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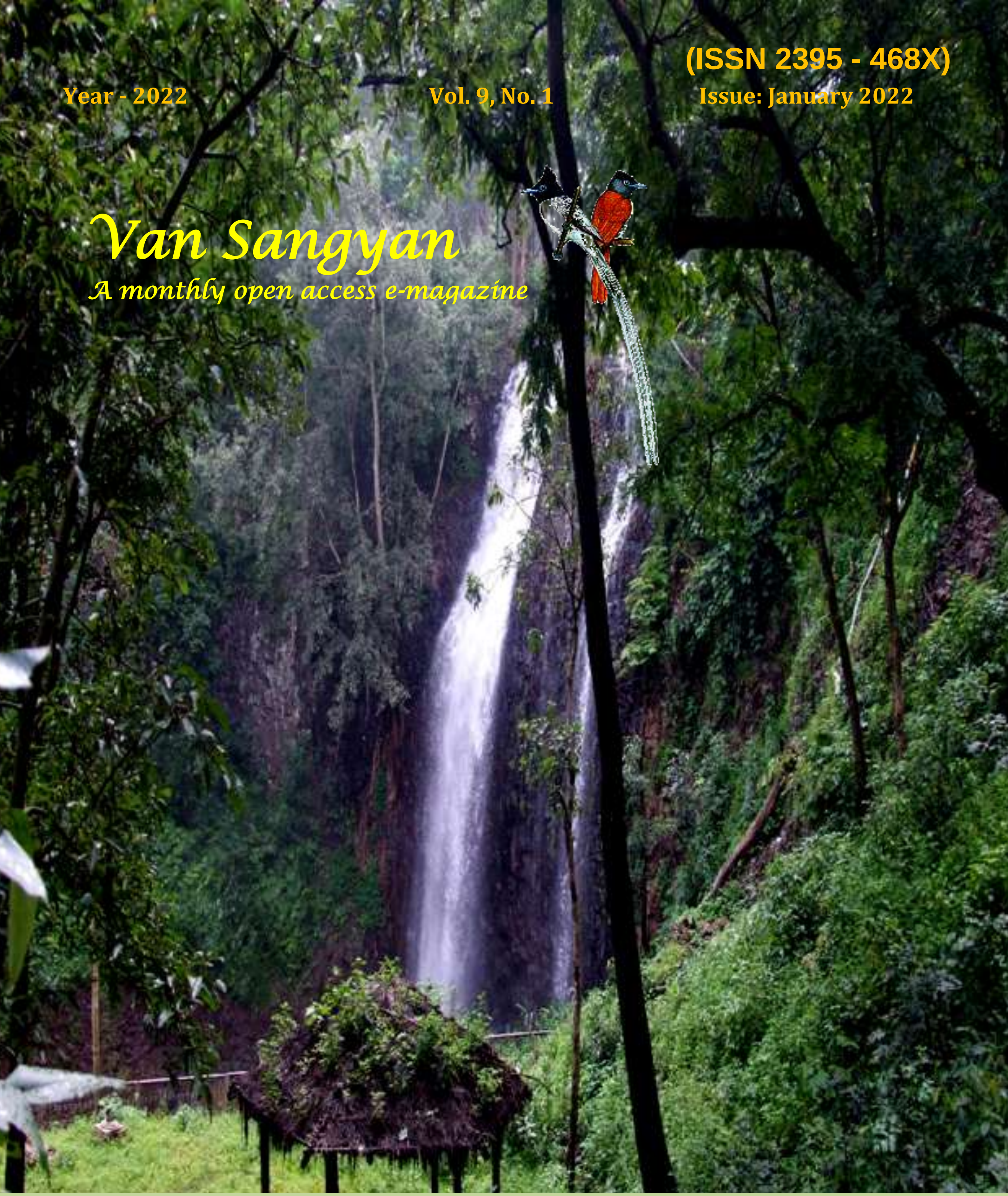

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Van Sangyan

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
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The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number.

TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve
Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)

From the Editor's desk

Sustainability of marine ecosystems and their services are dependent on marine biodiversity, which is threatened worldwide. Biodiversity is fundamental to sustain marine ecosystem services, such as food, maintenance of water quality, and recovery from perturbations. Despite its important role and contribution to human wellbeing, its lost has been reported world-wide. The main threats to marine biodiversity include habitat loss, overexploitation, pollution by hazardous substances, eutrophication, and invasions by non-indigenous species. Efforts to reduce these pressures for halting the biodiversity loss, a commitment of the signatory countries of the Convention on Biological Diversity is therefore essential for global food security, coastal water quality, ecosystem stability, and buffering the resistance and recovery of ecosystem services, thus enabling different types of future economic valuations and management. Restoring marine biodiversity through sustainable fisheries management, pollution control, maintenance of essential habitats, and the creation of marine reserves, are some of the opportunities for investments that can support the productivity and reliability of goods and services that the ocean provides to humanity. Marine management should ensure sustaining all of an ecosystem's biological parts at functioning levels—via conservation of biodiversity at all different levels (from genetic to ecosystems)—in order to maintain ecosystem integrity and stability. The objective of ecosystem-based management of marine environment is to ensure healthy, functional and diverse ecosystems by managing the key drivers of adverse impacts. Biodiversity indicators need to measure variables that are documented to respond to pressures, using methods that can distinguish the anthropogenic impact from natural variability

The ocean is one of the main repositories of the world's biodiversity. It constitutes over 90 per cent of the habitable space on the planet and contains some 250,000 known species, with many more remaining to be discovered—at least two thirds of the world's marine species are still unidentified.The ocean, and the life therein, are critical to the healthy functioning of the planet, supplying half of the oxygen we breathe and absorbing annually about 26 per cent of the anthropogenic carbon dioxide emitted into the atmosphere.

Evidence continues to emerge demonstrating the essential role of marine biodiversity in underpinning a healthy planet and social well-being. The fishery and aquaculture sectors are a source of income for hundreds of millions of people, especially in low-income families, and contribute directly and indirectly to their food security. Marine ecosystems provide innumerable services for coastal communities around the world. For example, mangrove ecosystems are an important source of food for more than 210 million people4 but they also deliver a range of other services, such as livelihoods, clean water, forest products, and protection against erosion and extreme weather events.

In line with the above this issue of Van Sangyan contains an article on Marine ecosystems- A reservoir of underground biodiversity. There are also useful articles viz. Bio-intensive and ecological integrated pest management in forestry, The great Himalayan national park - A mega emporium of biodiversity Major ion dynamics in playas of Rajasthan to infer their evolutionary pathways and Coffee borer, Zeuzera coffeae: Its pest profile and use as tribal food.

I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Marine ecosystems- A reservoir of underground biodiversity

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Introduction

Food, energy, and mineral resources all come from the ocean. The global climate is also influenced by the oceans. If plant biomass rules on land, animal biomass rules in the seas. Aquatic ecosystems are living environments that are based on water. Freshwater ecosystems and marine ecosystems are the two types of aquatic ecosystems (Balasubramanian A 2011). A marine environment is defined as any ecosystem that exists in or near salt water, which implies it can be found anywhere on the planet, from a sandy beach to the deepest depths of the ocean. In addition to this, salt marshes and wetlands near the coasts and river mouths are part of marine ecosystems. Several distinctive habitats, such as estuaries, tidal inlets, and foreshore ecosystems, are included within the coastal zone. Marine environments contain a wide range of physical circumstances in which life can thrive. The majority of marine plants is tiny and floats. Invertebrates make up a large portion of aquatic life. Their skeletons aren't particularly large. The management of marine ecosystems has a wide range of goals. A sustainable output of products for human use is usually regarded to be a fundamental concept of management from a biological standpoint. It's less clear whether this should be interpreted to suggest that the yield should always be of the same products. Fishing has a significant impact on the relative abundance of fish species. As a result, a biological goal should identify the ideal species mix (Larkin, P. A. 1996).

