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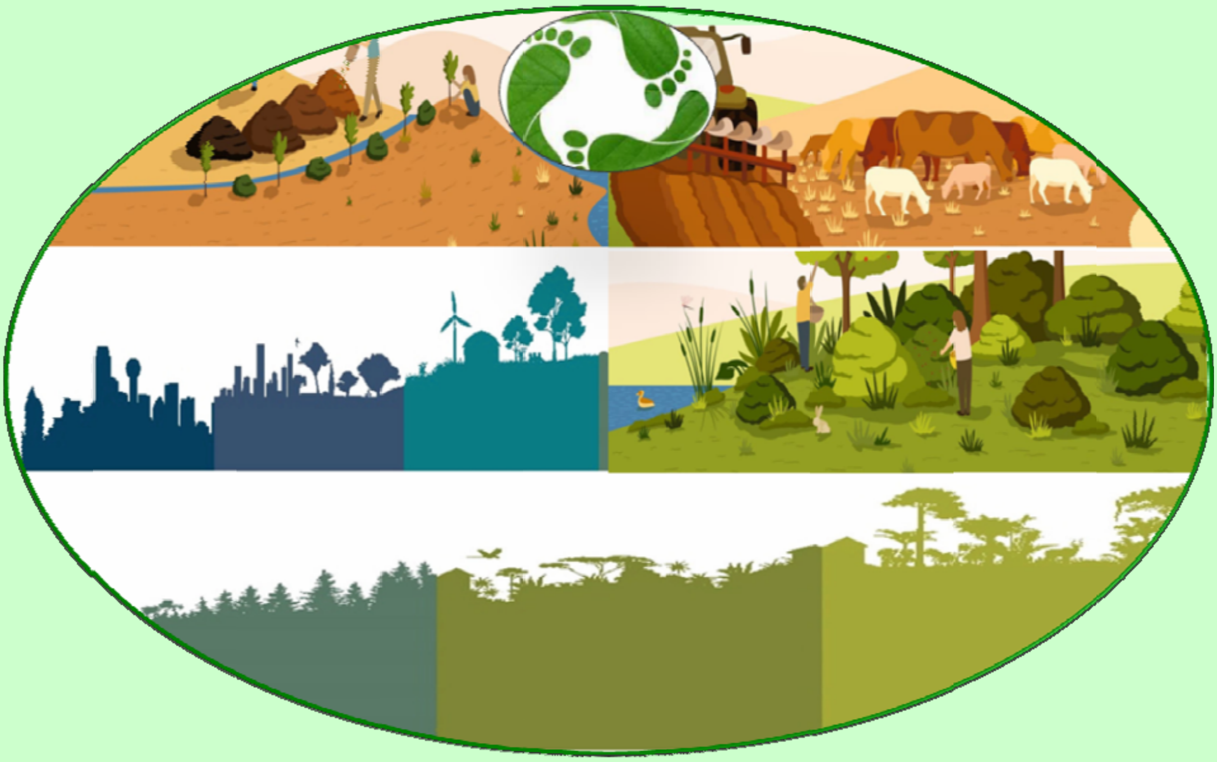
# Newsletter
# On
# Environmental Sustainability and Ecological Footprint



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## EDITORIAL

The concept of Ecological Footprint (EFP) was developed by Canadian ecologists William Rees and his student Mathis Wackernagel. It is the amount of productive area (land and water) on earth needed by a person, a region or a country in units of global hectares (gha). In 2014, the EFP was 2.8 gha while global biocapacity was 1.7 gha. In other words, the demand on productive resources of the earth was much more than capacity of the earth to satisfy it. Global Footprint Network, a non-profit organization, keeps track of EFP of individuals, regions, nations and mankind as a whole.

By now, anyone who has studied ecology and environment in upper classes in high school knows how precarious our existence in this planet has become. Productive land and usable water are both being depleted at alarming rates. Every day, we are losing several species: some are becoming extinct, others are getting into the red list of IUCN.

The first article deals with coastal and marine ecosystems with emphasis on salt marsh, mudflats, seagrass meadows, mangroves, estuaries, coastal lagoon, and coral reefs. The second article elucidates the concept, inssues and strategies of ecological footprint. The last article highlights the importance of dung beetles in some significant ecological functions such as bioturbation, reduction of GHGs, seed dispersal and many more.

