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Superoxide Dismutases (SODs) and Their Role in Regulating Abiotic Stress induced Oxidative Stress in Plants

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3.1 Introduction

Reactive oxygen species (ROS) including superoxide ($O_2^{\bullet-}$), hydrogen peroxide (H_2O_2) and hydroxyl radicals ($\bullet OH$) are produced inevitably in the redox reactions of plants, mainly in mitochondria, peroxisomes and chloroplasts (Apel and Hirt 2004; Sharma et al. 2012; Considine et al. 2015; Meitha et al. 2015; del Rio and López-Huertas 2016; Dietz et al. 2016; Mignolet-Spruyt et al. 2016; Sharma 2016; Choudhury et al. 2017). Photosynthesis is the key source of ROS in plants. The $O_2^{\bullet-}$ is produced at the antenna pigments and at photosystem I (PSI) by the Mehler reaction (Asada and Takahashi 1987). Singlet oxygen (1O_2) can be formed in PSII by the transfer of an electron from the excited triplet state of chlorophyll to 3O_2 , generally under high light intensities (Laloi et al. 2004). The reaction of $O_2^{\bullet-}$ with H_2O_2 leads to production of $\bullet OH$, the most reactive ROS, which can react with lipids, proteins, nucleic acids, and carbohydrates. The generation and scavenging of ROS must be controlled strictly in unstressed plants. At low concentrations, they act as signaling molecules and regulate many processes operating in plants including cell proliferation and differentiation, programmed cell death, senescence, pathogen defense, seed germination, growth of root hair, gravitropism, development of pollen tube, stomatal behavior, etc. (Foyer and Noctor 2003; Apel and Hirt 2004; Laloi et al. 2004; Suzuki et al. 2012; Dietz et al. 2016; Mignolet-Spruyt et al. 2016; Singh et al. 2016). Different abiotic stresses including drought, salinity, metal toxicity, chilling and/or different combinations of abiotic stresses (stress combination) enhance formation of different ROS in plant cells (Wise 1995; Hasegawa et al. 2000; Lukatkin 2003; Mittler 2006; Suzuki and Mittler 2006; Cruz de Carvalho 2008; Miller et al. 2010). Excessive generation of ROS caused by abiotic stresses is correlated with upsetting of homeostasis and oxidative stress in plants (Suzuki and Mittler 2006). At high concentrations they enhance lipid peroxidation (Buettner 1993; Davies 2000; Niki et al. 2005), inactivate enzymes (Fucci et al. 1983), and break DNA strands (Brawn and Fridovich 1981).

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Imidazole framework based metal oxide nanoparticles photocatalysts: An approach towards amputation of organic pollutants from water

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1 Introduction

Presently, rapid developments of industry and human population are putting an incredible strain on environment more likely as an environmental, water, and soil pollution leads to severe ecological and economical concern (Rajeshwar et al., 2008). Among all the preceding text, water pollution has become a major look out for the life standard of human being and animals. The pollutants or waste by-product released directly or indirectly from industry, agricultural, and domestic activities are the main sources of water pollution (Chaousis, Leusch, & van de Merwe, 2018). Previously, it has been reported that the major organic pollutants are responsible for the environmental threat coming from industrial and textile dyes, respectively. These dyes are very toxic and highly carcinogenic even at trace level (used in food and textile industries) and considered to be first contaminants in industrial waste water. Thus these dyes pose a serious hazard to human and to marine ecosystem at large. As per the report, each year, approximately ~0.7 million ton of organic synthetic dyes are manufactured for utilization in the paper industries, leather goods, industrial painting, food, cosmetics, plastics, and other consumer service sectors (Rajeshwar et al., 2008). These dyes are basically derived from the two main sources, that is coal tar and petroleum intermediates. About, 10%–20% (~1000 tons) of these nonbiodegradable textile dyes are directly discharged as effluents into the green environment (natural streams and to the water bodies) (Ajmal, Majeed, Malik, Idriss, & Nadeem, 2014; Houas et al., 2001; Pagga & Brown, 1986). As a result, worldwide 3.2 million people die every year because of polluted water, poor sanitation, and inadequate hygiene (Hisatomi, Kubota, & Domen, 2014). Thus it is of prime necessity to understand the fundamental aspects of dye in order to overcome their associated problems on the environment.



Environmental and Human Exposure to Antimicrobial Agent Triclosan: A Review

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Rekha Kumari, Shashwati Ghosh Sachan,
and Ashish Sachan

Abstract

Triclosan, commonly found in the ingredient list of several household and personal care products, exploded onto the market because of its broad-spectrum antimicrobial activity. Triclosan was introduced in the market owing to its antibacterial and antifungal properties but has now become a ubiquitous pollutant. Excessive use of triclosan has resulted in its presence not only in the environment but in the human body as well. The different mechanisms by which triclosan acts include efflux mechanisms, inhibition of fatty acid synthesis, and membrane destabilization. The major source of triclosan pollution in the environment is through wastewater. There are growing concerns regarding the possible harmful effects of triclosan on animal and human health. Triclosan, a known endocrine disruptor, has been reported to be a potent carcinogen, mutagen, and a teratogen. It is feared that its overuse may contribute to the growth of super-resistant bacteria. By the virtue of being similar in its mode of action to various antibiotics, it might confer antibiotic resistance among different bacterial species. This review article aims to present an overview of the advanced research on triclosan, primarily focusing on its toxicity and environmental persistence. It also highlights the potential hazards of triclosan including its link to developing cross-resistance. Keeping in view the limitation of the present knowledge base, future research directions have also been highlighted.

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Chapter 12

Microbial Potential and Biofuel Production



Priyanku Teotia, Manoj Kumar, and Vivek Kumar

Abstract Exhaustion of fossil fuel has driven consideration and notion all over the world to ascertain an auxiliary and long-time supportable energy resources and sources of power to fulfil the requirement of human beings. The microbial originated fuels, known as micro-biofuels has immense potential to substantially reduce the transportation fuel crisis. For cost-effective biofuels production, the use of microbes using industrial, agricultural waste and renewable matters will sort out energy crisis, climate change apprehensiveness and food assurance. Quantum of plant biomass on our planet is remarkable and the biomass can be converted by the microbes and their enzymes into renewable energy sources. Currently, on a large scale, the bioethanol is produced in countries like United States of America using corn or other raw materials to meet the requirements of transportation sector. On the contrary, though methane gas is produced on a significant level, it is yet to gain currency for industrial and transportation purposes. As regards the biobutanol, it has huge potential to supplement the existing petroleum products.

Instead of producing bioethanol or biodiesel from microbes, researchers are trying to manufacture advanced microbial fuels, such as long chain isoprenoid, alcohols and fatty acids based fuels from *Saccharomyces cerevisiae* and *Escherichia coli* or production of hydrogen using the cyanobacteria. In this chapter, we analyse and discuss the present status of microbial based biofuel production, their constraints and challenges.