Characteristics of marine ecosystem

They account for 70% of the earth's surface. The salts are dissolved in their own water. Humans are fed, and there are socioeconomic benefits. They belong to the aquatic ecosystems category. Seas, oceans, and wetlands are all included. There are two types of zones in it: Photic, which has light, and Aphotic, which does not. They have a lot of biological variety. Marine currents are in charge of transporting nutrients for the development of sea creatures. The water is thick.

Table 1: Marine ecosystem is also characterized by the many biotic and abiotic components.

Biotic components	Abiotic Components
Predators, Parasites, Competitors, and Mates are examples of organisms and their species.	Temperature, Concentration of Nutrients, Sunlight, Turbulence, Salinity and density.

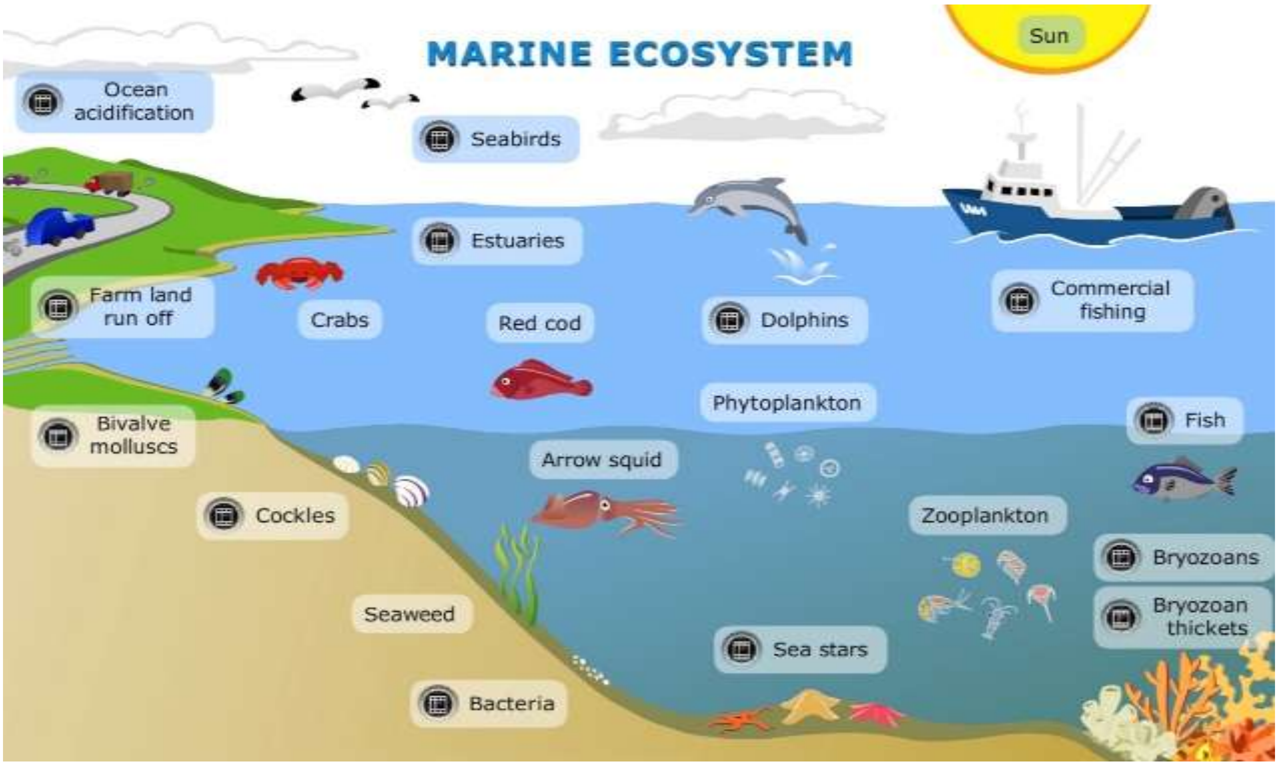

Fig. 1. Schematic representation of Marine ecosystem

Table 2: Based on the intensity of light the water body of marine ecosystems can be differentiated into three zones

Zone	Depth	Intensity of light	Organisms
Euphotic zone	100 m depth	illuminated zone	Production zone, rich with phytoplankton, primary consumers and secondary consumers.
Disphotic zone	100 and 200 m depth	weakly lighted	secondary consumers live with a few primary consumers, rare plant life
Aphotic zone	above 200m depth	No light	No light, no producers, no photosynthesis, secondary consumers, feed on other animals also.

Biodiversity of marine ecosystem:

In comparison to other ecosystems on the planet, the marine ecosystem has a high biodiversity. The aquatic culture has been adapted by the marine ecosystem's species for survival. Fish, like humans, have gills that allow them to breathe underwater. In the marine ecosystem, numerous plant and animal species coexist. Some of the most common aquatic species include kelp, phytoplankton, seaweeds, seagrasses, mangroves, fish such as sharks, tuna, grouper, eels, seahorse, gars, swordfish, clownfish, stingray, flatfish, rockfish, sunfish mola, mammals such as seals, dolphins, blue whales, walruses, manatees, otters, Mollusks like cuttlefish, conch, oysters, snails, octopus, clams, squids, slugs.

Types of marine ecosystems

Oceans

Because the ocean covers 71% of the planet, marine ecosystems account for the majority of the Earth's surface. The oceans contain both valuable and desperately needed natural resources. They are food, energy, and mineral sources. The temperature fluctuation in oceanic waters is minimal. Arctic water is colder. Tropical waters are generally warmer. Seasonal and diurnal variations exist. Temperatures affect ocean animals in a variety of ways.

There are two kinds of animals.

1. Stenothermal animals – the ones which live within 20°C
2. Eurythermal animals – the animals which can withstand the wide range of temperature variations.

Estuaries

Estuaries are coastal areas where the salty waters of the ocean meet the fresh waters of rivers. Estuarine habitats are typically very productive due to the accumulation of nutrients from a large river catchment. As a result, estuarine waters are salty or brackish in nature. They are deep funnel-shaped mouths structurally. They are a complex ecosystem with three zones: polyhaline (low salt), mesohaline (medium salt), and oligohaline (high salt) (fully saline). Estuaries can be small or large, depending on their size, shape, and the amount of river that stays and flows inside.

Table 3: Estuaries have following biota

Producers	**Zooplanktons**	**Benthic invertebrates**	**Fishes**	**Birds and wildlife**
Diatoms, dinoflagellates, and green algae are examples of phytoplankton. Red algae, green algae, and brown algae are macroalgae. Benthic diatoms are microalgae. Estuaries are rich in seagrasses.	Copepods, larval fish, fish eggs, and chaetognaths are examples of grazing herbivores and carnivores. Oysters, clams, corals, and other larval invertebrates Jellyfish is a type of jellyfish that (small & large)	Polychaete worms, amphipods, and decapods are molluscs that include clams, oysters, mussels, and snails.	Anadromous fish, striped bass and salmon, spotted seatrout, and red drum.	Plovers, skimmers, gulls, oyster catchers, terns, pelicans, ducks, and ospreys are among the birds. Sea turtles are reptiles that eat fish, invertebrates, and seagrasses. Mammals include otters, raccoons, nutria, dolphins, and occasionally whales.

Salt marshes

Salt marshes are flooded habitats made up of salt-tolerant flora and animals that flood during high tide. Salt marshes are essential for a variety of reasons: they provide habitat for marine life, birds, and migratory birds, they serve as key nursery places for fish and invertebrates, and they safeguard the rest of the shoreline by absorbing water during high tides and storms. Algae, plankton, birds, fish, and occasionally marine mammals such as dolphins and seals make up the salt marsh marine life.