With these few words, let us reaffirm our commitment to a cleaner and sustainable planet.

"The Earth is a fine place and worth fighting for" – Ernest Hemingway

Prof. Asoke Prasun Chattopadhyay
Dr. Subhankar Kumar Sarkar

## IN THIS ISSUE:

# Restoration of Degraded Marine Ecosystems: A challenge of this Decade

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## Introduction

From forests to peatlands to coral reefs, our survival depends upon services provided by the healthy ecosystems of our planet. But globally, ecosystems of all kinds are under unprecedented threat in terms of degradation or destruction due to anthropogenic pressure and global climate change. For example, a forest size of one football ground is lost every three seconds from the earth, severely compromising ecosystem services that we receive from the forest as a biodiversity hub, climate amelioration, and carbon sequestration. United Nations has declared the next ten years as the 'Decade on Ecosystem Restoration' on the eve of world environment day, June 05, 2021, to achieve two primary goals, bending the climate curve and put a stall on sixth mass extinction and biodiversity loss.

However unlike terrestrial ecosystems, services provided by global oceans and seas, are not often brought to the forefront. Globally the marine biome is the largest that includes estuaries, coral reefs, mangroves, seagrass meadows, kelp forests, lagoons, salt marshes, and intertidal zones. It is the home of microscopic plankton to the largest animal ever lived on the planet, the blue whale.The marine ecosystem provides vitalservices viz. food security, feed for livestock, raw materials for medicines, natural defences against hazards,absorb carbon dioxide, and serve as the foundation for much of the world's economy. Despite their importance, the oceans face unprecedented threats from human activity and natural calamities. Human activity affects the marine ecosystems by dumping nearly 8 million tons of plastic waste and discharging 80% of the untreated wastewater. Nutrient pollution contributes to the creation of dead zones, and overfishing threatens the viability of fish stocks in the ocean. So, to support the marine ecosystem, a stand was taken by The United Nations, which declared the decade 2021-2030 with a theme 'Ocean Science for Sustainable Development' aiming for integrated research, capacity building, and action from all stakeholders globally. Hence, Sustainable Development Goal 14 (life below water) and Decade of Ocean Science for Sustainable Development (2021-2030) should gain momentum at the backdrop of Decade on Ecosystem Restoration (2021-2030). This article focuses on threats faced by some of the major marine ecosystems and various restorative actions taken across different parts of the world.

## Types of the marine ecosystem and their restoration mechanisms

Coastal and marine ecosystems are spread over 123 countries and cover 1.6 million km of coastline. Marine ecosystems are divided into twotypes: nearshore and offshore. Nearshore ecosystems include salt marshes, mudflats, seagrass meadows, mangroves, estuaries, coastal lagoon, rocky intertidal systems, coral reefs, and the offshore systems pelagic ocean waters, deep sea, hydrothermal vents, and seafloor. Marine ecosystem restoration activities have focused mainly on nearshore environments due to proximity to the land and ease of access.

### *Saltmarsh*

Saltmarsh lies in the coastal intertidal zones regularly flooded by the tides. They are dominated by salt-tolerant herbs, grasses, or low shrubs. They provide ecological services by trapping and binding sediments in the coastal areas, preventing erosion, playing an essential component in the aquatic food web, and delivering nutrients to the coastal ecosystem. The major threats to saltmarsh ecosystems are climate change, pollution, land-use change, and invasive species. The natural recovery of salt marsh and their ecosystem functioning after human interference is relatively slow and uncertain. Recovery can be accelerated by replanting native salt marsh vegetation. The key to successfully restoring saltmarsh is to restore physical processes such as tidal regime, slope, soil physical and chemical properties in the first place.

## Mudflats

Mudflats are the coastal wetlands found in intertidal areas where tides or rivers have deposited sediments. These ecosystems support various wildlife and are critical for migratory shorebirds, certain crabs, fish, and mollusks. These ecosystems are under threat due to rising sea levels, land reclamation for development, dredging, and chemical pollution. Adequate sediment supply through estuaries seems to be a significant factor contributing to the development of healthy tidal mudflats. Hence, managing the catchment of a river basin and preventing the construction of unplanned big dams is the key. It has been observed that shore-parallel structures cause greater damage to the mudflats compared to the shore-normal structure.

