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About Conexus

Conexus is a multidisciplinary microjournal published annually by the Department of Basic Sciences & Humanities of Rajagiri School of Engineering & Technology (Autonomous), Kochi. It is an amalgamation of the disciplines of the department in order to exchange ideas across multiple fields of study. It focuses on concise and brief reviews on a specific theme drawn from disciplines such as Physics, Chemistry, English, Economics, Psychology and Physical Education. It signifies the belief that even brief entries can reveal meaningful connections among various disciplines.

The second volume of Conexus includes a collection of articles written by the students and faculty members of RSET. The students' articles pertain to the theme 'Environmental Degradation' and the aim is to provide a platform for interdisciplinary research and express critical perspectives to address the multifaceted issues of environmental degradation, thus creating an awareness and promoting a deeper understanding of the urgent need for collective action to protect planet earth from further depletion.

This microjournal is a source of education and inspiration for both the student and the faculty community. By documenting various dimensions of environmental degradation right from the field of biomedical to hardware waste, the microjournal acts as a platform for knowledge-sharing, and discussion. This creates awareness and prompts readers to think critically about their own environmental footprint and consider their role in addressing the issue.

Editor's Message

Dr. Poulose Jacob

Professor and Dean Research
RSET

The editorial team of Conexus has identified a theme of great relevance to humankind, namely environmental degradation.

In the developing society we belong to, environmental issues like air pollution, poor management of waste, edible-water scarcity, falling groundwater tables, water pollution, non-preservation of forests, et cetera, stare at our face. Adequate action at the governance front seems lacking too.

Depletion of natural resources is a cause of major concern as it results in grievous injury to mother earth, if not the universe. Everywhere we see hills being razed to the ground, water bodies getting filled up for massive construction, deforestation happening on the pretext of developmental initiatives, all these likely to add to a near collapse of the eco system. Wildlife, though not facing the threat of extinction, appear to be disturbed at the unfamiliar changes in their habitats, venturing to explore greener pastures, many a time causing extensive damage to cultivation and loss of human life and livestock.

To add to this, lack of self-discipline along with non-adherence to rules and regulations on the part of the citizenry, is often the cause of several mishaps that happen these days. Our youngsters must be sensitized to the various aspects of this negative trend so that corrective measures shall evolve at every level. Let the intended content of the issue contribute to a healthy environment congenial to peace and prosperity. The UN sponsored SDG stipulate to meet the needs of the prospering generation without compromising the quality of the environment for future generations.

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Generational Human - Environmental Degradation

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Abstract

This article highlights the man-nature interrelationship and how environmental degradation has proportionally deteriorated human psychological, physiological, and emotional well-being, making them inept at escaping the vicious generational loop of human value-nature degradation. This paper discusses the generational failure to recognize shifting conventions, ideologies, and expectations becoming invisible puppeteers that lure people into thoughtlessly misusing the environment, deepening the graves of upcoming generations of flora, fauna, and mankind. Hence, redefining environmental and human goals that require thoughtful deliberation is vital to breaking free from this desire-driven human bee-hive that curbs perspectives.

Keywords

Interdependence; Changing human desires/lifestyles; Environmental deterioration; Physical and psychological impacts; Thoughtless manipulation; Endless loop; Unawareness of traps

An Alien can be theoretically and philosophically described as an invasive being that defies and opposes the rules of nature and may possess the ability to control its environment as per its will. It is satirical, ironic, and above all saddening how this description has suited humans more than any other species, the most intelligent species that are considered to be on top of the food web, struggle daily to fit into a nature they are alienating themselves from yet are already a part of. It wouldn't be this concerning had we been an alien species, however being a being of nature, coming and returning to it, makes it a universal truth that we shall not sustain without it, and the very precautionary barricades of nature we break will lead us to the spiralling whirlpool of physical damage, and psychological constraints with no escape.

This paper aims to shed light on the intricate interconnections of nature with humans and highlight how every overlooked daily action has a Butterfly effect elsewhere on the planet.

Environmental degradation and its varied repercussions have gained widespread attention since the mid-twentieth century, with at least one article published each day discussing the damage done to the environment and how it affects the sustainability of dependent lifeforms, including humans. One of the earliest and most highly recognized publications on Environmental degradation is by Rachel Carson, an American marine biologist, writer, and conservationist, in her book 'Silent Spring' which gained global attention and acted as an eyeopener to all international institutions and to any common man who has read it. It details how every desire-driven blind action of humans to control and mould their surroundings comes back at them with higher intensity, driving them to take stronger self-sabotaging measures, and the intricate and delicate interconnection of all lifeforms, thus reminding and revealing to us the dire need for thoughtful retrospection, introspection, and amendments to human conduct. Human beings' failure to recognize the real issue lies within the corrupted system that aims at consumer cultivation and the trapping need to remain a consumer. This paper sheds light on how the shifting conventions, ideologies, and expectations in most consumed products of the food industry have played a part in human and environmental degradation over generations.