Coral reefs

Reef-forming corals with dinoflagellate primary producers living symbiotically in their tissues form coral reef habitats where conditions are suitable for their growth. Although dense coral growths can occasionally be found in the deep sea, these species lack photosynthetic symbiotes, develop slowly, and do not form important reef structures. Hard and soft corals, invertebrates of all sizes, and even giant animals like sharks and dolphins can all be found in healthy coral reef ecosystems. The hard (stony) corals are the reef-builders. The skeleton of the coral, which is comprised of limestone (calcium carbonate) and sustains small animals known as polyps, forms the foundation of a reef. The polyps eventually die, leaving the skeleton behind Many Invertebrates (hundreds of species of coral, sponges, crabs, shrimp, lobsters, anemones, worms, bryozoans, sea stars, urchins, nudibranchs, octopuses, squid, and snails) and Vertebrates (fish, sea turtles, and marine mammals) live on coral reefs (such as seals and dolphins).

Saltwater Wetland Marine Ecosystem

The saltwater wetland habitat is found around the coasts of oceans and seas. The marine ecology of saltwater wetlands is divided into two types: saltwater swamps and salt marshes. Saltwater swamps are tree-dominated areas, whilst salt marshes are grass-covered areas. Amphibians, reptiles, some migrating birds, shellfishes, a few fishes, and other water species commonly found in saltwater wetland ecosystems include amphibians, reptiles, some migratory birds, shellfishes, and a few fishes.

Mangrove Marine Ecosystem

Mangroves are a form of saltwater wetland that can be found in several tropical and subtropical coastal regions. Special species of trees that can live in a saltwater ecosystem can be found in mangrove swamps. These mangroves have a unique root system that allows them to absorb oxygen and thrive. The roots are visible above the surface of the water. Shrimps, jellyfish, birds, sponges, crabs, fish, crocodiles, and other animals find refuge in the mangrove habitat.

Benefits

The marine ecosystem plays a critical role in environmental preservation. Water plants, for example, assist to reduce carbon levels in the atmosphere in the same way that land plants do. Carbon dioxide is absorbed from the air by aquatic plants, which then releases oxygen back into the atmosphere.

Humans have traditionally benefited from marine ecosystems, gaining access to resources such as seafood as well as recreational and transit options. Indirect benefits are also provided by these ecosystems, which trap carbon and play crucial roles in the regulation of other planetary cycles. The ecosystem services offered by marine ecosystems provide a general description of the benefits obtained from these systems (Arkema, K. K et al., 2015)

Marine ecosystem services span four major categories

Provisioning and regulating, cultural and supporting services.

The most evident and easily appreciated provisioning services are food from catch fisheries, aquaculture, and wild foods. In 2009, almost 80 million tonnes of fish were caught in marine capture fisheries around the world, accounting for roughly 16% of human animal protein consumption (FAO Fisheries Department, 2010). Timber and fibre from mangroves and seagrass beds, as well as biochemicals for cosmetics and food additives, are among the other services provided. There is also the possibility of generating innovative natural products with medical applications from marine animals (Carte, 1996). Climate regulation, water regulation, erosion regulation, and water purification and waste treatment are only a few of the services provided by marine systems. Wastetransformation, detoxification, and sequestration are examples of other regulatory services supplied by marine systems (Peterson and Lubchenco, 1997). And "blue carbon," or the role of oceans as carbon sinks, is becoming more popular (Nellemann et al., 2009). Cultural services that are provided by marine ecosystem includes, Provision of conditionsthat support or enhance ethical values, Provision of conditions that support or enhance existence values and Provision of recreation and ecotourism opportunities. Coastal tourism is a key component of many economies around the world and is one of the fastest growing and most profitable sectors of tourism (United Nations Environment Program, 2006). Finally, they provide critical support services that underpin many of the world's biological activities and are a major influencer on the temperature, moisture content, and stability of the atmosphere (Colling, 2001).

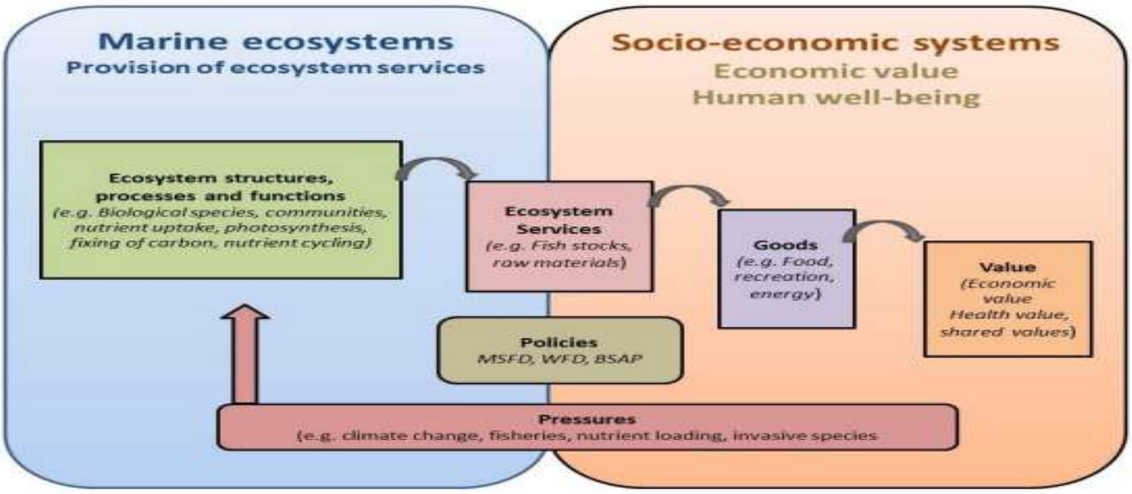

Fig. 2: Schematic representation of Marine ecosystem services.

Major challenges and mitigation

Human welfare is influenced by marine and coastal ecosystems both via their use and through the effects these services have on other sections of the environment.

Overfishing, eutrophication, contamination, habitat destruction, and biodiversity loss are all putting pressure on marine and coastal services. (UNEP – WCMC 2011). Concern for the preservation of global diversity has resulted in a large body of work on

threatened and endangered species. Marine fish species have not been thought to be in danger of becoming extinct in general, while marine animals, sea birds, and sea turtles have received the most attention. Marine parks and sanctuary zones are obvious initial steps toward giving some protection, at least for the species with a smaller range.

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Bio-intensive and ecological integrated pest management in forestry

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Bio-intensive IPM is defined as a systems approach to pest management based on an understanding of pest ecology. It begins with steps to accurately diagnose the nature and source of pest problems, and then relies on a range of preventive tactics and biological controls to keep pest populations within acceptable limits. Reduced-risk pesticides are used if other tactics have not been adequately effective, as a last resort, and with care to minimize risks (Benbrook, 1996). An important difference between conventional and bio-intensive IPM is that the emphasis of the latter is on proactive measures to redesign the agricultural ecosystem to the disadvantage of insect pest and to the advantage of its parasite and predator complex but at the same time, bio-intensive IPM shares many of the same components as conventional IPM. BIPM options can be classified into proactive or reactive. In simple terms the proactive measure includes biodiversity, cultural control, host plant resistance and transgenic crops and reactive measures include mechanical control, biological control and use of reduced risk pesticides.