Keywords Biofuel · Biogas · *Saccharomyces cerevisiae*

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Restoration of Pesticide-Contaminated Sites Through Plants

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12.1 INTRODUCTION

The term “pesticide” is a composite term that covers a wide array of chemical compounds, such as insecticides (for insects), termiticide (for termites), fungicides (for fungi), herbicides (for weeds), rodenticides (for vertebrate poisons), molluscicides (for gastropods), nematocides (for nematodes), plant growth regulators, disinfectants (antimicrobial), and sanitizers, among others. According to the United Nations Organization for Food and Agriculture, pesticides are any substance or group of substances applied to prevent, kill, or control pests (Garcia et al., 2012). A major

share of the green revolution can be attributed to pesticides, which were applied in huge quantities over crops to control pests and insects that would otherwise have reduced both the quantity and quality of food grains. The immediate benefits of pesticides made their application a standard method for pest control, but every synthesized chemical has its own risks. Concern over the toxicological effects of pesticides began with acute poisoning events reported in Rachel L. Carson’s book, *Silent Spring*, in 1962. The undesirable effects of pesticides on the environment and human health were documented in later years by several researchers indicating pesticides’

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Floral Species in Pollution Remediation and Augmentation of Micrometeorological Conditions and Microclimate: An Integrated Approach

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6.1 INTRODUCTION

6.1.1 Problems of the Current Era

The present scenario on our planet is bleak, due to the ever-increasing burden of the human population, which has reached over seven billion at present. Resources for nurturing the current human population are depleting at an alarming rate, and the carrying capacity of the earth is being pushed to the limit (Chakravarty et al., 2017). The State of the World's Plants report, 2016, presents the troublesome fact that over 21% of plant species face the threat of extinction due to developmental activities. One of the worst drawbacks of population growth on this planet is pollution. The pollution load in the environment

has created an unthinkable amount of detrimental effects. Glick (2010) mentioned that, if the pollution levels are low, ecosystems can efficiently tackle the pollutants naturally by dilution, degradation, and absorption processes. But the amount of pollutants generated is rising with the increase in population and urbanization. Apart from pollution, another disastrous impact of human interference is climate change. In the Fifth Assessment Report of IPCC, it has been depicted that 65% of global carbon dioxide emissions come from fossil fuels and industrial processes. Greenhouse gas emissions are considered as a major contributor of anthropogenic forced climate change. Forestry and other land use practices contribute to 11% of carbon dioxide emissions. Alterations to natural land cover on the surface of the earth have

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Ecorestoration of Polluted Aquatic Ecosystems Through Rhizofiltration

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5.1 INTRODUCTION

Population expansion, industrialization, and globalization are some of the key driving forces for ecosystem contamination. The consumption of fossil fuels and chemicals, mining of minerals, industrial discharge, and other anthropogenic effluents lead to ecosystem contamination with petroleum hydrocarbons, pesticides, heavy metals, dyes, and other pollutants. These contaminants may result in various health issues. Sustainable and cost-effective techniques are thus required for their effective removal. Phytoremediation is considered as one of the greenest and safest technologies for the restoration of contaminated aquatic ecosystems (Bauddh and Singh, 2015a,b; Bauddh et al., 2016a,b; Bharti et al., 2017; Chakravarty et al., 2017; Jisha et al., 2017; Kumar et al., 2017; Yeh

et al., 2018). Rhizofiltration is an effective method of phytoremediation (Vymazal, 2007; Veselý et al., 2012; Galal et al., 2017; Mikheev et al., 2017; Neha et al., 2017; Pérez-Palacios et al., 2017; Wang and Dudel, 2017). Rhizofiltration involves the method of using plant roots, which absorb and sequester toxic pollutants from contaminated land surfaces or groundwater (Fig. 5.1). Several plants like *Eichhornia crassipes*, *Phragmites australis*, *Pistia stratiotes*, *Arundo donax*, *Salvinia molesta*, *Trapa natans*, *Lemna minor*, *Helianthus annuus*, *Phaseolus vulgaris*, and other plants have been studied in order to assess their contaminant removal efficiency (Odjegba and Fasidi, 2004; Deng et al., 2004; Lee and Yang, 2010; Sweta et al., 2015; Oustriere et al., 2017; Wang and Dudel, 2018). Various studies have suggested certain desirable attributes in rhizofiltration

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Economics, Technology, and Environmental Protection: A Critical Analysis of Phytomanagement

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22.1 INTRODUCTION

Environmental degradation has become a “common concern” for humankind over the past few decades. The distinctive nature of the present environmental problems is that they are caused more by anthropogenic than natural phenomena. Mindless consumerism and economic growth have started to demonstrate pernicious effects on Mother Nature. In spite of this, the pace and desire for economic development have never ceased. It is economics that has dictated environmental policy. Emphasis has been placed on the role of science and technology as a catalyst for integrating ecology with economics. In this process, sustainable development became a buzzword. This concluding chapter delves into the philosophy behind the concept of green/clean development. It argues that the concept of green/clean development is a result of an understanding that is primarily driven by economic objectives.

The chapter highlights various economic approaches to address environmental issues. It also critically analyzes the role of technology in sustainable development. Finally, an attempt has been made to highlight socio-legal issues associated with the process of phytomanagement. Sincere efforts have been maintained to sustain a scientific overtone in writing, as per the requirement of the book. However, the author of this chapter claims the privilege to express his limitations of not being formally trained in science and technology.

22.2 ECONOMIC APPROACHES IN ADDRESSING ENVIRONMENTAL ISSUES

Environmentalists have stressed the adverse impacts of expanding the human economy (Gowdy, 1994). For them the principal hypothesis for understanding the relationship

Chapter 3

Effect of Hydrogen and Producer Gas Addition on the Performance and Emissions on a Dual-Fuel Diesel Engine



Abhishek Priyam, Prabha Chand and D. B. Lata

Abstract There is a global interest in the use of alternative fuels due to environmental concerns such as greenhouse emission, ozone depletion, air pollution. Also, the limited petroleum reserves invite the alternate solution for diesel engines. Several researchers have proposed various types of solutions. One among them is the use of different gaseous fuels with pilot diesel fuel. An experimental work has been done to find the performance of high-capacity diesel engine which uses diesel fuel with the variation of hydrogen and rice-husk-derived producer gas. The results of engine test with producer gas and hydrogen on brake thermal efficiency and emissions such as unburnt hydrocarbon, carbon monoxide, and NO_x are presented. Beyond 30% load, the brake thermal efficiency of dual-fuel operation is improved. Maximum efficiency of 38–43% is achieved with mixture of 10% PG and varying hydrogen from 5 to 25% and similarly for mixture of 40% PG and varying hydrogen gives the maximum efficiency of 43–48% at 60% load condition. It is found that specific energy consumption increases with the increase in PG and hydrogen flow through inlet of engine. The maximum fuel substitution has been found at 80% load with 10% PG and 25% hydrogen mixture. At higher loads, volumetric efficiency has been better as the oxygen or air intake would be more, but at mixture of 40% PG and 25% hydrogen, the volumetric efficiency reaches a level of 27% as there is sufficient amount of PG and hydrogen, but minimum intake of air took place. The higher CO and HC emission levels were recorded for increased producer gas content due to the CO content. NO_x emissions were maximum at higher loads due to the presence of nitrogen in air as well as fuel. Overall smooth running of engine is found in all cases. One major finding of

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Chapter 12

Ethnography: An Emerging Trend in Rock Art Research



Seema Mamta Minz

Abstract Conventionally, in rock art studies, the emphasis is focused on style, motifs and techniques. But in recent years, there is a growing body of work that recognizes the importance of interpreting rock art not only within the context of the rockscape, but within a holistic context that includes a more accurate view of pre-historic culture, information from contemporary indigenous people, their ethnography, culture and material and non-material culture, etc. In view of this, the chapter emphasizes on ethnographic source in rock art research, for there are many ethnographic sources that can be used meaningfully to examine the rock art, especially to interpret the subjective matters in them.

Keywords Methodological shift · Rock art · Ethnography method · Living rock art · Archaeology · Prehistoric period · Indigenous people and societies

In the historical journey of human civilization, there were inventions during the early phase (prehistoric phase) which are central to any change occurred in different periods of time for human development. We can mention of the invention of fire and wheel as examples. Also the invention that human had made during this period in the form of stone tools not only proclaims his/her intellectual capacity but puts the signature of his/her superiority over other living beings. In other words, during this period, human creativity distinguished their life from the life of animals. Many of his/her inventions and discoveries still inspire admiration and awe in today's civilized world. One of such human creativities is rock art which has been in existence ever since they appeared.

