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International Decade of Soils 2015-2024

FROM THE PRESIDENT'S DESK

The idea of using modeling is to estimate functions or services indirectly. Indeed, if the features of the soil that are key to the delivery of a particular service are identified over some expanse of land and can be assessed quantitatively, this information could in principle be used in one of a number of available mathematical models, like the very popular "Soil and Water Assessment Tool," SWAT, to estimate the corresponding service. For example, the process of downward percolation of water and the concomitant filtration of pathogens, bio-colloids, or particulate matter, leading eventually to aquifer recharge and to the supply of good-quality groundwater to human populations, can be approximated by measuring the hydraulic conductivity and filtration capacity of the soil at different locations and depths within the targeted area. Then after taking advantage of geo-statistical or other spatial statistics methods to interpolate between measured locations and produce continuous maps of relevant properties, one could use the resulting maps as input in models of water and solute transport in the vadose zone, in order to predict the extent of aquifer recharge.

There are, however, several problems associated with this approach, which explain largely why it has not yet been used much to quantify soil functions or services. It may not be too difficult to model soil processes at selected locations in a field, even though recent attempts at predicting soil services under these conditions demonstrate that for some soil characteristics, predictions are not optimal. Still, it is significantly more difficult to predict soil functions or services over specific land area and time spans longer than a few days. A key hurdle in the former case is that measurements are needed at a sufficient number of points to account for the spatial heterogeneity of the soil. Large numbers of measurements typically take an inordinate amount of time and therefore are onerous, especially if the area considered is large or the soil very heterogeneous spatially. Even if measurements could be carried out, the approach would still lead in most situations to relatively inaccurate predictions in the end. In the case of the prediction of aquifer recharge, uncertainty could result from inadequate handling of some key processes, like preferential transport, whose monitoring and modeling remain very challenging at this stage.

In addition to the tricky question of how big or small of an area needs to be considered, modeling efforts also run into the same resolution issue as does the direct quantification of soil functions and services. This is well illustrated in a landmark study wherein different grid sizes were used to estimate inputs to a spatially explicit, variable-source-area hydrology model, with which it was tried to predict soil water retention in a watershed. Data on topography, soil type, and land use were input at grid sizes from 10 to 600 m. Output data consisted of runoff and spatial pattern of soil moisture. Simulation results showed higher average soil water contents and higher evaporation rates for large grid sizes. During dry years, runoff was greatest for the smallest grid size.

It as an advantage that the simulation of watersheds in SWAT can produce outputs at different spatial and temporal scales. SWAT can provide data at the watershed, the sub-basin, and at the Hydrologic Response Unit (HRU) level, as well as for impounded areas like ponds, wetlands, etc., reservoirs, and/or reach geographical features at the average annual, monthly, daily, and hourly time frames." While this indeed shows the versatility of the modeling tool in question, it also raises a number of questions about the best way to approach the connection between ES and the various realities that are revealed at different spatial or temporal scales. Further research is definitely needed to provide guidance in this respect.

Meghalaya Chapter Observed 72nd Foundation Day of SCSI

The Meghalaya Chapter observed 'Foundation Day' of the Soil Conservation Society of India on 24th September, 2023 at School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, CAU, Barapani by initiating a plantation drive at the campus to make it "Green Campus".

Dr. Sanjay Swami, Professor (Soils) & Chairman of the SCSI-Meghalaya Chapter extended greetings to all the SCSI team members on the occasion of 72nd foundation day. In his presidential remarks, he apprised that the Soil Conservation Society of India was first established at Hazaribagh, Bihar (now in Jharkhand) in December 1951 and later on the HQ was shifted to New Delhi. He informed that this year, they are celebrating 72nd foundation day of the society today. He added that the SCSI is mandated to the welfare of farmers and all the rural people whose livelihoods are associated with the management of natural resources. It works for the cause of conservation, development, management and sustainable use of the soil, land, water and associated resources of plants and animals. The SCSI extends its activities by establishing State Chapters in various parts of the country and at present, 23 State Chapters of the SCSI are functioning including the Meghalaya State Chapter at CPGS-AS, Barapani. He also highlighted the concentrated efforts of SCSI team at national and international level in conserving the natural resources since its inception.

highlighted the importance of joining the SCSI, elaborated the benefits in academic career like participation in annual conference, publication of research papers, articles, keeping in touch with recent research trend and learning about innovative approaches for sustainable management of soil and water resources.