The most recent bio-intensive integrated approaches for pest management utilizes components such as cultural methods viz., crop rotation, summer ploughing, fallowing, intercropping, pruning, mulching, spacing, planting date, trap cropping etc and use of resistant cultivars; bio-agents viz., predators, parasitoids and bio-control agents, mycorrhizal fungi, botanicals including bio-fumigation, oil cakes, FYM, crop residues, green manuring and other organic amendments, physical methods viz., hot water treatment of planting material, soil solarization and bio-rational chemicals like pheromones.

Biointensive IPM incorporates ecological and economic factors into forestry/agricultural system design and decision making, and addresses public concerns about environmental quality and food safety. Biointensive IPM can be defined as more dynamic and ecologically-informed approach to IPM that considers the farm as part of an ecosystem, with particular characteristics that need to be understood and managed in order to minimize pest damage. In simple terms, Understands crops, pests and natural enemies as part of ecosystem, Implement proactive (preventive) measures, Monitor pests and their natural enemies (beneficial organisms) and Use least disruptive reactive (control) tactics as needed.

Food production process in India during the green revolution period has been based on the use of more chemical fertilizers and pesticides. The challenge before crop protection scientists is to boost the yield from the available land without harming the environment. Incorporating ecological and economic factors into decision making and addressing public concerns about environmental quality and food safety is the need of the hour. There is now wide array of techniques available to replace the use of conventional chemical insecticides in IPM programmes. These issues can be sorted out by adopting eco-friendly Bio-intensive Integrated Pest Management strategies.

Cultural practices for minimising pest incidence

With the awareness of environmental problems, exploitation of different cultural and mechanical practices has been advocated as a vital approach to curb pest populations. Altering the planting time, increasing the plant diversity, use of trap, barrier and intercrops, crop sanitation, fertilizer as well as water management and crop rotation etc., have been advocated. To make the environment uncongenial for pest and also to enhance the activity of natural enemies, the new cultural practices may be evolved. Pests of sucking nature can be managed to a greater extent with the adoption of resistant varieties. Further synchronization of susceptible stage of the crop with the inactive period of insect pest reduces the infestation and chemical intervention. For fruit fly management, growing of trap crop, setting pheromone traps, protein bait spray with permitted insecticide and good sanitation are required. Single line trellis system yields good result by the way of reduced borer incidence and downy mildew infestation in bitter gourd (Singh et al., 2007).

Pheromones for monitoring and management of pests

Semio-chemicals that control the communication of insects both interspecific (allelochemicals) and intra-specific (pheromones) and can be used in pest management either alone for pest monitoring and decision-making, for mass trapping or mating disruption, or in combination with insecticides, sterilants, or insect pathogens. Additionally, semio-chemicals released by plants can repel insect pests from the crop (‘push’) and attract them into trap crops (‘pull’). The potential use of semio-chemicals for pest management on small-scale farms remains underexploited.

Use of allelochemicals

There are numerous avenues for use of allelochemicals in IPM programs either directly against the insect pests or through enhancement of natural enemies. Volatiles from herbivorous insects and their host plants may serve as reliable cues for bio-control agents in search of suitable hosts (Hilker and Mcneil, 2008).

Entomopathogens

Like other organisms, insects also suffer from diseases caused by bacteria, viruses, fungi, microsporidia, rickettsia and nematodes. So far over 3000 species of microorganisms have been reported to cause diseases in insects but many more remain undiscovered or unidentified. Microbial control agents have shown annual growth rate of more than 10 per cent during the last decade due to their safety, specificity and self-perpetuating action (Glare et al., 2012). For example the target pests of the entomopathogenic fungus *Metarhizium anisopliae* is Coleoptera, Lepidoptera, Hemiptera and Orthoptera.

Biological control in Bio-intensive IPM

Biological control is often most effective when coupled with other pest control tactics in an integrated pest management (IPM) program. Many practices are often compatible with biological control such as cultural controls, crop rotation, planting pest-resistant varieties, using insecticides with selective modes of action, or spot treatments. Although more than 100 families of insects contain predaceous species, about 12 of these contain the major biological control agents of crop pests. Among the parasitoids, the egg parasitoids, *Trichogramma* spp. has been utilized to some extent for control of teak pests. Similarly, spraying of HP NPV at 250 larval equivalents/ha, has been found to be effective in controlling teak defoliators. *Chrysoperla carnea* is an effective predator for control of white fly, aphids, jassids and eggs for some lepidopterous borers. Similarly, the larval parasitoids of teak defoliators, *Apantales sp* and potential predators *Canthocana furcellata* can be incorporated into biological pest management because of their potential in suppressing the larvae is a serious problem in teak.

Use of botanicals

Botanical pesticides in general possess low mammalian toxicity thus constitute least or no health hazards and environmental pollution. A number of compounds found in neem seeds, notably azadirachtin, have proven useful as insecticides. Neem is the most effective against actively growing immature insects. Use of neem and pongamia cakes in the pest management in many major pests of forest is being done. NSKE sprays are recommended and the use of neem seed cakes is well known for controlling nematodes. These also reduce soil-borne insects like termites, grubs, etc. has been demonstrated recently at IFB Hyderabad . Sprays of neem and pongamia soaps were found to be highly effective in controlling insecticide.

Insect growth regulator (IGR)

New approach to insect pest control is the use of substances that adversely affect insect growth and development. These substances are classified as insect hormone mimics or insect growth regulators (IGRs) owing to their effects on certain physiological regulatory processes essential for normal development of insects or their progeny. IGRs may belong to this type of (selective) insecticides and can be grouped according to their mode of action, as chitin synthesis inhibitors (i.e., cuticle formation) and substances that interfere with the action of insect hormones (i.e., JHs, ecdysteroids) are newest of all approaches to operational and commercial insect control. For example, diflubenzuron and its derivatives were effective against insect pests and mites infesting field crops, and were relatively harmless to beneficial insect species. On the other hand, buprofezin, a chitin synthesis inhibitor, was used against homopteran), whiteflies, *Bemisia tabaci* (Gennadius), and scale insects attacking forest crops.

Host plant resistance (HPR) inhibits pest attack through toxic or repellent compounds or through physical factors such as color or toughness.

Moreover, it has the advantage of cumulative effect, specificity, eco-friendly, ease of adoption, compatibility with BIPM components and eliminates or reduces use of pesticides. The benefits of implementing BIPM can include reduced chemical input costs, reduced environmental impacts, and more effective and sustainable pest management and such reductions will benefit the grower and in turn the society. Hence, bio-intensive IPM is considered the desirable path for achieving sustainability. The challenge before applied entomologists is to develop, validate and disseminate the site-specific bio-intensive IPM technologies to the farmers.

Ecological pest managment programmes should represent a sustainable approach to manage pests combining biological, chemical, physical and cultural tools to ensure favourable economic, ecological and sociological consequences i.e., a system based on the underlying knowledge of the managed ecosystem, including natural processes that suppress pest populations.

Ecological pest management is an approach to increase the strength of the natural system to reinforce the natural process of pest regulation and improve the agricultural production. EPM makes full use of natural and cultural processes and methods including HPR and biological control. Emphasizes the growth of healthy crop with least possible disruption of agroecosystem thereby encourage the natural pest control mechanisms.

Key issues that need attention are as follows:

1. Emphasis should be on understanding: The ecological relationships between the host plant and the management practices, such as cultural, biological and host-plant resistance.
2. All the components – biological, chemical, cultural and physical – need to be integrated.
3. Such programmes should minimize economic, environmental and health risks and provides sustainability over time.