## Seagrass meadows

Seagrass are groups of submerged aquatic angiosperm confined to the shallow marine and marine-influenced environments along temperate and tropical coastlines (Short et al., 2007). They sequester carbon efficiently, stabilize sediment, and act as a food source for several grazing animals (dugong and green turtle). The natural (climate change, wave action, sedimentation) and anthropogenic (pollution, sedimentation, dredging, unsustainable aquaculture and fishing activity, and nutrient enrichment) factors affect seagrass's long-term survival and health. The seagrass restoration techniques include natural restoration, planting seedlings grown in the laboratory, planting seeds, and creating artificial habitats with cement slabs/ frames and metallic/ plastic wire mesh. Artificial habitats made up of cement, metal, and plasticcan be intrusive to the ecosystem. Hence,they should be used with caution.

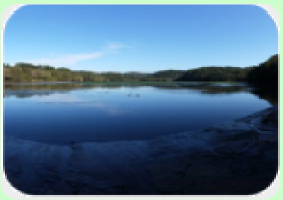
## Mangroves

Mangroves are shrubs or small trees grown in coastal and brackish water ecosystems which can tolerate a wide salinity range. Besides being a primary blue carbon stock, mangroves protect coasts from the batters of cyclones, tsunamis, and tidal surges, recycle nutrients, act as breeding and nursery grounds for finfish and shellfish and prevent soil erosion. Coastal development, aquaculture/ agriculture & salt production, climate change, and deforestation are the primary threat to the Mangrove ecosystem. A substantial number of mangrove restoration projects have focussed on planting mangrove seedlings in the tidal mudflat. However, excessive sedimentation, barnacle infestation, and wave battering lead to high mortality of replanted mangroves. Instead, it has been argued that reforestation of mangroves or natural succession in abandoned shrimp ponds or logging areas without affecting tidal mud flats is far more ecologically sound.

## Estuaries

An estuary is a partially enclosed brackish water ecosystem where the river meets the Ocean. It is subjected to strong salinity fluctuation owing to the periodic tidal inflow from the marine end and freshwater input from river/ rivulets. These are biologically productive ecosystems with rich fishery resources, act as a blue economy hub for maritime trade, tourism, and coastal industries. The major threats to estuaries include soil erosion in the catchment, damming and diversion of rivers, eutrophication, chemical pollution, overfishing, and dredging. Since estuaries can be heavily industrialized for its easy access to the port, restoration measures such as controlling nutrient input from point sources (creating wastewater infrastructure) and nonpoint sources, putting stringent guidelines on wastewater released by adjoining industries, ensuring enough supply of freshwater in the system can be proved effective.

## Coastal lagoon



Coastal lagoons are shallow water bodies that run along a shoreline but remain separated from the Ocean by sand bars/spits, coral reefs, barrier islands. By virtue of their high productivity, coastal lagoons act as a wintering ground for migratory birds and support rich fish stock. They provide livelihoods to the local communities in coastal tourism, bird watching, and fishing. Coastal lagoons are seriously threatened by eutrophication, siltation, pollution, and variousmodifications in their watersheds due to human activities. Entry of saltwater through the mouth keeps the salinity in a lagoon in the brackish range essential for the inhabiting flora and fauna. Coastal lagoons tend to choke, losing their connection to the sea when spits close downthe lagoon-sea connectivity either naturally or due to excessive siltation. Hence health of a lagoon can be ensured by maintaining optimal dimension of an inlet that sometimes needs artificial inlet/ mouth creation.