Mr. Shubham Singh, Mr. Basant Tamang and Mr. T.R. Meena also shared their views about how they are being benefitted from the SCSI activities such as getting exposure by attending conferences, online lectures, quiz and essay competitions, and winning various awards. Mr. Shubham Singh informed the fellow students that recently he applied for the post of guest faculty position, and got 2 marks for being a member of SCSI as there was a provision of marks for professional society membership. He urged the fellow students to join the SCSI team and contribute for the farmers and rural people.

Many members of SCSI-Meghalaya Chapter also participated in this event. The programme ended with vote of thanks proposed by Ms. Ventina Yumnam, a student member of the Meghalaya Chapter.

Dr. Swami also appraised the house about various activities taken up by the Meghalaya Chapter of SCSI for improving soil and environmental health in the hilly tract of Meghalaya and shared that their efforts in this direction has been recognized by the SCSI HQ as the Meghalaya Chapter was conferred with the prestigious Best Chapter Award - 2020 among 23 state chapters of SCSI in the country. He added that this is the result of hard and dedicated work of all its members and congratulated the Meghalaya Chapter team.

Ms. Pritisha Patgiri, an active member of Meghalaya Chapter shared her experiences to the house and

Harmonizing Agroecosystems: Symbiotic Dance of Microorganisms in the Era of Climate Change

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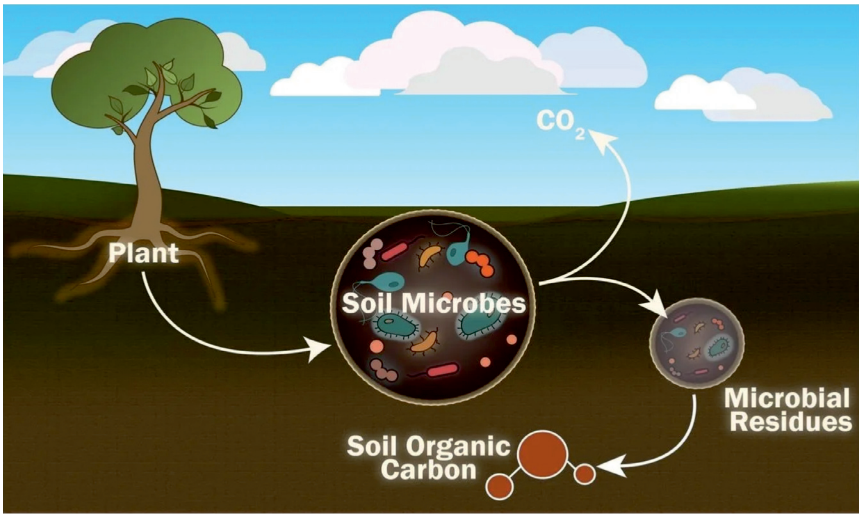
Climate change is altering global precipitation and temperature patterns, affecting agricultural land, urban-industrial agglomerations, and methane and nitrous oxide release. The 21^{st} century is predicted to see a 2-3^{0}C increase in global mean temperature, potentially threatening food security. Understanding climate and soil interactions is crucial for ecology. Most studies focus on direct effects of temperature and precipitation on microbial composition and diversity. Studies on the impact of temperature and precipitation on soil microbial community structure have shown mixed results. Some studies found that soil warming treatment altered the structure, while others found no significant impact. Precipitation manipulation also showed changes in bacterial community composition, but no significant direct effects were observed.

Experimental results on temperature and precipitation manipulation may overestimate the direct effects of climatic factors on soil microorganisms and underestimate the indirect effects. Direct effects involve changes in climatic factors directly affecting microorganisms, while indirect effects involve changes in other media like soil and vegetation. In natural ecosystems, climatic factors often determine changes in soil properties and vegetation that indirectly affect microorganisms. However, few studies have evaluated the importance of both direct and indirect effects to better understand climate change influence.