Conclusion

The concept of bio-intensive pest management proposes effective balance of pests and beneficial organisms in an ecological context. Needless to say, that the natural balance is disturbed in the ecology due to regular cultivation practices. However, the plantations are meant to yield economic levels of quality produce. Hence there is a need to strike a balance appropriation of various interventions for suppression of insect pests, which can be achieved through various methods as described in previous text. However, detailed scientific scrutiny or models on this aspect are yet to be proposed in Indian context. Bio-intensive IPM requires a shift in research focus and approach with a knowledge base far more different than conventional IPM. Additionally, this concept envisages habitat modification for beneficial organisms, development of healthy and biologically active soils, maintaining uncultivated lands for diversity of flora and fauna, developing entomophage parks for food and shelter to diverse beneficial insects, weed strips, hedge rows, wind breaks, inter crops and conservation of insect biodiversity. Mass emergence devices for *in situ* and laboratory reared natural enemies, reduced direct mortality or interference to natural enemies, botanicals and laboratory reared /mass cultured bio-agents may have added advantage to BIPM. This may be most useful in situations where the potentially effective natural enemies have become ineffective due to biotic or abiotic factors and the pests cannot be satisfactorily (economically and/or environmentally) controlled by other methods. This bio-intensive approach needs building the knowledge and information infrastructure by making changes in research and education priorities in order to emphasize ecology-based pest management and redesign management programs to promote bio-intensive IPM.

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The great Himalayan national park - A mega emporium of biodiversity

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Himachal Pradesh is predominantly a mountainous state and well known for its scenic beauty, meandering rivers and abundant forests. There exists considerable variation in the altitudinal gradients and climatic conditions across the state. The state represents many landscapes which are dotted with unique elements of biodiversity.Among the various beautiful geographical entities of Himachal Pradesh, the Great Himalayan National Park (GHNP)is unequivocallydistinct and special due to its immense ecological, biological, culturalsignificance and charismatic biodiversity. It was declared as a national park in the year 1999. Recognising its varied importancefor biodiversity conservation,the Great Himalayan National Park (GHNP) has been included in the prestigious list of United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites (Natural) on 23rd June, 2014.

Panoramic View of Interlocking Mountain Ranges of GHNP

The Great Himalayan National Park (GHNP) is situated in the Kullu district of Himachal Pradesh in India. Geographically, it is spread between 31^{o} 38' 28” to 31^{o} 54' 58” N longitude and 77^{o} 20' 11” to 77^{o} 45' 00” E latitude. The Park covers an area of 1171Km^{2}, including the eco-zone, Sainj and Thirthan wildlife sanctuary and collectively referred to as Great

Hangar meadow with the temple of local deity

Himalayan National Park Conservation Area (GHNPCA). It mainly covers catchments of Sainj, Thirthan and Jiwanal and Parvati rivers, which finally merges with River Beas. Topographically, the GHNPCA consists of interlocking mountain peaks, narrow valleys, high ridges, steep slopes and glaciated areas.The altitude varies from 1340 m to 6200m. The Great Himalayan National Park (GHNP) has the western Himalayan, temperate and alpine type of climate. A large area of GHNP falls under the alpine zone and remain covered with perpetual snow. There is variation in temperature from below zero to 30^{0}C. Rainfall is abundant during the monsoon season. During winters, the lower areas of the park experience moderate snowfall and heavy snowfall occurs in the reaches.

Extensive Forests and Diverse Habitats

Due to the varied topographic features, altitudinal and climatic variation, GHNP is gifted with a wide spectrum of forests representing the vegetation types of temperate, sub-alpine and alpine regions.As per Champion and Seth (1968) classification, eleven different types of forestsare found in the park area.The forested landscapes of the GHNP abounds in pure and mixed strands of Conifers and Broad leafed tree species *viz*., *Cedrus deodara* (Himalayan Cedar), *Pinus wallichiana* (Himalayan Blue Pine), *Abies pindrow* (West Himalayan Silver Fir*)*, *Picea smithiana* (West Himalayan Spruce), *Quercus semicarpifolia* (Kharsu Oak), *Quercus floribunda* (Moru Oak), *Quercus oblongata* (Ban Oak), *Betula utilis* (Birch), *Acer* spp (Maples), *Aesculus indica* (Horse chestnut). Besides trees, many genera of shrubs including *Berberis*, *Desmodium*, *Daphne*, *Debregeasia*, *Lonicera*, *Indigofera*, *Ribes*, *Rhamnus*, *Sorbaria* and *Viburnum* are found as under storey vegetation. *Drepanostachyum falcatum* and *Thamnocalamus spathiflorus* are the two species of hill bamboos which are found as undergrowth forming dense clumps.The thickets of hill bamboos occupying the moist and cool nichesare favoured habitats of pheasants and other birds. The park also boasts of attractive meadows and pastures imparting special grace. In all, the distinct terrestrial and hydrological features of GHNCPA constitute the unique habitats for the wild life. The entire GHNPCA encompasses many critical ecosystems and represents a big biological realm of global significance.

A treasure trove of biodiversity

The GHNPCA harbours a vast assemblage of Western Himalayan unique biota. It provides a range of habitats and more than 370 faunal species have been reported from different regions of the Park. The faunal diversity encompasses different species of species mammals, birds, reptiles, amphibians, annelids, mollusks and insects. The valleys and protected areas under the park support numerous verteberate fauna including several threatened and endemic species. Mammalian fauna isrepresented by over 31 species, including the *Naemorhedus goral* (Himalayan Goral), *Macacamullata* (Rhesus macaque), *Presbytis entellus* (langur), *Petaurista petaurista* (Flying squirrel), *Canisaureus* (Jackal), *Hemitragu sjemlahicus* (Himalayan Tahr), *Pseudois nayaur* (Blue Sheep), *Moschus chrysogaster* (Himalayan Musk Deer), *Capra ibex* (Himalayan ibex), *Pseudois nayaur* (Blue sheep) *Ursus thibetanus* (Black Bear), *Ursus arctos* (Himalayan Brown Bear), *Panthera pardus* (Common Leopard) and *Panthera uncia* (Snow Leopard).

Spectacular faunal species

Tragopanmelano cephalus (Westeran Tragopan) is a medium-sized pheasant having brightly coloured plumage. It is locally known as *Jujurana* which means King of birds. *Jujurana* is not only known for its striking appearance, but it also hasmany socio-cultural connections. That's why it is rightly declared as the state bird of Himachal Pradesh.It is a habitat specialist species and prefers to live in the dense coniferous ormixed forests having profuse growth of *Drepanostachyum falcatum* (hill bamboos). The GHNP (Kullu) in India supports a sizeable population of this unique species due to the favourable physical settings. Presently, this species is facing threats mainly because of habitat fragmentation and poaching. Now, it is under the IUCN (International Union for Conservation of Nature) Red List of Vulnerable Species.Beside western tragopan, other pheasants e.g. *Catreus wallichii* (Cheer), *Lophophorus impeyanus* (Monal), *Pucrasia macrolopha* (Koklas) and *Lophura leucomelana* (Kalij) are also found in different zones of GHNP.

Tragopan melanocephalus
(Source: google internet)

Pantherauncia (Snow Leopard) is one of

Pantherauncia

(Source: google internet

the most attractive animals of Himalayas. It is an amazing species which prefers the high reaches in the mountains and perfectly camaflouged the surrounding. Snow–Leopard is carnivore and eats herbivores e.g. blue sheep and Ibex It actsas an indicator of the ecological health of high altitude zones. It also comes under the IUCN (International Union for Conservation of Nature) Red List of Vulnerable Species. The high altitude ranges in the GHNPCA provides excellent habitat for this elusive and rare wild animal.

Moschus chrysogaster (Himalayan Musk Deer) is other important mammalian found in GHNP.It is a herbivorous animal which feeds on the grasses and leaves. *Moschuschrys ogaster* (Himalayan Musk Deer) is a shy and solitary animal and found in high altitudinal ranges. Male musk deer has a gland in the abdomen which produces odorous substance called musk. The musk is priced high and used in perfumery. The animal is hunted for obtaining the musk and it has come under the IUCN (International Union for Conservation of Nature) Red List of Endangered Species.