In recent academics there is a methodological shift in studying rock art. Due to this shift, the past of the people with whom the art is associated or with whose tradition a similarity continues is attempted to be constructed. In the process of this, construction ethnography of these people is found useful in combination with archaeological methods.

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A Comprehensive Evaluation of Heavy Metal Contamination in Foodstuff and Associated Human Health Risk: A Global Perspective

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Abstract

Heavy metal contamination has an adverse effect on the aquatic, terrestrial, and atmospheric environment. These may be natural or anthropogenic in origin and not easily degradable. Anthropogenic activities have unwantedly transferred these heavy metals in our food chain and food web. Directly or indirectly these heavy metals have entered in our food through irrigation by wastewater effluent released by industries; scarcity of available freshwater for irrigation, usage of fertilizers and insecticide, and other anthropogenic activities have caused acute and chronic diseases. The dose–response relationship suggests that the heavy metals have a narrow level of lethal concentrations which pose a threat to the target population. Anthropogenic sources of heavy metals generally dominate natural sources, and foreseeing the synergy of this with the degrading environmental conditions, the health of people is a matter of concern. When these heavy metals get accumulated in the human food, it results in abnormalities affecting human survival and mortality. Recent data suggest that the human body gets affected by heavy metal contamination at lower levels than previously anticipated and evidenced. Agrochemicals are resistant and adaptive in nature, and with the increasing dose and newly synthesized compounds to protect crops, undesired side effects and the costs of food production are on a hike. Practices like street food vending and addition of preservatives in packed food increase the chances of heavy metal contamination in food materials. A comprehensive evaluation of the food chain right from the primary producers to consumer level is necessary to ensure food security and quality.

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SPATIO-TEMPORAL EVALUATION OF LONG-TERM EARTHQUAKE EVENTS AND ITS CONTRIBUTION IN GENESIS OF *TSUNAMI* IN THE INDIAN OCEAN

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Commission V, WG V/7 & Commission IV, WG IV/6

KEY WORDS: Earthquake, *Tsunami*, GIS, Remote Sensing, Hypocentre, Disaster Management

ABSTRACT:

A very high magnitude earthquake (9.1 MW) triggered a devastating *Tsunami* in the Indian Ocean on 26th December 2004. The epicentre was located at 3.3° N, 95.8° E with a focal depth of ~ 30 km. The impacts of *Tsunami* were felt as far away in Somalia, Tanzania and Kenya along the east coast of Africa. Considering the role of earthquake, in the present study the spatio-temporal analysis of long term (1901 to 2019) earthquake events was performed, which recorded by USGS to understand the genesis of *Tsunami* (2004) in the Indian Ocean. The study exhibited that the maximum frequency of earthquake was observed between the ranges of 4 MW to 6 MW on the Richter scale during 2001 – 2010. There was only one earthquake event >8 MW on the Richter scale (26th December 2004 having depth 30 Km) in the Indian Ocean recorded during 1901 - 2019. The study exhibited that the maximum earthquake was observed between 30-40 km below the surface, and primarily of moderate to low magnitudes. The proximity analysis along the major fault line indicates that the maximum earthquakes were in the buffer of 200 km from fault line in Bay of Bengal. The decadal variation of earthquake exhibits that the maximum number of earthquake events (8427 events) were triggered during the year 2001-2010, whereas during the year 2004, the total 902 earthquake events >4 MW was recorded. The study indicates that the earthquakes >7 MW (on Richter scale) and depth below 30 km (shallow earthquake) are primarily responsible to major *Tsunami* events in the Indian Ocean. The very high magnitude (>9 MW on the Richter scale) and shallow depth (~ 30 km) are the major cause of 2004 *Tsunami* and its high level of damage. There were very low frequency (10 – 15 events) of earthquake occurred having magnitude >7 and depth < 30 km.

1. INTRODUCTION

Tsunami, often incorrectly called tidal waves, is a series of waves with a long wavelength and period (time between crests) (Mathur and Udani, 2015). Since 1750, the Indian Ocean has not experienced a natural disaster of such magnitude, with enormous consequences for the region's environment (Sirikulchayanon et al., 2008). On 26th December 2004, an earthquake of 9.1 MW occurred at 0:58:53 GMT in Indian Ocean. The epicentre of earthquake was located at 3.3 N, 95.8 E with a focal depth of approximately 30 km (Lavigne et al., 2013), which triggered a massive *Tsunami* in the coastal areas of Indian Ocean. Around 280,000 people were killed in South Asia, Southeast Asia, and East Africa (Lavigne et al., 2013). The vertical offset of the ocean floor by 7 to 10 meters on 26th December 2004, Sumatra earthquake displaced massive volumes of water, resulting in a destructive *Tsunami*. Because of the north-south direction of the fault line, the *Tsunami* was the strongest in the east-west direction. The wave height in deep water (open ocean) was measured through satellites to be approximately 60 cm, while traveling at a speed of 500 to 800 km/hr. The velocity decreased to only tens of kilometres per hour in shallow water near the shoreline, depending on the local bathymetry. This, however, resulted in large and destructive waves that reached run-up heights of 20 to 30 meters in Banda Aceh (Saatcioglu et al., 2005). The distribution of aftershocks (U.S. Geological Survey¹) suggests that the rupture extended over a distance of 1500 km (measured parallel to the arc), but seismic inversions for this event are non-unique and cannot resolve many details of slip, especially along the northern portion of the rupture (Ammon et al. 2005). Furthermore, considering that slip north of ~9°N appears to have generated little or no seismic radiation (Lay et al. 2005; Ammon et al. 2005), seismic inversions will only provide a minimum constraint on the extent and amount of slip, and geodetic

inversions will be required to provide a maximum (and perhaps more accurate) constraint. However, inversions of the sparse geodetic data that were available prior to this study provided only limited constraints on the amount and distribution of slip (Subarya et al. 2006). Since as per current research knowledge there is no established methods to detect the tsunami being generated due to earthquake or landslide. The phenomenon of tsunami is mainly generated undersea disturbance due to earthquake or landslide or activity near the coast or in the ocean and displace few kilometres to >1000 km apart from epicentre. The earthquakes mainly occurs in the region having a high tectonic subduction zones along with tectonic plate boundaries and high seismicity in a regions, caused due to collision of tectonic plates. When a disturbance happens the ocean, the ocean floor rise or falls and effects on water above it and as the water moves up and down, seeking to regain its balance, a tsunami is born. (Borrero, 2005; Kanamori and Kikuchi, 1993; Pelayo and Wiens, 1990; Tsuboi, 2000).

