes at rhizosphere, may help to formulate better plans. Common agronomical practices like rain water harvesting for crop irrigation, use of natural components that help in arsenic methylation, and biotechnological approaches may explore how to reduce arsenic uptake by food crops.

Mining and Human Health Hazards

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Mine dusts in ambient air are generally above allowable limits. Prolonged exposure to these dusts could lead to respiratory diseases (asthma, silicosis and tuberculosis) and skin disorders. The concentrations of these dusts present great risks to the health of miners and inhabitants around the mine. It is necessary to have control measures such as wet drilling, sprinkling of water on mine roads and planting of vegetation around mine to trap mine dusts. Although many countries require reclamation plans for coal mining sites, undoing all the environmental damages to water supplies, destroyed habitats, and poor air quality is a long and problematic task. Bad mining practices can ignite coal fires, which can burn for decades, release fly ash and smoke laden with greenhouse gasses and toxic chemicals. Furthermore, mining releases coal mine methane, a greenhouse gas 20 times more powerful than carbon dioxide.

Coal dust inhalation causes black lung disease among miners and those who live nearby, and kills thousands every year.

Major types of mining practices

There are two widely used ways of mining: strip mining and underground mining.

Strip mining

Strip mining (also known as open cast, mountaintop or surface mining) involves scraping away earth and rocks to get to coal buried near the surface. In many cases, mountains are literally blasted apart to reach thin coal seams within, leaving permanent scars on the landscape as a result.

Strip mining accounts for about 40 per cent of the world's coal mines but in some countries, such as Australia, it accounts for about 80 per cent of mines. Even though it is highly destructive, industry often prefers strip mining as it requires less labour and yields more coal than underground mining.

There is an increased risk of chemical contamination of ground water when minerals in upturned earth seep into the water table, and watersheds are destroyed when disfigured land loses the water it once held. Strip mining causes dust and noise pollution when top soil is disrupted with heavy machinery and coal dust is created in mines.

The result of all this is barren land that stays contaminated long after a coal mine shuts down.

Underground mining

The majority of the world's coal is obtained through underground mines. While underground mining, which allows coal companies to extract deeper deposits of coal, is viewed as less destructive than strip mining.

The principal *airborne hazards* in the mining industry include several types of particulates, naturally occurring gases, engine exhaust and some chemical vapours; the principal *physical hazards* are noise, segmental vibration, heat, changes in barometric pressure and ionizing radiation. These occur in varying combinations depending on the mine or quarry, its depth, the composition of the ore and surrounding rock, and the method(s) of mining. Among some groups of miners who live together in isolated locations, there is also risk of transmitting some infectious diseases such as tuberculosis, hepatitis (B and E), and the human-immunodeficiency virus (HIV).

Common health threats posed by coal mining

- Pneumoconiosis, aka black lung disease or CWP, is caused when miners breathe in coal dust and carbon, which harden the lungs. Estimates show that 1,200 people in the US still die from black lung disease annually. The situation in developing countries is even worse.
- Cardiopulmonary disease, chronic obstructive pulmonary disease, hypertension, lung disease, and kidney disease have been found in higher-than-normal rates among residents who live near coal mines.

Airborne Particulate Hazards

Free crystalline silica is the most abundant compound in the earth's crust and, consequently, is the most common airborne dust that miners and quarry-workers face. Free silica is silicon dioxide that is not chemically bonded with any other compound as a silicate. The most common form of silica is quartz. Respirable particles are formed whenever silica-bearing rock is drilled, blasted, crushed or otherwise pulverized into fine particles. Exposure can occur in any mining operation, surface or underground, where silica is found in the overburden of a surface mine or the ceiling, floor or ore deposit of an underground mine. Silica can be dispersed by the wind, by vehicular traffic or by earth-moving machinery.

With sufficient exposure, silica can cause silicosis, a typical pneumoconiosis that develops insidiously after years of exposure. Exceptionally high exposure can cause acute or accelerated silicosis within months with significant impairment or death occurring within a few years. Exposure to silica is also associated with an increased risk of tuberculosis, lung cancer and of some autoimmune diseases, including scleroderma, systemic lupus erythematosus and rheumatoid arthritis. Freshly fractured silica dust appears to be more reactive and more hazardous than old or stale dust. This may be a consequence of a relatively higher surface charge on freshly formed particles.

The most common processes that produce respirable silica dust in mining and quarrying are drilling, blasting and cutting silica-containing rock.

Silica exposure also occurs at stone quarries where stones are cut to specified dimensions. Often attached to or nearby a stone quarry is a mill where pieces are sculpted into a more finished product. Unless there is very good local exhaust ventilation, exposure to silica can be high because vibrating and rotating hand tools are used to shape the stone into the desired form.

Respirable coal mine dust is a hazard in underground and surface coal mines and in coal-processing facilities. It is a mixed dust, consisting mostly of coal, but can also include silica, clay, limestone and other mineral dusts. The composition of coal mine dust varies with the coal seam, the composition of the surrounding strata and mining methods. Coal mine dust is generated by blasting, drilling, cutting and transporting coal.

More dust is generated with mechanized mining than with manual methods. The generation of coal mine dust can be reduced by changes in coal cutting techniques and its dispersion can be controlled with the use of adequate ventilation and water sprays.