Medicinal flora

The floral biodiversity of the Park also includes a plethora of medicinal plants. The alpine meadows in different valleys of the park adorned with beautiful flowers represent a kaleidoscopic and mesmerising view. Out of the good number of herbs and shrubs found in the park, some species are rare and endemic. These species are also fairly known for medicinal value. They have been harvested for use in traditional health care system as well as for trade. Consequently, many of these are now in the threatened or endangered list. Prominent herbaceous medicinal flora of the Park include *Dactylorhiza hatageria*, *Arnebia benthamii*, *Carex munroi*, *Aconitum* spp., *Thlaspi andersonii*, *Jurinea macrocephala*, *Meconopsis aculeata*, *Picrorhiza kurroa*, *Saussurea obvallata*, *Corydalis govaniana*, *Valeriana jatamansii*, etc. These species occur in the higher altitudinal ranges of GHNP.

Dactylorhizahatageria

Meconopsisaculeata

Saussureaobvallta

Though, the Great Himalayan National Park (GHNP) is well managed from conservation perspective. But the challenges due to climate change and global warming compounded by ever increasing anthropogenic interferences are posingserious threats to the splendour of this wondrous entity on earth. The GHNP not only offers plentiful opportunities for the nature lovers to watch it in its pristine state but also provides ample scope for the researchers to carry out research and monitoring for understanding dynamics of floral and faunal complex processes and for realisation of the motto statement of GHNP.

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Major ion dynamics in playas of Rajasthan to infer their evolutionary pathways

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Introduction

Playas

Playa or Evaporitic basins are hydrologically closed basins. Formation of playas needs certain conditions: (1) evaporation must exceed inflow and precipitation as in arid and semi-arid climates (2) it should be closed, outflow must be very restricted (Langbein, 1961; Hardie et al., 1978). Hydrological setting of a closed basin is influenced by both the climate and the tectonics which in turn, alters the sedimentation and depositional environment where sediments accumulate (Eugster, 1980). Basins generally have a low, flat floor, surrounded by mountains acting as precipitation catchment. Since it is a closed basin, the hydrological, water-chemistry, sedimentological and mineralogy are closely associated with each other.

Deposition in such environments cans occuronly when adequate supplies of solutes are available from various inflow sources (Yan et al., 2002). Chemical sediments of closed basins can illustrate much about the important processes that have reformed the Earth's surface throughout the geologic time. The small changes in evaporation and precipitation can cause lake-level changes, salinity change and subsequently in the sedimentary rocks (Battarbee, 2000).

Chemistry of brines

The ionic composition for majority of the brines can be constituted by four cations and three anions: Na, K, Ca, Mg, Cl, SO_4 and HCO_3^--CO_3^-. The five major brine types as described by Hardie et al., (1978) are:

1. Na-CO_3-Cl
2. Na-CO_3-SO_4-Cl
3. Na-SO_4-Cl
4. Na-Mg-SO_4-Cl
5. Ca-Mg-Na-Cl

The two aspects that influence the chemistry of playas are:

Environmental controls

This incorporates following three factors;

Hydrology

The major outflow and inflow sources which regulate the formation and persistence of a saline lake are:

- The water and solutes in saline lakes can be derived from direct precipitation, associated surface flow or groundwater, and some interstitial fluids asthey are typically more concentrated than surface waters due to frequent water-mineral interactions (Jones et al., 1969).
- Reactions involving dissolution–precipitation of hydrated phases can play a significant hydrologic role in brine evolution (Gamazo et al., 2011).

- The leakage ratio (ratio of subsurface water outflow to inflow) can have a significant effect on the salinity development in playas (Sanford & Wood, 1991).
- Hydrological setting plays a role in secondary modifications, by mixing of two chemically distinct inflow waters, interactions like pore-water exchange and residence times of various ions (Jones et al., 1969; Lerman& Jones, 1973).

Climate

This factor plays a significant role in closed basins. The balance between amount of inflow through precipitation and followed by evaporation due to temperature fluctuations can affect the brine chemistry adversely through various precipitation and dissolution reactions (Last, 1999).

Geology

The composition of bedrock and sediments available in or around basins greatly influences the composition of inflow waters. Geology of watershed is affected by tectonic activities also, like volcanic activities or upliftment of certain rock ranges providing chemically distinct inflow waters and thus altering brine type.

Compositional controls

This includes following two factors;

Inflow composition guides solute acquisition

The great variability in brines can be due to the composition of dilute inflow waters (Meybeck, 1981; Rasmy& Estefan, 1983; J. I. Drever, 1988). These waters provide the primary material for brine formation. Among the various processes, rainwater and weathering reactions are the chief solute sources. The rainwater satisfies all the seven-principal solute except silica. Various kinds of weathering reactions provide the solute load to inflow waters, these are:

- Minerals like gypsum and halite are soluble, and through congruent (i.e., solid to liquid) dissolution can supply ions to water.
- Waters rich in CO_2 (acidic) can dissolve calcite and contribute bicarbonate.
- During weathering, redox reactions are important as in the event of iron silicate dissolution and sulfide oxidation, Fe acts as the lateritic element and the sulfide oxidation takes place via the bacterial pathways.
- The mineralogical composition of watershed and the bedrock lithology also direct the dilute waters composition.
- The soft Ca-Na-HCO_3 waters are produced by igneous and metamorphic rocks.
- Limestone produces hard waters like Ca-HCO_3 and poor in silica.
- Basic and ultra-basic rocks produce alkaline Mg-HCO_3 waters.

Brine evolution

The surface evaporation, sub-surface evaporation of groundwater in vadose zone and evapotranspiration increases the evaporative concentration, thus growing the solute load and ultimately leading to mineral precipitation (Eugster, 1980; J. I. Drever, 1988). The various fractionation processesduring the brine evolution include:

Mineral precipitation

When one or more minerals precipitate, the future growth of water composition through *"chemical divide"* is affected profoundly. As the calcite precipitates the Mg/Ca ratio increases. The Ca^{2+} source is calcite and Mg^{2+} sources can be seawater, sub-surface fluids of marine and/or meteoric origin, or from high Mg aragonite and smectite clays. As the Mg/Ca ratio increases, it favors production of dolomite, firstly it produces low Mg calcite and, in the end, high Mg calcite and later proto dolomite.The next saturation mineral after calcite is Gypsum.

Eugster, 1980 discussed about the fate of inflow waters **(Figure 1)**:

If the water is rich in HCO_3>>Ca+Mg, the following waters will give CO_3+HCO_3 brine and depleted Ca+Mg, a sodium carbonate brine.

For waters initially with Ca+Mg>>HCO_3, the following waters will produce alkaline earth and depleted in CO_3+HCO_3 brines.

The amount carbonate to be formed depends upon the molar ratio of HCO_3/Ca+Mg, if the ratio is higher extensive carbonate production occurs and vice versa. Just like calcite precipitation provides a chemical divide between $Ca^{2+}$and carbonates, similarly gypsum precipitation shows chemical divide between sulphate and calcium. Ca^{2+}/SO_4^{-} ratio decreases, producing either Na-Cl-SO_4 or Ca-Na-Mg-Cl type brines.