## Coral reefs

These are under water ecosystems formed of colonies of coral polyps held together by calcium carbonate. Occupying less than 0.1% of the world's ocean area, coral reefs provide habitat for at least 25% of all marine species. Coral reefs deliver their ecosystem service through shoreline protection, fisheries, and tourism. It is estimated that the annual global economic value of coral reefs is US$30–375 billion, benefitting nearly 500 million people globally. Nowadays, coral reefs are under threat due to disease, predation, invasive species, bioerosion by grazing fish, algal blooms, geologic hazards, excess nutrients load (nitrogen and phosphorus), rising temperatures, ocean acidification, overfishing and harmful land-use practices, runoff, and seeps. Some well-documented coral reef restoration practices are relocation, coral farming, creating substrates, removal of invasive algae etc. Coral farming/ culture is the most widespread and effective method for coral restoration.In this process, coral seeds are grown in nurseries, then replanted on the reef. The substrate such as discarded vehicle tires, scuttled ships, subway cars, and formed concrete, reef balls, and bio rocks are supplied to allow more corals to find a home to expand the size and number. Inoculating coral reefs with genetically modified bacteria or selective propagation of heat-tolerant varieties of coral symbiotes, which can tolerate warmer ocean temperature, are other effective coral restoration strategies.

## Conclusion

The marine ecosystems are disappearing rapidlyat an alarming scale worldwide when most of their benefits are yet to be discovered. Time has come to criticallyassess the benefits provided by these systems vis a vis to improve marine management and policy. Ambitious marinerestoration projects at local, regional, and national levels are to be initiated. At an individual level we need to adopt sustainable consumption pattern, donate, and volunteer marine conservation or restoration activities. It is high time that all stakeholders, individuals, groups, the scientific community, governments, businesses, and organizations join hands to prevent and reverse marine ecosystem degradation and restore its integrity for the greater good of humanity.We should leave a safe, clean, productive, healthy, and resilient oceanfor the next generation to enjoy and appreciate.

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# Ecological Footprint and Sustainability

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**Abstract:** Ecological footprint is the assessment of the amount of natural resource that is consumed at various level of organization for fulfillment of the basic requirements of life. This helps to assess the various anthropogenic activities and their associated impacts over the environment and natural assets. From the perspective of sustainability, eco-footprint is a very important perspective to generate awareness among the people about various forms of natural assets. Various forms of ecological footprint are existing at the present context due to various anthropogenic effects. From sustainability perspectives reduction of footprint is very much essential for survivality of the mankind. It would also help to achieve the future sustainability goals.

**Keywords :** Ecological footprint, Environment, Ecology, Sustainability

## Introduction

At present time the growth of science and technology along with economic development is taking place with an unprecedented rate accompanied by booming of the human population. As a consequence resource depletion, environmental degradation becomes the inevitable truth and challenge for the mankind [1,2]. This condition has lead to set sustainability as the main target of humanity [3]. The main focus of modern economical research is to maintain abalance between the economic growth and environmental friendliness [4]. Ecological sustainability implies all round well being of the society followed by fulfilling the goal of sustainable development[5]. Therefore proper monitoring of the earth's carrying capacity in relation to human consumption pattern is very much important from sustainability perspective.

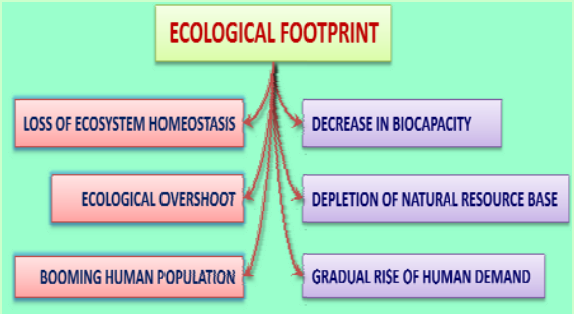


**Fig. 1 : Dimensions of ecological footprint**

Thus, the concept of ecological footprint provides a comprehensive information about the biocapacity and carrying capacity of the earth surface to support the humanity[6] (fig. 1). The concept was originated by Rees [7] and Wackernagel [8] in 1992 . This was attempted to evaluate the pattern of human consumption associated with the regenerative capacity of the ecosystem that helps to evaluate the issue of ecological sustainability [9,10]. Quantitative estimation through EF has made it a suitable indicator for SD [11]. Studies on EF would help to know about the anthropogenic pressure on nature as well as awareness generation [12,13, 14]. EF calculation was done for various natural resources later on by various workers across the globe. Wackernagel and other workers have calculated the EF for more than 50 countries across the globe [15]. For example Cuadra and other workers evaluated sustainability of crop production in Nicaragua [16].