The case of Pokkali rice cultivation can be used to infer the effects of changing life requirements affecting both the fields and the farmers. Pokkali is a heritage heirloom rice crop cultivated in the coastal areas of Kerala, particularly Ezhikkara and Ernakulam. Pokkali fields are one of the oldest rice varieties in Kerala, with cultivation dating back at least three millennia. The Pokkali Fields once stretched across the saline plains of Vypin. It is also the oldest crop in the world grown using organic farming methods. Pokkali rice has a more pronounced flavour than other rice varieties, therefore rice products made from it fetch higher market prices, increasing the demand for Pokkali cultivation. Pokkali cultivation was carried out by the accumulated generational farming knowledge of the locals and was cultivated alongside prawns through a rotational intercropping method where the prawns feed on the leftovers of the harvested crop and the rice crop draws the required nutrients from the prawns' excrement and other remnants leaving no necessity for artificial fertilisers. However, this heirloom cultivation is now practised only in fields in the Kadamakkudy region as the rise in

the cost of living, redistribution of land to immigrants, urbanisation, globalisation, etc. about half a century ago, caused the fields to slowly disperse as people moved to cities for better facilities, farmers focusing exclusively on shrimp farming to achieve higher yields, lack of labour to manage the farms, sale of redistributed plots by migrants, low recognition of the relatively more expensive Pokkali on the Markets due to cheaper substitutes, infrastructural needs for converting farms for better transportation, communication, housing, and tourism facilities, etc. not only disrupted the transmission of knowledge among generations, but also gradually deprived the fields of the source of life.

Traditional Pokkali agriculture played a crucial role in maintaining soil quality, supporting numerous plant species, and protecting the soil from damage during high tides and floods. Now the once fertile and lush soil can neither fully withstand floods nor support diverse plant varieties like mango, guava, lemon, etc. like before. Those who resisted and attempted to continue their generational farming suffered heavy losses and harassment from uncooperative unions and were discriminated against with “growing crops for the rich” propaganda. Farmers who wished to continue had difficulty finding local workers who were knowledgeable of the soil or were willing to learn from the elderly. The unions that provided storage and marketing facilities preferred the cheaper varieties of rice and other products that earned higher profits than Pokkali. This caused the farmers to suffer severe losses and were forced to abandon and sell their lands to make up for the loss and discover new sources of income.

As the Government and people are gradually realising the importance & benefits of such traditional produce, it stands too late to regain the lost, as the soil no longer possesses the necessary vigour, and the last generation with the knowledge to cultivate the crop is almost gone. People prefer "societally approved" elite jobs for achieving social necessities of respect, honour, prestige, and security, despite the exponential rise in demand for jobs such as Waste Management Specialist, Recycling Research Scientist/Engineer, Materials Recovery Specialist, etc. in today's world with its deteriorating environment. Many of those who had to shift to new lifestyles from their traditional Pokkali farming still struggle to overcome the losses and adapt to the changing demands & elite expectations of the urban world and straining gluttonous companies where they have to work several times harder physically and mentally for the minimal pay to afford what they once had at their doorstep. Amid the next

revolution to automate the automators, people are struggling to find sustainable employment, forgetting that these "basic" facilities of today were designed to make people's lives easier.

People have to pay more for products that are devoid of poisonous substances when that is only how the product should be produced, driving people to their purchase by shrewd industrial tactics, and having to work harder to afford the treatment of the aftermath caused by ingesting these contaminated products. Being unable to afford these constantly changing and evolving necessities is a vicious cycle that inhibits people from leading backward-compatible lives, damages their physical health, and curbs creativity and enhanced cognitive function, which are fostered by close contact with nature which lowers cortisol levels, mental fatigue, and burnout—events that have come to represent the current generation.