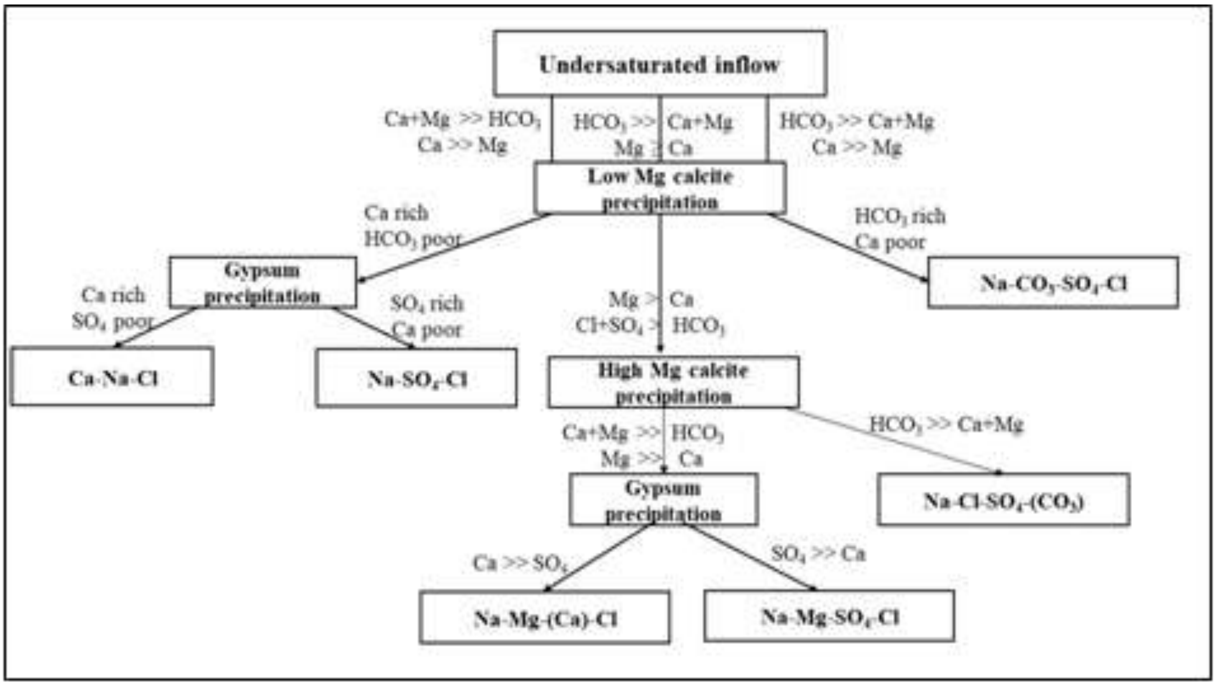

Fig 1: Brine evolution model (adopted from Eugster, 1980)

Sorption on active surfaces

Active surfaces are provided by clays which can cause solute loss by up-take and exchange of cations.

Degassing

A decrease in carbonate species can be observed by degassing of CO_2 to maintain equilibrium with the atmosphere or an increase in temperature of the atmosphere.

Redox reactions

Bacterial reduction to H_2S and then degassing and sulfide precipitation are used to remove the sulphate from the brine (Eugster& Jones, 1979).

Playas of Rajasthan

The state of Rajasthan covers an area of 342,239 km^2 and is situated in the north-west part of India between 23°30' and 30°11' North and 69°29' and78°17' East. It is bounded by the Aravalli Range of mountains on the east, which divides Rajasthan into two parts: semi-arid eastern part and arid western part. The region receives rainfall through south-west monsoon system. The summer temperature of the region rises up to 50°C and to as low as 6°C in winters. The evapotranspiration in this region exceeds precipitation in larger amount thus generating a negative water budget in the hydrologically closed basins and gives rise to saline nature lakes in the districts of Barmer, Jaipur, Jaisalmer and Nagaur, namely Sambhar, Didwana, Pachpadra and Pokhran (Figure 3).

Fig. 2: Sambhar Playa, a) Lake Stretch with salt collection on boundaries b) Playa lake water, pores present for gaseous exchange c) Dried playa with crevices during intense heating period.

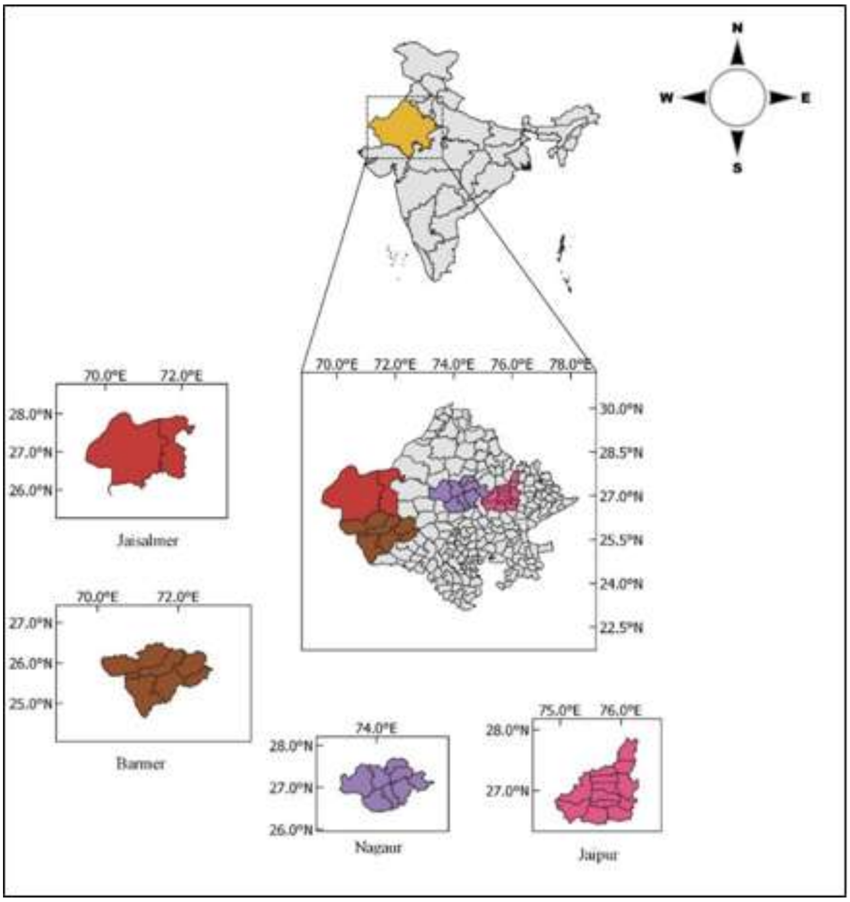

Fig. 3: Location map of various districts of Playas.

Data analysis

Hydrogeochemical processes (scatter plots)

- To study the contribution of evaporites in the playa samples, a relationship between (Ca+Mg) vs. HCO_3 and (Ca+Mg) vs. (HCO_3+SO_4) plot can be established. In (Ca+Mg) vs. HCO_3 plot, if the data points lie more towards HCO_3, it suggests less contribution of evaporites (Rajmohan&Elango, 2003; Rina et al., 2013)and also suggests fresh water recharge or water through meteoric means (Nazzal et al. 2014).
- The plotfor (Ca+Mg) vs. (HCO_3+SO_4) reveals about thecycle of ion exchanges in water due to calcite, dolomite or gypsum dissolution (Fisher and Mullican 1997). Also, the excess of HCO_3 in (Ca +Mg) vs. (HCO_3+SO_4) reveals about the contribution of silicate weathering (Singh et al., 2013).
- Ca^{2+} v/s Mg^{2+} concentrations plots are used in order to classify the source of carbonate in the sampled waters (Rina et. al., 2013; Patel et al., 2020).
- The study for the evaporative prevalence in playas can be done using SO_4^{2-} v/s Cl^- plot (Patel et al., 2020).

Binary plots

- The effect of gypsum dissolution in waters is studied by relationship between the noncarbonate mineral-derived Ca and Mg using the formula (Ca^{2+} + Mg^{2+})-0.5HCO_3^- v/s SO_4^{2-} (Kimblin, 1995).
- The effect of calcite dissolution in sampled waters is studied by HCO_3^- v/s Ca^{2+} plot (Abdel Wahed et al., 2015).