## Concept of Ecological footprint

In order to achieve sustainable development there was a continuous research programme to explore methods to have proper decision making [17]. It was observed that there was a allround degradation of the environment due to human consumption pattern [18]. Thus, natural resource management is the need of the hour along with proper steps for waste management [19]. The ioneer work of ecological foot print get into existence from Mathis Wackernagel and William Rees who evaluated the resource use and consumption pattern and also to evaluate the ability of nature in terms of its support towards assimilative and supportive capacity . According to them , ecological footprint refers to the productive land to produce required amount of resources to feed human population followed by assimilation of wastes [20].Thus eco-footprint quantifies the capacity of regeneration for biosphere as well as consumptive pattern of renewable resources . With gradual growth of science and technology the awareness regarding ecological footprint has increased considerably. Works reported from United Kingdom revealed the popularity of the concept by quantifying footprint for every local area under REAP (*Resource and Energy Analysis Programme)* [21]. According to the report of global footprint network footprint is a quantification of the existing ecological condition of the nature and its associated changes that we need to look over [22]. In the process after quantifying the footprint of an area the next approach includes to find ways of reducing the footprint as much as possible. Such strategies for footprint reduction can take place at organization level or at the individual level

## Issues of ecological footprints

With the gradual passage of time the human need and greed is now increasing at an alarming rate. Such conditions lead to ecological overshoot condition (Rockström et al., 2009). Thus it indicates towards proper quantification and evaluation of the biosphere and its demand and supply scenario. Thus, Ecological Footprint Accounting encompasses the issue of biocapacity as well as the concept of overshoot that is going beyond the carrying capacity of the earth [23].

Within a span of 49 years (1961- 2010) Ecological Footprint increment has taken place upto 140% which is challenging the earth's bioproductive area and the future appears to be very blink under the pressure of increasing demand of human beings . At global level migration of human population is eventually taking place due to biocapacity deficit across the country and regions [24]. As a consequences some countries such as Australia, Argentina , Brazil , Canada are found to be becoming deficit in biocapacity having share of very meager amount of renewable resources and ecosystem services . On the other hand the technologically advanced countries have become the biocapacity importers. Overall, it was observed that the overshoot condition is likely to increase at the global level [25]. Future prediction interprets that the mankind footprint would show further steady increase of about 2.6 times than the planet actually has to support the humanity till 2050.

## Strategies to ecological footprint reduction across various sectors

Various strategies at sectoral level have been implemented to reduce the level of ecological footprint . In the transport sector switching over to the eco-friendly mode by using railway, bicycles and various other green communication mode would help to reduce the emission as well as energy footprint . New technologies such as hydrogen fueled vehicles, electric vehicles would also help to reduce the enrgy footprint of an area.

At the domestic level it was observed that the consumptive lifestyle was found to be highly responsible for increasing the overall footprint of the humanity. Use 0f ecofriendly energy sources would help to reduce the footprint value to some extent . Now-a-days the focus of the modern world is to move towards energy efficient technologies to reduce the consumption of the energy . Green consumerism , public awareness regarding day to day life would also help to reduce the overall foot print of the humanity. Proper management and recycling of waste would reduce the pollution load and resource depletion event and thus the footprint of the natural resources.

Different forms of plantation, urban greening, development of green belt technologies are also very much necessary to reduce the footprint and move towards the goal of sustainable development. One needs to protect the ecological systems along with their ecological services in order to maintain the ecosystem homeostasis and balance between the various ecosystems. This would thus help to reduce the footprint at the global level and help to achieve the sustainable development .

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# Ecological Functions of Dung Beetles

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## Introduction

Dung beetles, also known as coprophagous beetles, are the most diverse and widely distributed beneficial insects belonging to the family Scarabaeidae of the mega insect order Coleoptera(fig.1). These beetles act as indicator species for habitat disturbance due to their rapid respond to environmental changes by showing variations in their community structure, abundance and diversity [1]. They are also considered as a potential bioresource because of one specific function in which they speed up the process of manure conversion to substances usable by other organisms (fig.2). On the basis of their feeding and nesting strategy, dung beetles are broadly classified into three categories namely endocoprid (dwellers) nesters, paracoprid (tunnelers) nesters, and telecoprid (rollers) nesters [2,3]. They are one of the most diverse and most studied insect taxa worldwide, their burial activity improves the soil structure and fertility, decreases parasite incidence, and cleans pasture surface in livestock areas [4].