Other mines where asbestos is found in the ore

Among miners throughout the world, exposure to asbestos has elevated the risk of lung cancer and of mesothelioma. It has also elevated the risk of asbestosis (another pneumoconiosis) and of airways disease.

Gases and Vapours

The most important naturally occurring gases are *methane* and *hydrogen sulphide* in coal mines and radon in uranium and other mines. Oxygen deficiency is possible in either. Methane is combustible. Most coal mine explosions result from ignitions of methane and are often followed by more violent explosions caused by coal dust. Throughout the history of coal mining, fires and explosions have been the principal cause of death of thousands of miners.

Radon is a naturally occurring radioactive gas that has been found in uranium mines, tin mines and some other mines. It has not been found in coal mines. The primary hazard associated with radon is its being a source of ionizing radiation.

Other gaseous hazards include respiratory irritants found in diesel engine exhaust and blasting by-products. *Carbon monoxide* is found not only in engine exhaust but also as a result of mine fires. During mine fires, CO can reach not only to lethal concentrations but also can become an explosion hazard. *Nitrogen oxides* (NO_x), primarily NO and NO_2, are formed by diesel engines and as a by-product of blasting.

Oxygen deficiency can occur in many ways. Oxygen can be displaced by some other gases, such as methane, or it may be consumed either by combustion or by microbes in an air space with no ventilation.

There is a variety of other airborne hazards to which miners are exposed. Exposure to mercury vapour is a hazard among gold miners and millers and among mercury miners. Exposure to arsenic, and risk of lung cancer, occurs among gold miners and lead miners. Exposure to nickel can lead to lung cancer and skin allergies among nickel miners.

Some plastics are finding use in mines also. These include *urea-formaldehyde* and *polyurethane foams*, both of which are plastics made in-place. They are used to plug up holes and improve ventilation and to provide a better anchor for roof supports. Formaldehyde and isocyanates, two starting materials for these two foams, are respiratory irritants and both can cause allergic sensitization. Formaldehyde is a human carcinogen.

Other hazards

Noise is ubiquitous in mining. It is generated by powerful machines, fans, blasting and transportation of the ore. The underground mine usually has limited space and thus creates a reverberant field.

Ionizing radiation is a hazard in the mining industry. Radon can be liberated from stone while it is loosened by blasting, but it may also enter a mine through underground streams. It is a gas and therefore it is airborne. Radon and its decay products emit ionizing radiation, some of which have enough energy to produce cancer cells in the lung. As a result, death rates from lung cancer among uranium miners are increased. For miners who smoke, the death rate is very much higher.

Heat is another hazard particularly in underground mines. The principal source of heat is from the rock itself. The temperature of the rock goes up about 1 °C for every 100 m in depth. Very deep mines (deeper than 1,000 m) can pose significant heat problems, with the temperature of mine rising to about 40 °C.

Many mines operate at high altitudes (e.g., greater than 4,600 m), and because of this, miners may experience altitude sickness. This can be aggravated if they travel back and forth between a mine at a high altitude and the site with more normal atmospheric pressure.

World Health Organization considers 55 $\mu g/m^3$ as acceptable value and above 90 $\mu g/m^3$ as unacceptable value of dust in ambient air. Researches have shown that suspended particulate matter is the major causes of asthma, lung cancer, cardiovascular diseases and premature deaths in humans. The concentrations of SPM at drilling site were more than these prescribed values by WHO.

The impact of these dusts on the health of miners depends on the exposure level, the duration of exposure, the frequency of exposure, the chemical and mineralogical composition of inhaled particle. Miners dressed in torn clothes without wearing any personnel protection equipment such as, hard hat, cover-all, nose and ear muffs are more vulnerable.

In India, miners and people living in the coal fields, inhaling fine dust particles of up to 5µm in size often suffer from asthma and bronchitis, cancer, tuberculosis and skin diseases. There is a greater incidence of these occupational diseases among miners and people living in the coal fields in India compared to China, Japan and western countries because the mines in India are emitting PM_{10} into the atmosphere in excess of allowable WHO limits.

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21-22 February 2019; Kuala Lumpur, Malaysia.

Website: https://bioscienceconference.com/

Email: info@bioscienceconference.com

GPB 2019

Third Global Congress on Plant Biology and Biotechnology

11-13 March, 2019; Singapore

E-mail: plantbiology-2019@magnus-group.org

Website: https://plantbiologyconfere nce.com/

5th International Conference on Pollution Control & Sustainable Environment

14-16 March, 2019; London, UK

E-mail: pollutioncontrol@earthscienceconferences.com

Website: https://pollution.environmentalconferences.org/conference-brochure.php

3rd International Conference on Ecology, Ecosystem and Conservation Biology

20-21 March, 2019; Chicago, USA

Contact: Conference Series LLC Ltd.

47 Church Field Road W3 6AY,

London, U.K.

E-mail: ecology@earthscienceconferences.com

Website: https://ecologyecosystem.conferenceseries. com/

5th World Congress on Medicinal Plants and Natural Products Research

15-16 April, 2019; Hong Kong

E-mail: medicinalplants@pharmaceuticalconferences.org

Website: https://medicinalplants.pharmaceuticalconferences.com/

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