Chocolate interacts with neurotransmitter systems such as dopamine (containing the dopamine precursor tyrosine), serotonin, and endorphins, which contribute to appetite and mood regulation. However, real chocolate is neither sweet like spring love nor is dark chocolate a heavenly rich elixir. The sweetness of Milk Chocolate comes from sugar which constitutes more than half the total weight while Cocoa is little more than 25%. Even Dark chocolate contains a minimum of 40% sugar and high concentrations of caffeine. The effects of the infamous ‘white poison’ sugar are well-known to people, but it should be also noted that caffeine and cocoa in large concentrations too may cause harm. Caffeine can induce increased urination, nervousness, sleeplessness, and faster heart rate. Cocoa can cause allergic skin reactions, trigger migraine headaches, cause nausea, stomach discomfort, etc in higher concentrations. Known for its rich flavour, creamy texture, and aromatic scent, chocolate has long been associated with luxury, wealth, and romance.

Historically, chocolate was considered a measure of wealth and opulence because its production required access to cocoa plantations, sugar and coffee plantations, and enslaved labour to work there. Consequently, giving chocolate as a gift was seen as a gesture of great affection and consideration, symbolising love, appreciation, and devotion. This association has been further romanticised in literature, art, and media, where chocolate often appears in love stories, poems, and romantic films as a symbol of romance, passion, and desire. Despite industrialization, which has made chocolate widely available in various forms due to its variety of shapes and flavours, it is still considered a symbol of love, largely due to historical connotations and active advertising that reinforces its romantic imagery. The advertising is

aimed specifically at teenagers and children and takes advantage of their malleability and preference for sweet treats. This marketing perpetuates the perception of chocolate as a luxurious and romantic gift, ensuring its continued popularity and cultural significance.

Putting aside the well-known health concerns of chocolate and other sugar-based products such as Caloric Density, Potential Allergen, Caffeine Sensitivity, and Potential Contaminants due to bulk manufacture, and Psychological effects like Dependency, Emotional Eating, Disordered Eating Patterns, Associations with Rewards & Punishments, and Impact on Mood & Behavior, etc, for whose expensive treatment we have to further deplete our health to be able to pay, let us ponder on how large scale manufacture of this daily product simultaneously affects the environment. Cocoa farming often drives deforestation, particularly in regions like West Africa, which produces a significant portion of the world's cocoa, and the Ecocycle disrupts monoculture, where large areas of land are dedicated solely to cocoa cultivation. This practice depletes soil nutrients, increases susceptibility to pests and diseases, and reduces biodiversity in the region, which ultimately calls for more deforestation to compensate for the depleting nature quality. Alongside improper use of fertilisers and pesticides that can lead to soil and water pollution, harming local ecosystems and wildlife, unauthorised water usage, carbon emissions, and waste generation, cocoa labourers face poor working conditions and remuneration.

Child labour and human trafficking still exist in this sector to make up for the large labor requirements in these far-stretched plantations as it’s convenient to employ a starving stomach for ‘The best way to keep a prisoner from escaping is to make sure he never knows he's in prison’. According to Anti-Slavery International, 284,000 children still work in hazardous conditions on cacao farms, and at least about 15,000 of them have been enslaved through human trafficking. The above details solely belong to Cocoa farms alone without including their companions- sugar & coffee.

As seen with chocolate and Pokkali rice, the media, literature, art, common beliefs, and other forms of cultural expression all play an important part in shaping people's perceptions and attitudes toward numerous issues, including social, political, and cultural ones. Through storytelling, imagery, symbolism, their trust in the sources, etc, they can influence how individuals understand and interpret the world around them and a given situation. Accumulation of knowledge and concealment of lurking dangers ‘to maintain

societal harmony' is no different from the once-uprooted monarchical and capitalist rule. Living in a society where a plant's or animal's worth is determined by its utility to humanity and aesthetic appeal, we must realise that we too are being judged accordingly. Every bit of information we encounter subconsciously shapes our perspective; even facts we forget are remembered as patterns in our brains, forming the rolling stone that eventually determines our judgments. Butterflies are seen as symbols of freedom, transformation, hope, and rebirth, whereas their close relatives, Moths, are seen as death and messengers of the afterlife due to the slight difference in appearance and activity pattern during the day; painful is the realisation that this applies to all flora and fauna, including humans, which, as previously stated, become the rolling stone for necessities, desires, and actions. With public opinions, ideologies, beliefs, and expectations carefully carved to meet the needs of the producers, we should learn to assess the veracity of information about what happens around us and distinguish our actual necessities from projected societal necessities, because we are being knitted into a bee-hive system in which we first consume the problem and then the pre-prepared solution, and attempting to leave leads to moribundity.