Natural causes of climate change:

Volcanic eruptions: Volcanoes can have both cooling and warming effects on the planet's climate. They emit gases and particles, reflecting sunlight away from the Earth and contributing to the greenhouse effect. Large eruptions, like Mount Pinatubo in 1991, can significantly cool the planet, while their warming impact lasts longer. Continental drift: The continents we know today formed due to landmass drift millions of years ago, impacting



The study reveals that urea application alters microbial composition, decreases archaeal amoA and mcrA gene abundances, and increases bacterial amoA gene abundances. It also shows that environmental factors like soil Eh, land use conversion, and organic fertilizers can increase CH_4 emissions. Landscape characteristics and water bodies influence microbial greenhouse gas emissions and carbon storage. The balance of methane on Earth depends on three groups of microbes: methanogenic, methanotrophic, and methane-oxidizing bacteria.

climate by altering physical features, water body positions, and ocean currents. This drift continues today, with the Himalayan range rising by 1 mm annually.The Earth's tilt: Earth orbits the sun at a 23.5° angle, with the northern hemisphere tilting towards the sun during summer and away during winter. Seasons are influenced by tilt, with more tilt causing warmer summers and colder winters. The Earth's elliptical orbit varies the distance between the Earth and the Sun, and precession, a gradual change in the Earth's axis, causes climate changes. Ocean currents: Oceans cover 71% of Earth and absorb twice as much sun radiation as the atmosphere or land surface. Ocean currents move heat, affecting climate. Water vapor, Earth's most abundant greenhouse gas, escapes from the oceans and contributes to cloud formation, cooling the surface. These phenomena can impact climate, as seen at the end of the last Ice Age.

Human causes:

The Industrial Revolution in the 19^{th} century led to the widespread use of fossil fuels, leading to increased greenhouse gases, particularly carbon dioxide. Land use patterns, deforestation, and agriculture have contributed to this increase. Domesticated animals contribute to a quarter of methane emissions. The Intergovernmental Panel on Climate Change predicts a global average temperature increase of 1.8 to 4.0°C by 2100.

Role of microorganisms in climate change

Soil microorganisms regulate organic carbon storage and release, providing macronutrients and regulating productivity. Plants contribute significantly to carbon storage through mycorrhizal fungal symbionts. Higher CO_2 levels increase primary productivity, leading to higher carbon emissions. Temperature influences terrestrial organic matter decomposition, and soil microbial decomposition releases 7.5-9 times more atmospheric carbon than anthropogenic emissions annually. Soil also controls methane emissions and acts as a carbon sink in agricultural lands.

Impact of climate change on microbes

Temperature can impact microbial biodiversity through various mechanisms, including increased metabolism, growth rates, ecosystem productivity, plant species, species interactions, evolutionary processes, and environmental factors. Higher temperatures lead to higher metabolic rates, which set the pace of life and support more species. They also lead to higher rates of ecological interactions, such as parasitism, predation, and competition, which differentially affect species diversity. Additionally, temperature interacts with other environmental factors, such as water availability, carbon and nutrient availability, and pH, indirectly affecting biodiversity.

Warming affects soil decomposers' physiology, causing increased CO_2 emissions. However, higher temperatures also increase soil nitrogen levels, suppressing fungal decomposition and negatively impacting microbial activity. Consequently, bacterial biochemical reactions release more carbon as carbon dioxide, affecting soil efficiency. The effects of temperature on carbon dioxide release vary among soils, with managed agricultural soils demonstrating better carbon use efficiency.Rainfall plays a crucial role in soil moisture variability and respiratory activity, affecting terrestrial microbial community structure and soil decomposition. Climate change impacts the abundance of bacteria and fungi, with changes in precipitation and soil moisture levels affecting community composition. Changes in soil moisture can change the dominance of species in soil fungal communities, while bacterial communities remain intact. Climate change also affects microbial activity under snow in coniferous forests, leading to increased mortality of trees and decreased carbon fixation. Therefore, climate change impacts soil moisture and microbial activity.

Carbon dioxide storage in geological formations can cause pressure increases, fluid migration, and microbial reactions. CO_2 injection reduces microbial diversity and increases pH only control, affecting geological formation safety. Increased CO_2 flux decreases bacterial diversity and Acidobacteria and Chloroflexi phyla abundance, impacting ecosystem functions like pollutant degradation and nutrient cycling. Higher CO_2 levels also increase CH_4 efflux and decrease methane uptake by soil microorganisms. This could have widespread consequences on the food chain.