The various ecological functions performed by dung beetles are discussed below.

## Soil nutrient enhancement:

Beetles of the family Scarabaeidae are considered as the most valuable agents in promoting dung pat decay and soil nutrient enhancement. They by decomposing and recycling dung, increase soil nitrogen content[5]. On account of this noble ecological role, these beetles are immensely used by many countries for improvement of their pasture and cattle industry. In Australia, CSIRO (Commonwealth Scientific and Industrial Research Organization) has imported and introduced 20 scarab species from the Mediterranean basin and South Africa to bury dung of domestic stock and reduce the population of pestilent bush flies[6]. New Zealand too has introduced these beetles for the benefit of their cattle and pasture industry. Moreover, these beetles also prevent the loss of Nitrogen through ammonia volatilization by burring dung under the soil surface [7] and increase soil fertility by enhancing Nitrogen uptake by plants through mineralization[8].

## Reduction of Greenhouse gas fluxes:

Dung beetles also play remarkable role in reducing greenhouse gas (GHG) emission from dung pats and nutrients sanitation by feeding and aerating dung, they have also been used as an indicator group for monitoring influences of habitat modification. They may help mitigate GHG emissions and aid carbon sequestration through removing dung deposited on the pastures, increasing grass growth and fertilization. Dung beetles return the carbon and nitrogen present in cattle and sheep dung to the soil, so that the nutrient cycles can be maintained [9,10,11]. As agriculture is one of the largest anthropogenic sources of GHGs, with dairy and beef production accounting for nearly two-thirds of emissions, these beetles were utilized for the reduction of GHGs from agricultural and pasture fields in many countries.

## Parasite Suppression:

Adult and larval dung beetles, while feeding and nesting, control the abundance of dung-breeding hematophagic and detrivorous flies and dung dispersed nematodes and protozoa. These beetles serves as a major component in the biological control of pests and parasites which use dung as a breeding ground. They reduce the population of horn flies (*Haematobia irritans* L.) by 95% and bush flies (*Musca vetustissima* Walker) by 80-100% from dung [12]. Several laboratory studies reveal that the feeding activities of scarab species reduces the passage of hook and round worm eggs by nearly 100% [13]. These beetles can also transmit dung-borne pathogens within their gut or upon their exoskeleton, acting as intermediate, incidental or paratenic hosts [14].

Fig.1: Dung beetle

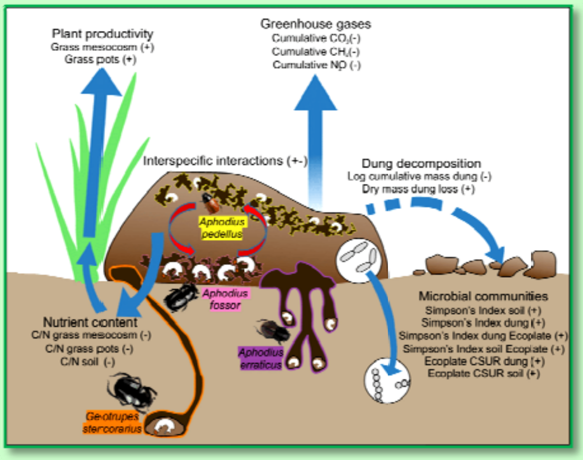


Fig.2: Nutrient cycling by Dung beetle

**(source:** Slade et al. 2017 [11] and https://scitechdaily.com/crappy-news-for-the-dung-beetle-and-agriculture-greenhouse-gasses/**)**

## Soil aeration:

Activities of adult rollers (telecoprids) can remove most of the fresh dung from the soil surface in less than a week, increasing the aeration, water filtration, and nitrogen levels of the soil beneath and beside the dung pat. These beetles, while feeding and nesting, enhance nitrogen volatilization and mineralization rates by altering the microorganism fauna in dung pats and brood balls [8].