The earthquake of 26th December 2004 occurred due to slip on the subduction interface between the Indo- Australian plate and the Burma microplate below Andaman and Nicobar Islands and Aceh province, Sumatra. The Indian plate has been moving north-east at a rate of approximately 60 mm/year, subduction under the overriding Burma microplate. The epicentre of the quake was about 155 km west of Sumatra and about 255 km south-east of Banda Aceh, Indonesia (Saatcioglu et al., 2005). Along the Java Trench to the southeast of Sumatra, the Australian plate subducts beneath the Sunda Shelf in a direction nearly orthogonal to the trench and at a rate of about 63 mm/year. (Bock, 2003; Michel et al., 2001). Along Sumatra the direction of convergence becomes increasingly oblique towards the north-west and the relative plate slip is partitioned into nearly perpendicular thrusting at the trench and trench-parallel, right-lateral slip at the Sumatran fault (SF) (Fitch, 1972). The strength of a *Tsunami* depends upon the magnitude of earthquakes occur in the Ocean. There are a number

¹ <http://neic.usgs.gov/neis/poster/2004/20041226.html>

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SAR – OPTICAL REMOTE SENSING BASED FOREST COVER AND GREENNESS ESTIMATION OVER INDIA

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KEYWORDS: ALOS PALSAR MOSIAC, Browning, Greening, LAI, SAR, Vegetation cover

ABSTRACT:

Indian natural forest has a high ecological significance as it holds much biodiversity and is primarily affected due to deforestation. The present study exhibits the forest cover change on Global Forest Non-Forest (FNF) data for India and greenness trend using MOD15A2H LAI product, which is the best product available till date. JAXA uses of SAR datasets for forest classification based on FAO definitions. Later, Forest Survey of India (FSI) used different definitions for forest classification from FAO and was to compare with JAXA based forest cover. The global FNF study exhibited that total forest cover was reduced from 568249 Km² to 534958 Km² during 2007-17 in India. The significant loss of forest cover (33291.59 Km²; by -5.85% change) was primarily evident in Eastern Himalayas followed by Western Himalayas. Whereas forest cover increase was observed in Eastern and the Western Ghats from 2007 to 2017. The state of forest report by FSI states an increase in the forest cover from 690889 Km² to 708273 Km² during 2007-17 by 2.51%. The difference in forest cover as estimated by JAXA global FNF datasets and FSI report is attributed to differences in forest cover mapping definitions by both the agencies and use of varied datasets (SAR datasets by JAXA and optical datasets by FSI). It is to note that SAR is highly sensitive to forest cover and vegetation's as compare to optical datasets. Recent satellite-based (2000 – 2018) LAI product reveals the increase in leaf area of vegetation during 2000-18. It may be attributed to proper human land use management and implications of green revolutions in the region. The greening in India is most evident from the croplands with insignificant contribution from forest cover.

1. INTRODUCTION

Forest is the most essential and critical element of earth's surface, and its dynamics on the landscape are driven by both human activities and natural processes (Morales-Diaz et al. 2019; Tucker and Richards 1989). The green leaves of vegetation play a crucial role in maintaining terrestrial carbon balance and also supports climatic systems as it amalgamates sugar from water (H₂O) and CO₂, using the energy that leads to cooling of the surface by transpiring a large amount of water (Chen et al., 2019; Piao et al., 2003). The growth of vegetation in an ecosystem can be strongly influenced by climate change and human activity (Cavicchioli et al., 2019; Chu et al., 2019; Liu et al., 2019). Long-time change in greenness of vegetation are driven by multiple factors such as biogeochemical drivers i.e., fertilization effects of eCO₂, regional change of climatic factors as temperature, precipitation and radiation and varying rate of Nitrogen deposition or cycle change and land-use effects i.e., change in land use/ land cover (LULC) due to land management intensity, including use for fertilizers, irrigation, deforestation and grazing) (Wang et al., 2014). So, it is crucial to monitor vegetation changes because spatiotemporal changes can alter the structure and function of landscapes, subsequently influencing ecology and biodiversity and became an important issue in global biodiversity change (Li et al., 2012; Peng et al., 2012, 2011; Steidinger et al., 2019).

Greenness on earth's surface can be monitored through various developed indices like Normalized Differential Vegetation Index (NDVI), Leaf Area Index (LAI). Enhanced Vegetation Index (EVI) and many more used by several researchers (Chu et al., 2019; Rani et al., 2018). LAI (one half the total green leaf area per unit horizontal ground surface) can be more efficient

to monitor the greenness because it is one of the main driving forces of net primary production, water and nutrient use, and carbon balance and important structural property of vegetation (Bréda, 2008; Fang and Liang, 2014).

Remote sensing is a beneficial technique for studying various earth observations on regional to a global scale. Optical remote sensing (ORS) data are widely used for the vegetation mapping by using a near-infrared and red band as it useful for vegetation mapping. As per current research knowledge, very less study has applied microwave remote sensing (MRS) datasets for vegetation mapping due to the requirement of robust hardware for processing. Major advantages of MRS over ORS is that it has day and night capabilities and penetration of cloud cover and can provide an image at any time (Woodhouse, 2005). There are various spectral bands at which SAR data is being captured. X-band is useful for various surface deformation and movement tracking activities (Lal et al., 2018), C-band is used for both ground surface deformation and vegetation studies, L-bands are used for vegetation studies primarily because of its higher penetration depth (Antropov et al., 2017; Kumar et al., 2019; Plank et al., 2017). By increasing the wavelength in SAR datasets, vegetation type classification accuracy will increase because of its penetration depth. Mapping a vast region with optical datasets leads to inaccuracies due to cloud cover data and have to be replaced with another time periods datasets, whereas by SAR datasets researchers can overcome these problems accuracies will be more.

With continuous availability of satellite-based datasets, the efforts to accurately classify forest types have increased over the year to correctly capture the real dynamism of any ecological landforms/landscapes. The ambiguity in management approaches for forest conservation raises the need to develop

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Performance Limitation of Si Nanowire Solar Cells: Effects of Nanowire Length and Surface Defects

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Abstract. In Si nanowire (SiNW) solar cells enhanced light confinement property in addition to decoupling of charge carrier collection and light absorption directions plays a significant role to resolve the drawbacks of bulk Si solar cells. In this report we have studied the dependence of the photovoltaic properties of Si NW array solar cells on the SiNW length and enhanced surface defect states as a result of enhanced surface area of the NWs. The SiNW arrays have been fabricated using metal catalyzed electroless etching (MCEE) technique. p-n junction has been produced by spin-on-dopant technique followed by thermal diffusion process. Front and rear electrodes have been deposited by e-beam evaporation techniques. SiNW lengths have been controlled from ~ 320 nm to 6.4 μm by controlling the parameters of MCEE technique. Photovoltaic properties of the solar cells have been characterized by measuring quantum efficiency and photocurrent density vs. voltage characteristics. Morphological studies have been carried out by using scanning electron microscopy. Reduction in light trapping capability comes at the benefit of reduced surface defects. The reduction of surface defects has been proved to be more advantageous in comparison to the decrement of light trapping capability. The major contribution to the changes in cell efficiency comes from the enhancement of short circuit current density with a very weak dependence on open circuit voltage. This work is beneficial for the production of commercial Si solar cells where SiNW arrays could be used as an antireflection coating instead of using separate antireflection layers. Thus could reduce the production cost.

INTRODUCTION

Silicon nanowires (SiNWs) have attracted global attention as a promising material to achieve high efficiency at low cost due to their unique structural, optical, and electrical properties [1, 2]. As Si has low absorption in the visible and near infrared region of the solar spectrum, so efficient commercial Si solar cells to fully absorb incident sunlight need relatively large amounts of high-purity solar-grade Si. In this decade, worldwide effort has been started to address this problem by fabricating SiNW based solar cells. Due to light-trapping within the NW arrays these cells exhibit a higher absorbance per unit thickness compare to commercial Si solar cells and thus open a path to avoid the need of extra antireflection coating layer that could lower the production cost [3].

There are several processes like CVD, molecular beam epitaxy, reactive ion etching in addition to lithography, metal catalyzed electroless etching (MCEE) technique etc. which are used to fabricate SiNWs [4]. Among these MCEE technique is only simple and low-cost while others are costly and time consuming. By MCEE technique

Mitigation effect of exogenous nitric oxide (NO) on some metabolic compounds of maize seedling grown under salt stress

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Abstract . Salt stress is considered as a major limiting factor for plant growth and crop productivity. The present study was conducted to investigate whether using nitric oxide (NO) molecule could alleviate the adverse effects of salt stress in maize (*Zea mays* L.) seedling. Sodium nitroprusside (SNP) was used at 60 μ M concentration, as NO donor in the nutrient solution of maize seedlings grown with three concentrations of NaCl (0.0, 150 and 200 mM). Leaf samples were collected on the 7th and 15th day after NaCl treatment. Chlorophyll contents and lipid peroxidation gave different values under salt stress. The NO treated seedling showed high content of proline, phenolic and flavonoid. Nitric oxide induced an increase in antioxidant enzymes including peroxidase (POD) and catalase (CAT) activities. These data indicated that the exogenous NO application is useful way to mitigate the salinity-induced oxidative stress in maize seedling.