Conclusion

The role of microorganisms in determining the atmospheric concentration of greenhouse gases is commendable, but it has yet to be properly understood and appreciated by the scientific community. If harnessed properly, microbes could be an important natural resource for controlling climate change. However, if due attention is not given, it could act as the most emerging accelerator to the problem. Soil quality and fertility is governed by its microbial communities and their activities in soils. With changing climate scenario in present days, there might be changing composition and activities of micro-organisms in the soils that ultimately affect the soil ecosystem. So, A deep understanding of microbial ecology and soil–plant–microbe interactions in a changing climate scenario is essential to use microbial technology for climate change adaptation and mitigation.

SCSI HQ, New Delhi Celebrated 72th Foundation Day

The 72nd Foundation Day of Soil Conservation Society of India was celebrated on September 24, 2023 in the conference room of SCSI. Dr. TBS Rajput, Senior Vice President, Dr P.S. Brahmanand, Vice President, Dr. S. Manivannan Vice-President, Dr Mukesh Kumar, Treasurer, Sh. O.P. Choudhary, Councilor and Sh. Shamsher Singh, special invitee attended the open discussion on covering the aspect of Soil and Water Conservation in the context of Climate Change.

Dr TBS Rajput informed that the conservation of water and its efficient use especially in drought prone areas are very important. Water scarcity is growing even in those areas where water was plenty. Due to climate change the pattern of rainfall has changed. There is advancement in the onset of monsoon and many times it is delayed causing early sowing/delayed sowing of *kharif* crops. Also, there is drought situation as well as heavy cloud burst due to which there is significant loss of human and animal life and crop production. Citing the example of micro-irrigation introduced in Rajasthan's Ajmer district, he informed that the income of farmers increased many fold due to introduction of vegetables and other cash crops. It could be achieved by pooling the resources from various schemes and by effective involvement of farmers of that area. This approach was replicated in many villages. Better utilization of water resources come later water resource development including water harvesting and safe storage. Awareness of importance water harvesting and thereafter its efficient use will provide a way out to handle the effect of climate change.

Dr P.S. Brahmanand emphasized that the ground water is depleting in many areas due to overdrawal recharge aquifers. The ground water recharge therefore is the main issue in water deficit areas. The crop planning based on water availability needs special attention. Water harvesting in tanks, ponds and aquifers need to be prioritized for crop production. Dr Manivannan informed that the transfer of technology for harvesting the rainwater and its utilization for crop production are the thrust areas. In many regions water is surplus which is to be utilized judiciously. Sh Shamsher Singh emphasized that the maintenance of structures and other assets created under various schemes needs to be maintained to the benefits as the Soil Conservation Acts prevailing in the states do not have provision for maintenance. There is sever threat by floods as the natural drainage system i.e.stream and river beds have silted up. The drainage system is to be properly planned, executed and maintained. Shri O.P Choudhary informed that the programmes of watersheds in the state of Madhya Pradesh, Rajasthan and Haryana have been nicely implemented and the benefits are visible on the ground. Similar activities have been implemented in other states.

72nd Foundation Day of SCSI celebrated jointly by Gujarat Chapter and NSS Unit of Forestry through cleanliness drive at NAU, Navsari

Seventy Second Foundation Day, September 24, of Soil Conservation Society of India (SCSI) was celebrated jointly by SCSI, Gujarat Chapter and NSS unit of College of Forestry by organizing a cleanliness driveon 30th September 2023. The drive also fulfilled the objectives of '*Swachhata Hi Seva*' campaign given by Hon. Prime Minister Shri Narendra Modi. The day started with the briefing about the programme by Dr. R S Chauhan, Assistant Professor & Nodal Officer NSS, COF and encouraging words of Dr. P. K. Shrivastava, Dean, College of Forestry about importance of cleanliness and involvement of young students for the welfare of society. Later, faculty, members of the society and NSS volunteers actively participated in the programme and made the college premises and roads plastic garbage free.