## Plant growth enhancer:

Tunnelling activity of these beetles generally increase soil aeration and water porosity in the upper soil layers [15] and their activities result in significant increases in plant height and net primary productivity [16].

## Fly controller:

Several studies reveal that the feeding and breeding activities of Scarabaeinae beetles reduces the significant numbers of fly eggs and young larvae and also increases the fly mortality rate [17]. The activity of both adults and larvae quickly breaks dung pat and as a result the dung dries out quickly the development fly larvae in the dung stops[18]. By burying dung and carrion as food for their offspring, tunnelers may increase the rate of soil nutrient cycling and reduce egg and larval populations of parasitic flies present in fresh dung of mammals [19].

The above mentioned benefits lead to improved nutrient cycling and uptake by plants, increase in pasture quality, biological control of pest flies and intestinal parasites and secondary seed dispersal. Therefore, the role of dung beetles in the ecosystem is remarkable. The populations of different species of these beetles are declining rapidly throughout temperate and tropical ecosystems due to changes in agricultural practices including intensification and reduced pasture grazing and habitat loss [20]. Appropriate strategies should be taken up for the conservation of this ecologically important insect group.

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## Report of World Environmental Day-2021 Celebration

The DESKU ENVIS Resource Partner on Environmental Biotechnology, University of Kalyani, celebrated **World Environment Day, 5th June, 2021** through organized a webinar due to COVID-19 pandemic. At the outset, the Coordinator, ENVIS-RP, Prof. Asoke P. Chattopadhyay welcomed the dignitatires, the speaker of the webinar and the participants. He mentioned that theme of the World Environment Day-2021 on 'Ecosystem Retoration' through the efforts to 'reimagine, recreate and restore.' Then the webinar was inaugurated by the Hon'ble Vice Chancellor, University of Kalyani Prof.(Dr.) Manas Kumar Sanyal, in the virtual presence of dignitaries and more than 60 participants. He spoke on the need to restore the state of the environment and threats the latter is facing today. Prof.(Dr.) Goutam Paul, Hon'ble Pro-Vice Chancellor, University of Kalyani, spoke on the theme of environment day. He also mentioned the efforts of scientists from Alexander Fleming to the latest developments on developing drugs from biological entities. Prof.(Dr.) Keka Sarkar, Dean, Faculty of Science, in her talk spoke on the need to preserve the environment and what academicians, scientists and others can do in that direction.

Dr. Subhankar Sarkar, Deputy Coordinator of ENVIS-RP introduced the speaker, Dr. Suman Bandyopadhyay, Head, Upstream Process Development, Dr. Reddy's Laboratories Ltd., Hyderabad. Dr. Bandyopadhyay delivered a lecture on 'Biologic Drugs and Biosimilars'. Participants actively took part in the discussion. The ENVIS Coordinator concluded the session with vote of thanks to the University authorities, ENVIS secretariat, MoEF & CC, Govt. of India, all guests, speakers, participants and organisors.

## FORTHCOMING EVENTS

| Events | Date | Place & Correspondence |
|---|---|---|
| 29th LISBON – PORTUGAL International Conference on "Agricultural, Medical and Environmental Sciences" (LAMES-21) | 5th to 7th July 2021 | Lisbon, Portugal http://drabl.org/conference/320 |
| 2nd International Conference on Geology and Earth Sciences (ICGES 2021) | 15th to 17th July 2021 | Singapore http://www.icges.org/ |
| 6th International Congress on Water, Waste and Energy Management (WWEM-21) | 21st to 23rd July 2021 | Rome, Italy https://waterwaste-20.com |
| 10th International Conference on Environment, Energy and Biotechnology (ICEEB 2021) | 22nd to 24th July 2021 | Jeju Island, Korea (south) http://www.iceeb.org/ |
| 7th International Conference on Bioengineering and Biotechnology (ICBB'21) | 5th to 7th August 2021 | Prague, Czech Republic https://2021.bbseries.org/ |
| 2021 4th International Conference on Bioenergy and Clean Energy (ICBCE 2021) | 26th to 28th August 2021 | Sapporo, Japan http://www.icbce.org/ |

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