Keywords: Antioxidant enzymes, proline, malondialdehyde, salt stress, signaling messenger

Introduction:

Salt stress as a major adverse factor can lower leaf water potential, leading to reduced turgor and some other responses, and ultimately decrease crop productivity in arid regions. When a plant is exposed to high salinity stress, its major processes such as photosynthesis, protein synthesis, and lipid metabolism are adversely affected. High concentrations of salts lead to damage at the molecular level, arrested growth, and even death (**Implay, 2003**). Under salinity conditions, tolerant plants typically maintain low sodium (Na) in the cytosol of cells (**Jeschke, 1984**). The control of Na⁺ movement across the plasma-membrane and tonoplast to maintain a low Na⁺ concentration in the cytosol is a key factor to the cell adaptation to salt stress (**James et al., 2011**). Another common biochemical change occurring when plants are exposed to salt stress is the accumulation of reactive oxygen species (ROS), which unbalances the cellular redox in favor of oxidized forms, thereby creating oxidative stress that can damage DNA, inactivate enzymes and cause lipid peroxidation (**Manaa et al., 2013**). The



UP-SCALING PADDY YIELD AT SATELLITE-FOOTPRINT SCALE USING SATELLITE DATA IN CONJUNCTION WITH CCE DATA IN SAHIBGANJ DISTRICT, JHARKHAND

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KEYWORDS: Yield prediction, Remote sensing, NDVI, EVI, AquaCrop model, CCE data

ABSTRACT:

Agriculture plays a vital role in the economy of India as almost half of the workforce dependent on agriculture and allied activities. Rice is an important staple food and provides nutritious need for the billions of population. Mapping the spatial distribution of paddy and predicting yields at district level aggregation are crucial for food security measures. This study has utilized the time-series MODIS-based Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) data in conjunction with CCE data to derive a statistical model for up-scaling paddy yield at satellite-footprint scale over Sahibganj district in Kharif (monsoon) season 2017. The CCE data were collected from ten random paddy plots. In addition, Area, Production, and Yield (APY) data were collected during harvesting period by interacting with eighty farmers belong to eight villages. The AquaCrop model was also used to simulate the paddy yield for Kharif season. The key results showed that based on the farmers-based yield data, paddy yield was observed as ~3200 kg/hectare, whereas, NDVI and EVI-based yield models based on satellite data showed about 2,960 and 3,530 kg/hectare, respectively. Moreover, multi-regression-based yield model showed the mean yield of 3,070 kg/hectare. With respect to farmers-level yield data, the relative deviation (RD) of yield based on NDVI data was -7.5% (underestimation), while EVI was 10.31% (overestimation). The multi-regression-based yield model and AquaCrop model were underestimated by -4.06 and -10.16%, respectively. Thus, it can be inferred that the multi-regression-based yield was close to farmers-based survey yields. It can be concluded that the satellite databased yield prediction can be reliable with $\pm 10\%$ of RD. Nevertheless, remote sensing technology can be beneficial over traditional survey method as the satellite-based methods are cost-effective, robust, reliable, and time-saving than the traditional methods.

1. INTRODUCTION

Agriculture plays a vital role in the economy of India as almost half of the workforce dependent on agriculture and contributes nearly 18% to the national GDP. Rice (*Oryza Sativa*) has a significant role by providing the nutritious requirement to 1.3 billion of the Indian population. Yield prediction before harvesting using remotely sensed satellite imagery and crop models are significant steps to make a key decision on food storage, procurement, public distribution, export-import (EXIM), and national food security.

Remote Sensing (RS) techniques and crop growth simulation models have been provided a dynamic and robust way to monitor the agriculture system in the current decades. These methods are cost-effective, accurate and reliable; require less manpower and time, as compared to traditional survey methods. In the contemporary world, remotely sensed information collected from various satellite sensors (multi-spectral, hyperspectral, synthetic aperture radar) have facilitated the development of modern agriculture systems by providing a wide range of spatial data to monitor crops and to predict crop yields (Ranjan and Parida 2019; Mondal et al. 2018; Panigrahy et al. 2010). Over the years, Remote Sensing (RS) sensors have been improved the quality of data by enhancing the spatial, temporal, spectral, and radiometric resolutions. Consequently, these RS data have been utilized to extend the accuracy of crop

acreage estimation as well as yield forecasting owing to synoptic coverage, a wide range of multi-temporal and multi-spectral data.

In this regard, several studies have accounted that RS satellite data have the potential for crop growth monitoring, acreage estimation, and yield prediction, as the spectral response of crops were strongly associated with crop canopy cover and biophysical parameters (Schgal et al. 2002; Patel et al. 2006). On account of yield prediction, numerous studies have recognized a virtuous correlation between the satellite-derived Vegetation Indices (VIs) and crop yields (Nuasra et al. 2012; Son et al. 2014).

Nevertheless, crop simulation models have been frequently used across the world to monitor and simulate the crop yield. Many crop simulation models viz. AquaCrop, DSSAT, InfoCrop etc. have been extensively used in diverse climatic condition to monitor and predict the various crop yield at regional to a national scale (Greaves and Wang 2016; Aggarwal et al. 2006). Crop simulation models are also a robust and dynamic way to monitor and estimate the crop yield at various scale in diverse climatic and geographic condition. As simulation, models require a smaller number of input parameters to calibrate the models. Thereby, crop simulation models are also very cost-effective, timesaving, robust and reliable over the traditional crop survey methods.

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Investigation of Sulfurization Effect on Magnetron Sputtered CZTS Thin Film

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Abstract. $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) thin film is a *p*-type quaternary semiconducting compound composed of earth-abundant and non-toxic material used as an absorber material in heterojunction CZTS thin film solar cell. In this work, CZTS thin film has been developed by magnetron sputtering of metal targets of Copper, Zinc and Tin on Molybdenum (Mo) coated soda lime glass (SLG) followed by Sulfurization. The sulfurization conditions like annealing temperature and duration were varied. First, CZTS thin film has been sulfurized at three different temperatures for temperature optimization. Then films were sulfurized for different time durations at an optimized temperature for further sulfurization time optimization. Surface morphology and film thickness, elemental composition, phase determination, and Phase conformation have been observed under SEM, EDS, XRD and Raman Spectrometer respectively at different annealing time and temperature. With the ratio of $\text{Cu}/(\text{Zn}+\text{Sn})$, Zn/Sn and $\text{S}/(\text{Cu}+\text{Zn}+\text{Sn})$ were ~ 0.96 , ~ 1.29 and ~ 0.97 respectively, the grain size has been found to be ~ 800 nm in the optimized sample. CZTS phase formation has confirmed by XRD and Raman spectroscopy in all samples.

INTRODUCTION

In the last decade, CZTS has gained much attention due to its high absorption coefficient of 10^4 cm^{-1} and the optimum direct band gap of 1.4-1.5 eV which is suitable for absorber layer in photovoltaic devices [1]. Comparison with CdTe and CIGS material CZTS has advantages of earth-abundance and non-toxicity which attract the researcher to explore further for solar cell application. However, the growth of pure CZTS without secondary phase is challenging due to the presence of the gaseous phases like tin sulfide and zinc [1, 4]. These secondary phases are responsible for the degradation of performance of the solar cell. During sulfurization, annealing time and temperature are the key factors that decide the purity of CZTS. A small change in these can lead to the formation of unwanted phases and deviation from the required stoichiometry of CZTS.