Dynamic Remotely Operated Navigation Equipment (Drone) and Modern Indian Agriculture

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SKUAST-J, Jammu

The adoption of modern technologies in agriculture, such as the use of drones or Unmanned Aerial Vehicles (UAVs) can significantly enhance risk and damage assessments and revolutionize the way we prepare for and respond to disasters that affect the livelihoods of vulnerable farmers and fishers and the country's food security. Currently, agricultural operations provide the primary means of subsistence while increasing GDP, contributing to national commerce, lowering unemployment, supplying raw materials for other sectors to produce goods, and generally developing the economy. It is essential that agricultural practices be evaluated in order to propose novel solutions for sustaining and enhancing agricultural activity given the exponential growth in population. The introduction of AI to agriculture will be enabled by other technological advances, including big data analytics, robotics, the internet of things, the availability of cheap sensors and cameras, drone technology.

Scope of Drone application in Indian Agriculture:

Drone technology, equipped with artificial intelligence (AI), machine learning (ML), and remote sensing features, is rising in demand because of its advantages.

- **Soil and field analysis:**

  Drones can be used to mount sensors that can analyze the soil, terrain, moisture, nutrients, and fertility levels of the soil. These sensors can then be used to plan the pattern of sowing different crops, schedule irrigation, and manage fertilizer applications while taking into account the spatial variability of crop growth and field conditions.

- **Planting crops and trees:**

  Crops may be planted using drones, which will decrease labour costs and lessen human labor-intensive tasks. Drones can save fuel, reduce harmful gas emissions produced during fuel exhaustion while operating tractors in the field, avoid compaction of subsoil, and prevent the formation of plough pan, which typically forms due to repetitive movement of tractors on soil surface. This is because drones wouldn't be used to sow crops in the field. By launching biodegradable seed pods or seed bombs, drones may be utilized to plant trees or crops in off-the-grid locations. As a result, they can be used for afforestation, reforestation, and the planting of trees to restore damaged land.

- **Crop monitoring:**

  Throughout the growing season, drones may be used to monitor agricultural conditions, enabling prompt, need-based response. A prompt and effective response can stop yield loss. Farmers won't need to visually evaluate their crops anymore thanks to this technology. They are able to keep an eye on horticulture crops and other types of crops in far-off places like hilly locations. They can effectively monitor the tall crops and trees, which are difficult for farmers to manually scour.

- **Weed identification:**

  The presence of weeds in the field may be determined using drones. So that they do not compete with the primary crop for resources, these weeds might be swiftly eradicated from the field. Spraying crops: Depending on the spatial diversity of the crops and field, drones may be used to spray chemicals like insecticides, fertilizers, and others. Depending on the crop circumstances or the severity of the insect-pest assault, the amount of chemicals to be sprayed might be changed. Drones open the door to precision agriculture in this way. This eventually improves the effectiveness of the chemicals used, lowering their negative environmental effects by reducing soil and water contamination. As a result, it could result in sustainable agriculture. Chemicals are sprayed by drones more quickly than by traditional means. It may also lead to a reduction in the quantity of chemicals used, which might lower input costs. While spraying pesticides over tall crops, there is another issue with unbalanced tractor-operated equipment, which can occasionally lead to accidents. Therefore, drones may effortlessly and damage-free spray pesticides over tall crops. The main issue facing Indian farmers after harvesting the crops is managing the leftover agricultural wastes on the field. These agricultural wastes are exceedingly expensive and time-consuming to remove from the fields. As a result, farmers frequently burn these wastes, which harms the ecosystem and the health of the soil. Spraying microbial formulations in the field that break down agricultural residues can effectively and economically manage these residues. Drones, which can maintain soil quality and avoid environmental contamination, may carry out this task successfully.

- **Irrigation scheduling of crops:**

  Drones equipped with optical, multispectral, and thermal imaging sensors can precisely locate crops that are under water and heat stress. Depending on the crops' needs, irrigation can be applied using this method. Water waste will be avoided, and irrigation water will be used effectively as a result.

- **Crop health assessment:**

  Different multispectral indices may be calculated based on the reflection pattern at various wavelengths utilising various visible, NIR, and thermal infrared sensor types. The circumstances of crops, such as water stress, insect and pest assault, illnesses, etc., may be evaluated using these indicators. Before any symptoms are obvious, the sensors mounted on the drones can detect the prevalence of illnesses or nutritional deficiencies. They function as a tool for early illness detection as a result. Drones can be employed in early warning systems in this fashion, enabling rapid application of corrective actions based on the level of stress.