It can be concluded that the definition of necessity has evolved significantly throughout time. As we progressed through this paper, we noticed the complex relationship between humanity and the environment, and how our collective actions have an equal impact on both our livelihood and the environment. It became clear that our well-being is inextricably linked to the health of nature. Aside from the stark realities of environmental degradation and its profound impact on our psychological, physiological, and emotional health, nature also provides a solution. Spending time in nature has a calming effect on the mind and body, reduces stress, and increases emotional well-being. Regular contact with nature increases stress resistance and enables individuals to cope with life's challenges more effectively. Research shows that spending time in nature lowers cortisol levels, reduces anxiety, relieves stress-related symptoms, promotes feelings of happiness, and relieves symptoms of depression. Activities such as nature walks, gardening, hiking, outdoor exercise, and spending time in green and naturally lit areas are associated with improved mood and overall mental and physical health. Additionally, interacting with nature improves cognitive function, attention, memory, creativity, cognitive performance, focus, and problem-solving skills. Nature provides a healing environment that allows the brain to recharge and revitalise,

providing opportunities for introspection, appreciation, and connection with the world that contribute to increased feelings of happiness, life satisfaction, and overall well-being. To promote harmonious coexistence with nature and ensure the preservation of our world for future generations, we must encourage thoughtful reflection and sustainable action. To break out of the destructive cycle, we must redefine our environmental and human goals while recognizing the evolving societal norms and expectations that have led to environmental exploitation and human suffering. By fostering a deeper understanding and respect for the interconnectedness of all life forms, we can overcome the desire-driven attitude that ensnares us in this destructive generational and cyclical human-environment relationship and essentially embrace perspectives that support the health and vitality of our environment and prioritise all its residents.

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Environmental Monitoring with the latest Technological Methods: DETER

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Abstract

Monitoring the environment is crucial in determining its current condition, spotting trends and changes and issuing early alerts about dangers. It supports decision-making by policymakers regarding sustainability and the environment. This article discusses how Brazil has recently employed satellite technology to address deficiencies in law enforcement caused by weak institutional frameworks. DETER is a system designed to target environmental enforcement in the Amazon by processing satellite imagery and issuing near real-time deforestation alerts.

Keywords

Air Quality Monitoring; Water Quality Monitoring; Soil Monitoring Sensors and Instruments; Data Analysis and Monitoring.

1. Introduction:

The yearly carbon dioxide emissions from the devastation of tropical forests amount to 5.4 Gt CO2e yr−1, which is twice as much as the emissions linked to the clearing of the remaining global forest formations. According to recent research, deforestation and climate change are endangering the tropical forest which serves a vital function as the largest sink of greenhouse gases in the world, removing about 7.0 Gt CO2e yr−1 annually. Despite several attempts to stop deforestation and increased public awareness around the world, the annual loss of tree cover has increased steadily since 2000 and will surpass 12 million hectares in 2023. Under these conditions, a crucial component of deforestation reduction programs is near real-time (NRT) forest disturbance detection systems, which are characterized as an assembly of algorithms and processes able to detect tree loss or disturbance on a regular (monthly, weekly, or even daily) basis. The Near Real-Time Deforestation Monitoring System (DETER) is the primary NRT forest disturbance monitoring system in use in the

Brazilian Amazon. DETER was created to assist the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) and other related organisations in monitoring and addressing deforestation and forest degradation in the Amazon. As a result, one of DETER's primary features is its capacity to quickly and with a low false-positive rate identify priority disruption occurrences. As part of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm), DETER began sending out alerts in 2004. This, along with the deployment of law enforcement teams on the ground and the delineation of protected areas, led to an 83% decrease in the rates of deforestation between 2004 and 2012. Nevertheless, since DETER relies on optical data, its accuracy may be significantly impacted by the nearly constant cloud cover in specific Amazonian regions during specific times of the year, given that the average annual cloud cover in the Brazilian portion of the biome is roughly 74%. Over the past few decades, substantial advancements in portable electrochemical sensing technologies have enabled the realization of home/field diagnostics potential. But this hasn't been clearly outlined yet. The main objective of this work is to describe DETER-R early and present routines, as well as to describe the various useful functions of electrochemical sensors in monitoring the environment.

1.DETER-R (Real Time Deforestation Detection System).