Till now, several chemical and physical techniques have been explored to develop CZTS thin film-like sol-gel, spin coating, dip coating, sputtering, thermal evaporation, etc. [5]. Every method has its advantages over others, but sputtering is one such deposition technique which has the potential to deposit on a large scale with good film uniformity, adhesion and suit best for industrial application. Moreover, sputtering gives precise control over the stoichiometry of elements. In 1988, Ito and Nakazawa were the first who utilized the sputtering for the fabrication of CZTS film [8]. In 2018, Xiaojing Hao and their team had achieved the record efficiency of 11% using sputtering at UNSW, Sydney. CZTS film was developed by co-sputtering of Cu, ZnS, and SnS and followed by sulfurization within a combined chamber Sulfur and SnS atmosphere at 560°C for three minutes [4].

In this work, two steps process is employed to synthesis CZTS. Firstly, the CZT precursor was deposited on Mo-coated SLG followed by sulfurization. Sulfurization temperature and time were varied to control composition, grain size, and phase purity.

MAPPING VELOCITY OF THE POTSDAM GLACIER, EAST ANTARCTICA USING LANDSAT-8 DATA

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KEY WORDS: Glacier velocity, image matching, pixel tracking, Landsat-8 OLI, Antarctic glacier

ABSTRACT:

Most of the glaciers have been retreating and thinning globally due to climate change. Glacier velocity is one such important parameter of glacier dynamics, which helps to understand the mass balance. The variations in velocity at different areas of the glacier can be used to identify the zones of ablation and accumulation. Zones of accumulation are identified as areas with higher velocity. This data is useful to incorporate in the glacier mass balance analysis. This study aims to derive the glacier velocity, using feature tracking technique for Potsdam glacier, east Antarctica. Feature tracking is an efficient way to derive glacier velocity, which is based on a cross-correlation algorithm that seeks offsets of the maximal correlation window on repeated satellite images. In this technique, two temporally different images are acquired for the same area and a distinct feature on both images is identified and the velocity is calculated with respect to the movement of that particular feature from one image to the other. Landsat-8 data for the year 2016 was used to derive velocity. Finer resolution promotes better feature tracking so the panchromatic band (band 8) of Landsat-8 OLI with a resolution of 15 m was utilized for deriving velocity. This technique was performed using COSI-Corr module in ENVI. This tool calculates displacement between the east-west and north-south directions, and the resultant velocity is calculated using the displacement in both directions and the temporal difference of two images. The velocity map generated at a resolution of 240 m showed that the resultant velocity ranged between 18.60 and 285.28 ma^{-1} . Bias and root mean square error (RMSE) have been calculated with respect to the point-by-point MEASUREs data provided by National Snow and Ice Data Centre at 1000 m resolution. The RMSE was found to be 78.06 ma^{-1} for 2016. The velocity for Potsdam glacier was also pictorially validated with the DGPS measurements from literature.

1. INTRODUCTION

Glacier ice deforms under the force of gravity and is able to slide on the ground. The resulting ice flow observed at the surface represents the mass transport between areas with predominant snow accumulation and those with prevailing mass loss by ice melt or break-off. The effects of climate warming are for instance evident in the continuous retreat of glaciers. Thus, measuring glacier flow-fields decisively contributes to understanding glaciers and related hazards (Kääb et al., 2002). Glacier velocities can be measured using different remote sensing techniques such as, Interferometric Synthetic Aperture Radar (InSAR), Differential Interferometric SAR (DInSAR), offset tracking, feature tracking with GPS, speckle tracking, feature tracking, etc. These techniques work on different time scales and have different strengths and shortcomings, and so they complement each other in glaciological studies (Heid et al., 2011). Like GPS based tracking, It is more advantageous when only small features are available for tracking in a study area because these features may not be discernible on the images. On the other hand, GPS is disadvantaged by the problem of accessibility. Remotely sensed data helps in handling the issues of inaccessibility.

Although glacier-surface velocities can be measured directly on the glacier with high accuracy at arbitrary spatial and temporal

resolutions, observations over long periods involve frequent revisits of the survey points, which can only be located on the accessible parts of a glacier. Therefore, field measurements commonly result in very sparse spatial coverage. Because of the huge degree and troublesome openness of high rugged landscape, remote-sensing strategies give an effective method to gather information in disparate regions. In contrast, remote sensing-based measurements provide the opportunity to achieve large and possibly complete spatial coverage, even in very remote areas. Remotely sensed imagery can provide detailed and timely data for Earth observation across both time and space, which enhances the ability to map and monitor glacier flow on a nearly global scale (Pandit et al., 2018). Optical satellite image-based ice-velocity measurement using feature tracking is a well-established method (Jawak et al., 2018). Feature tracking involves tracking identifiable features between pairs of optical satellite images using an image-matching algorithm such as normalized cross-correlation (NCC), cross-correlation operated in the frequency domain on orientation images (CCF-O), and co-registration of optically sensed images and correlation (COSI-Corr) (Liu et al., 2017). Cross correlation is also applied to provide in image registration in areas devoid the bedrock exposure. The use of cross-correlation software is a significant improvement over previous manually-based

SEASONAL COMPARISON OF VELOCITY OF THE EASTERN TRIBUTARY GLACIERS, AMERY ICE SHELF, ANTARCTICA, USING SAR OFFSET TRACKING

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KEY WORDS: Amery Ice Shelf, Glacier Surface Velocity, Offset Tracking, SAR, Remote Sensing

ABSTRACT:

Antarctica and Greenland are two major Earth's continental ice shelves which play an important role in influencing Earth's energy balance through their high albedo. The ice sheets comprise of grounded ice or the continental glaciers and their associated ice shelves. Surface velocity is an important parameter that needs to be monitored to understand the glacier dynamics. Marine terminating glaciers have higher velocity than land terminating glaciers. Therefore, ice shelves are generally observed to have higher velocity as compared to continental glaciers. The focus of this study is Amery ice shelf (AIS) which is the third largest ice shelf located in east Antarctica terminating into the Prydz Bay on the eastern Antarctica. The surface ice-flow velocity of AIS is very high compared to its surrounding glaciers which flows at a rate of 1400 ma^{-1} and drains about 8% of the Antarctic ice sheet. AIS is fed by different glaciers and ice streams at the head, as well as from the western and eastern side of the ice shelf before it terminates into the ocean. The primary objective of this study was to compute velocity of the eastern tributary glaciers of AIS using SAR from Sentinel-1 data. The secondary objective was to compare the winter and summer velocities of the glaciers for 2017-2018. The offset tracking method has been applied to the ground range detected (GRD) product obtained from Sentinel-1 satellite. This method is suitable for regions with higher glacier velocity where interferometry is generally affected by the loss of coherence. The offset tracking method works by tracking the features on the basis of another feature and calculates the offset between the two features in the images. Two tributary glaciers near the Clemence massif and another glacier near the Pickering Nunatak feed into this ice shelf from the eastern glacial basin region that drains ice from the American Highland, east Antarctica. The glaciers near the Clemence massif showed low annual velocity which ranged from 100 ma^{-1} at the head to $\sim 300 \text{ma}^{-1}$ near the end of the glacier, where it merges with AIS. The glaciers flowing near the Pickering Nunatak exhibited moderate velocity ranging from 150 ma^{-1} at its head and reaching up to 450 ma^{-1} near the tongue. The summer velocity (March 2018) was observed to be higher than the velocity in winter (July 2017) and the difference between the summer and the winter velocities was found to be between 50 ma^{-1} and 130 ma^{-1} . The results for the velocity were obtained at 120 m resolution and were compared with the previous MEaSURES (Making Earth System Data Records for Use in Research Environments) yearly velocity at 450 m and 1 km resolution provided by National Snow and Ice Data Center portal. The results were evaluated using statistical measure- bias and the accuracy was derived using the root mean square error. The bias did not exceed 20 ma^{-1} for the three glaciers and the accuracy was observed to be more than 85% for most of the regions. The accuracy of the results suggests that the offset tracking technique is useful for future velocity estimation in the regions of high glacier velocity.