Drone Operations in Indian Agriculture:

Drones are now being promoted in India largely as an automated spray device that can be used to spray pesticides, herbicides, and other chemicals over crops in order to eliminate the health risks associated with hand spraying and to save time, resources, and human labour. The Indian government has made many announcements recently stating that it is focusing on boosting drones in the agricultural sector. According to the federal budget for India for 2022–2023, the government is eager to employ 'Kisan' drones to strengthen the nation's agricultural industry. The use of Kisan Drones for crop evaluation, digitizing land data, and fertilizer and pesticide spraying will be encouraged. As large capacity drones may be utilized to transport vegetables, fruits, and fish directly from the farms to the market, Kisan Drones might start a revolution. Farmers and fisherman will make more money since these products will be delivered straight to the market with little to no harm and in a shorter amount of time.

The ecosystem of drone startups in India is just taking off and private players are all set to enrich it with a much-needed competitive edge. These agriculture drones start-ups have been contributing their part to the agriculture sector

Recent Government initiatives that support/facilitate drone use in Agriculture

The Indian government has offered a variety of incentives on drone purchases in an effort to lower the cost of drones for farmers and other stakeholders and to encourage drone use. The Indian Agriculture Ministry is offering a 50% or Rs. 5.0 Lakh maximum subsidy to SC-ST, small and marginal, women, and farmers in the north-eastern states to encourage the usage of Kisan Drones. Financial aid will be provided to other farmers up to 40%, or a maximum of Rs. 4.0 Lakh. The Farm Machinery Training & Testing Institutes, Institutions of the Indian Council of Agricultural Research, Krishi Vigyan Kendra (KVK), and State Agricultural Universities (SAUs) are all eligible to receive 100% of the cost of a drone for use in farmer fields. Farmers Producers Organizations (FPOs) get funds worth 75% of the cost of the drones for use in field demonstrations. Existing and new Custom Hiring Centres (CHCs) under Cooperative Society of Farmers, Farmers Producer Organizations (FPOs), and Rural Entrepreneurs offer financial support for drone purchases up to Rs. 4.0 Lkah (40 percent of the total cost of the drone). Additionally, graduates in agriculture who create CHCs are entitled for financial aid at 50% of the cost of the drone, up to a maximum of Rs.5.00 Lakh. Thus, with these subsidies in place drones are free for agri-training and research institutes. Also, implementing agencies are eligible for subsidies per hectare if they hire drones for demonstrations rather than buying them. (PIB, Govt of India)

Challenges:

- The cost of manpower for manually spraying an acre is around INR 350–400, and a person may spray up to 2 acres in a day, but with difficulty. In light of the current going average rate of around INR 700 per acre, the spray cost in the case of hiring drones for spray is now on the higher side. However, employing drones for spray results in significant time savings. If drone spraying costs go little lower, they may really capture the market of spraying and farmers would perhaps be willing to rent drones on a pay per use basis and shift to drones for their spraying requirements.
- The need for qualified personnel to operate, maintain and provide services for drones is both a difficulty and an opportunity. The difficulty is to develop a pool of skilled workers in rural regions close to farms who can operate and supply drone services at a cost-effective price to the farmer.

Drones have the power to completely change Indian agriculture. Future technological advancements are anticipated to make drone manufacture economically feasible. Due to the arduous labour and tedium required in farming, modern adolescents are not drawn to it. The potential use of drones may captivate young people and inspire them to pursue agriculture. Over agricultural regions, drones offer high-quality, real-time aerial photography that is superior to that provided by satellites. Additionally, drones may be used for applications including weed and disease localization, soil property determination. Farmers will therefore be helped to produce more food while using less resources chemicals. Almost all farmers who have used drones have benefited in some way. They can manage their farm more effectively, get rid of pests before they ruin entire crops, enhance irrigation for plants suffering from heat stress, improve soil quality to promote growth in trouble spots, and track fires before they get out of control. As a result, drones may play a significant role in agriculture in the future by assisting farmers in more effective and sustainable management of their crops and resources.

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