Ternary plot

- A ternary plot is constructed to study the anion dominance in playa samples, using AqQA.

Saturation indices (S.I.)

In order to determine mineral reactivity in the basin, saturation indexes are necessary. A positive SI reveals the oversaturation and saturation of a mineral, whereas a negative SI talks about the undersaturation of a mineral, thus its contribution in waters (Mallick et al., 2018).

Significance of playas and their study

A detailed study in the future may provide information about sedimentary depositional history, paleoclimate and economically valuable evaporative mineral formations. Playa study also helps in studying the weathering in catchment. Water chemistry generates an understanding of interaction of complex matrices of hydrology and geology. It provides a quantitative account of major ions in the playas and thus helping in inferring the possible geogenic and anthropogenic sources. In the current scenario, with respect to climate change, the temperature will affect the evaporation rate and rainfall will affect the wetting and drying period thus altering the ionic concentration, leading to altered sedimentation.

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Coffee borer, *Zeuzera coffeae*: Its pest profile and use as tribal food

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Abstract

The coffee borer or the red borer, *Zeuzera coffeae* Nietner (Lepidoptera : Cossidae) is a major insect pest of tea and coffee growing areas of India. The pest profile of this borer has been described and a long list of host plants is mentioned. Further, this article has highlighted the use of borer larvae as tribal food.

Key words: Coffee borer, *Zeuzera coffeae*, pest profile, host plants, tribal food

INTRODUCTION

Zeuzera coffeae Nietner (Lepidoptera : Cossidae) (syn. *Zeuzera roricyanea* Walker) is commonly known as the coffee borer or the red borer. This is a borer of the stems and branches of numerous dicotyledonous trees and shrubs. *Z. coffeae* is a major insect pest of tea and coffee growing areas of India and Sri Lanka (Beeson, 1941). The present article deals with this borer, its host plants and borer larvae as tribal food.

Pest profile

This wide spread species is a borer of the woody stems of young living saplings and the living branches of bushes of very many species. The detailed life history of *Z. coffeae* has been studied by Beeson (1941). The adult female lays strings of yellow eggs on the bark of small stems or branches. On hatching, the young larvae spin a network shelter of silk. Eventually some larvae settle on suitable hosts and bore in the in the cambium and bast, making a long , irregular mine that may completely girdle the infested part and may extend down into the bark of the roots, ejection holes are made at intervals and through these are pushed out yellowish or reddish gummy pellets of refuse. The larval feeding varies from 60-120 days. The full grown larva is about 40 mm long, mainly reddish above and yellowish below, with a brown head and thoracic shield. Before pupation, the larva partially cuts a circular flight hole, which remain closed by a thin skin of bark and then pupates in its tunnel within a loose mesh of silk. The pupal period lasts for three weeks to a month. The moth emerges, leaving the empty pupal skin protruding from the hole in the bark. The moth is white with pairs of small black dots on the thorax and numerous small black spots and streaks on the fore wing and a few black spots on the hind edge of the hind wing and with a wing span of about 35-45 mm. The length of the life cycle varies considerably; it lasts 4-5 months in south India and probably extends to a year at high elevations and north India.

Host plants of *Zeuzera coffeae*

Z. coffeae frequently attacks yearlings and small saplings in forest and horticultural nurseries and young plantations of *Albizia falcata* (L.) Backer ex Merr. (family Fabaceae), *Anona squamosa* L. (family Annonaceae), *Amherstia nobilis* Wall. (family Fabaceae), *Bauhinia malabarica* Roxb. (family Fabaceae), *Cassia auriculata* L. (family Fabaceae), *C. fistula* L. (family Fabaceae), *C. grandis* L.f. (family Fabaceae), *C. siamea* (Lam.) Irwin et Barneby (family Fabaceae), *Casuarina equisetifolia* Linn. (family Casuarinaceae), *Cestrum nocturnum* L. (family Solanaceae), *Chikrassia tabularis* A. Juss. (family Meliaceae), *Cinnamomum camphora* (L.) J. Presl. (family Lauraceae), *C. zeylanicum* Blume (family Lauraceae), *Citrus* spp. (family Rutaceae), *Clerodendron infortunatum* L. (family Lamiaceae), *Coffea robusta* L.Linden (family Rubiaceae), *Eriobotrya japonica* (Thunb.) Lindl. (family Rosaceae), *Eucalyptus deglupta* Blume (family Myrtaceae), *Flindersia brayleana* F. Muell. (family Rutaceae), *Grevillea robusta* A.Cunn. ex R.Br. (family Proteaceae), *Hibiscus rosa sinensis* L. (family Malvaceae), *Hydnocarpus wightiana* Blume (family Achariaceae), *Lagerstroemia speciosa* L. (Pers.) (family Lythraceae), *Melia azedarach* L. (family Meliaceae), *Nephelium litchi* L. (family Sapindaceae), *Ochroma lagopus* (Cav. ex Lam.) Urb. (family Malvaceae), *Pericopsis mooniana* (Thw.) Thw. (family Fabaceae), *Persea gratissima* C.F.Gaertn.(family Lauraceae), *Phyllanthus emblica* L. (family Phyllanthaceae), *Psidium guajava* L. (family Myrtaceae), *Pterocarpus dalbergioides* Roxb. ex DC. (family Fabaceae), *Santalum album* Linn. (family Santalaceae), *Schleichera trijuga* Willd. (family Sapindaceae), *Swietenia macrophylla* King (family Meliaceae), *S. mahagoni* Linn. (family Meliaceae), *Taraktogenos kurzii* (King) Warb. (family Achariaceae), *Tectona grandis* L.f. (family Verbenaceae), *Terminalia bellirica* (Gaertn.) Roxb. (Family Combretaceae), *T. brassii* Exell. (Family Combretaceae), *T. ivorensis* A. Chev. (Family Combretaceae), *Thea sinensis* L. (family Theaceae), *Theobroma cacao* L. (family Malvaceae), *Toona ciliata* M. Roem (family Meliaceae), *Toona sinensis* (A.Juss.) M. Roem. (Family Meliaceae), *Vitex pubescens* Vahl (family Lamiaceae) and *Xylia xylocarpa* Roxb. Taub. (family Fabaceae) (Beeson, 1941; Browne, 1968; Senthilkumar and Murugesan, 2015; Sundararaj et al., 2019; Roychoudhury and Mishra, 2021). *Z. coffeae* is often an important pest of forestry crops, injurious principally to year old seedlings and small saplings in both nurseries and plantations (Browne, 1968).

Zeuzera coffeae as tribal food

Bodenheimer (1951) mentioned that Kerr (1931, quoted from Bodenheimer 1951) finds some satisfaction in the fact that in Siam the caterpillars of some pests like the coffee borer, *Z. coffeae* are turned to useful purposes. This larva tunnels in the branches of various trees and shrubs, such as *Sesbania roxburghii* Merr. (family Fabaceae) Though not cultivated in the fields, it yields two edible products: the flowers which are eaten and the larvae of *Z. coffeae* which live within the stem and branches. When fully grown these 'Duang sano' are collected for eating. Aynthia is the province where they are chiefly obtained, the host plant growing plentifully along the river. There is some trade in the larvae, which are sent down to Bangkok alive during September/October. They are prepared for the table by frying. Prince Sithiporn told Bristowe that his cousin, the late king of Siam, was very fond of the caterpillars of *Z. coffeae* (Siam: Duang), which are extracted from *Sesbania aculeata* (Willd.) Pers., the larvae being roasted and eaten with salt and rice.

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