1. INTRODUCTION

The ice and snow in the Polar Regions play a crucial role in Earth's radiation budget as the cryosphere reflects about 90% of the incoming solar radiation (Jawak and Luis, 2014). The continental shelves of Antarctica and Greenland are almost completely covered by ice (Jawak et al., 2018). In the southern hemisphere Antarctica hosts larger ice mass and in the northern hemisphere Greenland contains relatively less ice mass, both of which could contribute to sea level rise of 66 m, if completely melted. Most of the cryospheric regions are situated in severe weather conditions and accessibility to these regions is limited due to their rough terrain, harsh weather conditions, sometimes all year round and high logistic cost. The inaccessibility due to various factors make remote sensing the best and most affordable

technique that could be used for monitoring different dynamics of the glaciers in these regions (Jeong et al., 2017; Jawak et al., 2017; Pandit et al., 2017; Jawak et al., 2018). The availability of satellite remote sensing technology and its progress in recent decades has enhanced our capability to monitor these regions at regular time intervals over a long period of time (Jawak and Luis, 2014).

The mass balance of glaciers is pivotal to understanding the accumulation of ice and its subsequent drain into the sea due to ablation (Lugli and Vittuari, 2017). Various factors that cause glacier ablation are surface melt, surface melt water runoff, sublimation, avalanching and windblown snow. The velocity of

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Effect of indentation load on mechanical properties and evaluation of tribological properties for zirconia toughened alumina

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ABSTRACT

In this study, co-precipitation processing route has been opted to prepare the ZTA composites. The well homogenized powders are compacted in a circular shape die-punch arrangement using hydraulic press. The mechanical properties of developed composites are evaluated on Vickers testing machine. In this study, a wide range of test load (0.5–50 N) has been applied on the samples to see its effect on hardness. A significant decrease in the value of hardness and fracture toughness has been observed with increasing load. An interesting result has been observed beyond 25 N loads, where stagnation in the said properties is observed. After evaluation of mechanical properties the ZTA composites are used to investigate the tribological properties. A comparative study has been made between alumina and ZTA ceramics at a load of 20 N with sliding velocity of 0.5 m/s. The observed results show an improvement of 57.8% in case of specific wear rate, whereas 19.78% improvement has been achieved in case of coefficient of friction for ZTA ceramics as compared to alumina ceramics. The improvements in tribological properties are attributed to the soft phase of zirconia reinforced inside hard matrix of alumina which provides a toughening effect.

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1. Introduction

Now a day's environment friendly materials are emphasized due to stricter enforcement of new standards, imposed by United Nations Environment Programmes (UNEP). In this context, ceramic materials, specially zirconia toughened alumina (ZTA) are one of the best alternatives to replace the conventional one due to high hardness, fracture toughness, environment friendly and nontoxic in nature. The rough and tumble properties of ceramics gained its importance in structural applications in many industries like manufacturing medical aerospace etc. Alumina based ceramic has been widely known to industries due to its better thermo-mechanical properties and high resistance to thermal and chemical attack. Recently, many researchers dedicated their research to counterbalance the demerits associated with alumina ceramics. In this regard, Bindal et al. [1] showed a significant improvement in hardness (~46%) and fracture toughness (~53%) of alumina

matrix with incorporation of 10 wt% yttria stabilized zirconia (YSZ) inside alumina. The powders were synthesized through co-precipitation method, the size of the powder ranging from 100 to 300 nm. Bindal et al. also demonstrated that the presence of zirconia restrict the abnormal grain growth and helps in formation of equiaxed and homogeneous grain growth. Recently, a comparative study was carried out by Singh et al. [2,3] for different percentage of YSZ inside alumina. The investigation clearly demonstrated that 90:10 wt% ratio of alumina:YSZ has high mechanical properties among all composites. The incorporation of additives like MgO [4], Cr₂O₃ [5] and CeO₂ [6] inside alumina matrix also showed significant improvement in the mechanical properties of alumina ceramics. The effect of indentation load on the mechanical properties to developed proportional specimen resistance model (SPM) was well illustrated by Gong et al. [7]. Researcher illustrated that the indentation size effect (ISE) at low loading condition, the value of hardness is high and at high loading condition the hardness is low.

In the application of any advance materials, which are used in harsh environmental condition for a prolong time the tribological

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Adaption Mechanisms in Plants Under Heavy Metal Stress Conditions During Phytoremediation

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13.1 INTRODUCTION

Heavy metal contamination of soil not only reduces agricultural production, but also adversely affects the health of wildlife and humans inhabiting these areas (Kloke et al., 1984; Sharma et al., 2010). Soils are often found contaminated with various heavy metals, including lead (Pb), zinc (Zn), nickel (Ni), cadmium (Cd), iron (Fe), chromium (Cr), arsenic (As), and copper (Cu) (Kabata-Pendias and Pendias, 1984; Sharma and Dubey, 2005; Sharma et al., 2006; de Vries et al., 2013; Sharma et al., 2014a). Phytoremediation, a low-cost and economically sound technique can be used to remove pollutants from soil (Salt et al., 1995). The different categories of phytoremediation include phytodegradation, phytoextraction,

rhizodegradation, phytosequestration, phytohydraulic, and phytovolatilization (Tsao, 2003). Among these categories, phytoextraction is an attractive method for heavy metal remediation from contaminated land. Phytoextraction utilizes hyperaccumulator plants that possess the capability to grow on metal-rich soils and to tolerate and accumulate unusually high quantities of metals in their aerial organs, such as shoots or leaves, without any visual toxic effects (Raskin et al., 1994; Kumar et al., 1995; Rascio and Navari-Izzo, 2011). Various hyperaccumulator plants have been identified that can hyperaccumulate Cd, Ni, Cu, Zn, Pb, Cr, and As in their aerial organs. Hyperaccumulators, *Thlaspi caerulescens* (Brassicaceae family), *Pteris vittata*, and *Arabidopsis halleri* (sister species of *Arabidopsis thaliana*), are attractive model plants

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Invasive Species and Their Impact on Tropical Forests of Central India: A Review

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Abstract

Tropical forests are the richest biodiversity hotspots and are under immense natural and anthropogenic pressures that lead to biodiversity loss. One such cause is alien plant invasion that alters the native forest stand structure and composition and disrupts the vital ecosystem functions. Central India, which mainly spans across the three states, viz. Madhya Pradesh, Chhattisgarh and some parts of Maharashtra, is well-known for its sprawling tropical deciduous forests, which are also no less immune to the present-day pressures, including the plant invasion. Alien invasive plants arrive via several pathways and possess unique traits that help them to surpass the barriers in the new habitats, where many influential

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Biochar Amendment in Agricultural Soil for Mitigation of Abiotic Stress

14

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Role of Major Forest Biomes in Climate Change Mitigation: An Eco-Biological Perspective



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Abstract The rapid alteration in the global climate due to anthropogenic activities has profound eco-biological impacts, which invariably affect the ability of natural communities to effectively perform ecosystem services. The eco-biological impacts could be viewed across various dimensions including loss of biodiversity as well as ecosystem goods and services, changes in phenology, prevalence of droughts and forest fires, disease outbreaks, reduced crop yields and increase in intensity and frequency of extreme weather events. Although, the natural ecosystems are innately endowed with the ability to maintain homeostasis by means of resistance and resilience, this ability to cope up is severely impacted by various other factors like deforestation, habitat fragmentation, land-use change and biological invasion, which exacerbate the effects of climate change. The eco-biological impacts of climate change are tied with socio-economic aspects by means of market values of the produce, poverty, undernourishment, livelihood security, etc. At this crucial juncture, forest biomes offer an immense ecosystem service towards climate change mitigation through carbon sequestration. Nevertheless, the three major forest biomes, viz. tropical, temperate and boreal, with their unique characteristics, vary in their response to climate change as well as mitigation potential and response. This review chapter aims to understand the varied climate change impacts and the crucial roles of major forest biomes in climate change mitigation and their various ecological services to formulate better forest management strategies.

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Removal of Dyes from Industrial Effluents by Application of Combined Biological and Physicochemical Treatment Approaches

17

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and Shashwati Ghosh Sachan

Abstract

One of the major crises that the world is facing today is environmental pollution. Synthetic dyestuffs find uses in various industries like textile, cosmetics, leather, paper printing, tannery, food coloring, etc. Recalcitrant azo dyes (-N=N-) are the predominant class of molecules used because of their color fastness, persistence in aquatic environment, stability, and resistance to degradation. These detrimental compounds are quite complex and structurally diverse, containing azoic linkages. It is evident from prior researches that these dyes and their by-products, specifically the aromatic amines, which result due to the reductive cleavage of the azo bonds, are classified as extremely toxic, carcinogenic, mutagenic, and genotoxic to humans and aquatic biota and are also capable of causing serious skin irritations. They inhibit aquatic photosynthesis by obstructing light penetration, deplete dissolved oxygen (DO) level, and compromise both aesthetics and ecological balance of water bodies. Dye-laden wastewater from industries is often released into the environment, untreated or poorly treated, to avoid the complexity and investment of capital for setting up of treatment plants, thus absolutely defying the environmental standards. The developing and underdeveloped countries are exposed to a bigger risk as they are being exploited as lucrative spots for the development of production sites by the textile industries to lower the production costs. The existing processes for color removal consist of physical, chemical, and physicochemical ones, the recent addition to the list being the biological means. Though the accepted techniques are quite capable, yielding satisfactory

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Ecological and Practical Applications for Sustainable Agriculture



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Chapter 2

GIS-based Multi-Criteria Analysis for Delineation of Groundwater Potential Zones: A Case Study from Jodhpur District, Rajasthan, India

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ABSTRACT


In the present study, delineation of ground water potential in Jodhpur district, Rajasthan is framed by using geospatial technique (i.e., remote sensing and GIS) and with multi-criteria leadership (MCDM) procedure. The analytical network process (ANP) is one of the suitable strategies that makes the research workable for delineation methodically, and incorporate the analytic hierarchy process (AHP) as an uncommon case. For proper value to recognize the ground water potential zone in Jodhpur, Rajasthan, the AHP and ANP methods are utilized to decide the values of different parameters and their classes. The AHP values are then connected in a direct mix into raster calculator to get five distinctive groundwater potential zones in the investigation region, to be specific as 'very poor' (2052.0 km²), 'poor' (4225.9 km²), 'moderate' (6355.1 km²), 'good' (6451.2 km²), and 'very good' (3301.7 km²). It has been presumed that about 9752.9 km² area of Jodhpur district has very good to good groundwater potential, which is about 43.56% of the complete study area.

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Chapter 21

Sentinel SAR Data and In-Situ-Based High-Resolution Above-Ground Carbon Stocks Estimation Within the Open Forests of Ramgarh District

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ABSTRACT

The present study deals with an approach to estimate the above ground biomass (AGB) to assess the total carbon stock of forest cover present in Ramgarh district using remote sensing and GIS techniques. Due to the fact that biomass estimation is one of the most influential biophysical parameters in traditional carbon sequestration techniques, satellite remote sensing plays an important role in AGB and carbon stock estimation. Presently, AGB is estimated using Sentinel1A SAR data in conjunction with in-situ field data, which is conducted in 20 different sites within the forest area. Biomass is calculated for each plot, and a correlation analysis is performed with the backscatter value obtained from SAR data to generate an allometric equation that is used to calculate the AGB and carbon stock for the entire forest cover. Both Polarization VV and VH are correlated with field data in which cross-polarized backscatter value shown a stronger correlation of 0.75 (R2 Value). C-band is proved to be the best band for the estimation of biomass and carbon stock in tropical mixed forests.

1. INTRODUCTION

Forest on the earth covers nearly one-third of total surface area and plays a vital role in the global carbon cycle changes (Franklin, 2001). Forest biomass which is also expressed as dry weight per unit area is one of the most influencing factors of the forest ecosystem, accurate estimation of Above Ground Biomass

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Chapter 7

Synergy of Satellite-Derived Drought Indices for Agricultural Drought Quantification and Yield Prediction

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ABSTRACT

The present study was conducted over Jharkhand state (India) for assessing the drought condition and corresponding yield of paddy (district-level) during Kharif 2018. Vegetation drought indices, namely Vegetation Condition Index (VCI), Temperature Condition Index (TCI), Vegetation Health Index (VHI), and vegetation indices (VI) anomaly, were derived from different VI (i.e., NDVI, EVI) to assess the paddy health condition during drought year (2018) and non-drought year (2017). Later, the correlation between the DES-based yield data and derived drought indices (for the year 2017) were made to develop the district-level paddy yield model for

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Chapter 8

Comparative Flood Inundation Mapping Utilizing Multi-Temporal Optical and SAR Satellite Data Over North Bihar Region: A Case Study of 2019 Flooding Event Over North Bihar

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Development of a Smart Village Through Micro-Level Planning Using Geospatial Techniques—A Case Study of Jangal Aurahi Village of Gorakhpur District

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Abstract

In the current scenario, there is an urgent need for re-designing and re-building our villages for their overall upliftment. The motive behind this research is the development of villages in such a way that it will be well capable in providing all basic services. Keeping this in mind, a study was carried out for micro-level planning and development of natural resources available in Jangal Aurahi village (Sansad Adarsh Gram), Gorakhpur district, using high-resolution satellite data, i.e., CARTOSAT-I and LISS IV merged and DEIMOS satellite data. Remote sensing and GIS technology is used as an effective tool for promoting development, enhancing educational status and increasing local business opportunities, etc., means an overall enhancement of rural dwellers. The basic objectives were performed to map, monitor, and manage existing resources, facilities, and infrastructures of a village and preparation of suitable actions plans for soil and water resources management, solid waste and waste water management, and land use management.

Keywords: Rural development, smart village, remote sensing, GIS

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Role of Geo-Informatics in Natural Resource Management During Disasters: A Case Study of Gujarat Floods, 2017

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Abstract

Disasters, be it natural, anthropogenic, or biological, are generally sudden and intense, resulting in considerable loss in terms of destruction, injuries and deaths, disruption of normal life, as well as the process of development for years to come. Vulnerability of disasters is further enhanced with burgeoning population and socio-economic setup as there is increase in the magnitude, frequency, and economic impact of the disasters. The geo-climatic condition of India with high population density renders it highly vulnerable to all sorts of disasters. Geo-informatics, with robust data handling capabilities, is the ideal for disaster management. It has immense potential from generation of awareness to dissemination of information during disaster mitigation, preparedness, and response as part of disaster management measures.

Keywords: Disasters, disaster management, vulnerability assessment, remote sensing, geo-informatics, flood monitoring

17.1 Background

17.1.1 Understanding Disasters: Natural and Anthropogenic

Disaster has been defined by the United Nations as “the occurrence of a sudden or major misfortune which disrupts the basic fabric and normal

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