Project Area:

Initially, a DETER-R prototype was applied to five experimental locations that were under INPE("Instituto Nacional de Pesquisas Espaciais" which is the National Institute for Space Research)'s special supervision as part of a regular monitoring program known as DETER-INTENSO (Intense DETER). The majority of the Brazilian Amazon's deforested lands in 2020 were found in these 458,000 square kilometre locations. The Brazilian Amazon Biome is the full Area of Interest (AOI) for the operational version of the DETER-R system. It makes up 48.7% of Brazil's total area, or 4.21 million kilometres^2. The approach solely considers changes to the forest cover inside the AOI; it does not include regions already cleared of trees until 2020, savannas, rivers, rocky outcrops, floodplains, and beach areas.DETER-R is monitoring 2.81 million km2, or 66.7% of the total AOI, as the remaining area. Figure 1 shows the extension of both operational and experimental AOIs.

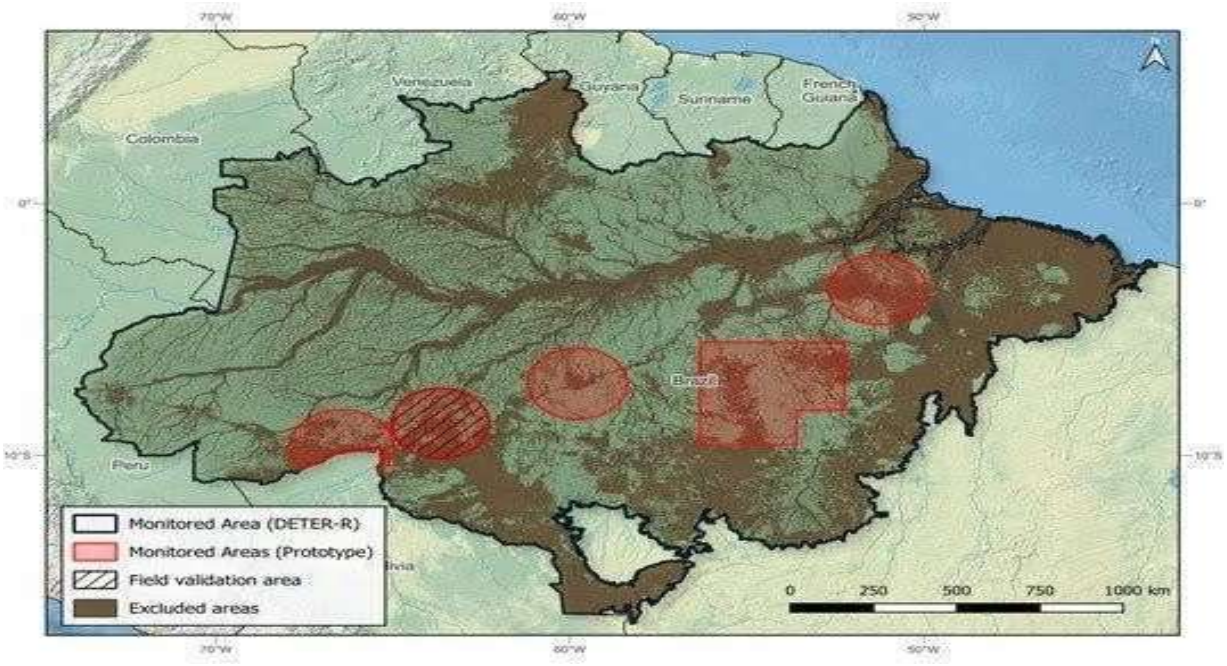

Figure 1. Area being monitored by the DETER-R system. The dark line represents the limit of the Amazon biome within the Brazilian borders. The brown-shaded areas represent regions belonging to the categories not monitored by the DETER-R system: already deforested areas, rivers, flood plains, savannas, beaches, and rocky outcrops. Red areas denote the experimental AOI where DETER-R prototype 2020 testing took place. The hatched circle shows the area of the field validation campaign. [1]. (Copyright © 2022. Reproduced with permission from Mdpi)

The European Space Agency (ESA) provides the Sentinel-1 (S1) satellites with the SAR images that are used in the DETER-R system at no cost. After acquiring the images the DETER System analyses the images using algorithms (hybrid parallel-pipeline processing paradigm). The pixel-wise detection method, which is the system's core, operates over the GEE platform's parallel architecture, but the image selection and detection results are handled via a synchronous, sequential workflow. On completing the analysis using these programs, the following results were obtained.

3. Results:

In November 2020, a combined mission called CENIMA/INPE flew over 100 warnings from the DETER-R prototype that were randomly selected and given in the vicinity of Porto Velho (State of Rondonia). The mission's goal was to evaluate the warnings' dependability in an operational setting. Additionally, 170 early warnings were confirmed (without a second imaging). The objectives and outcomes of this validation trip are displayed in Figure 2.

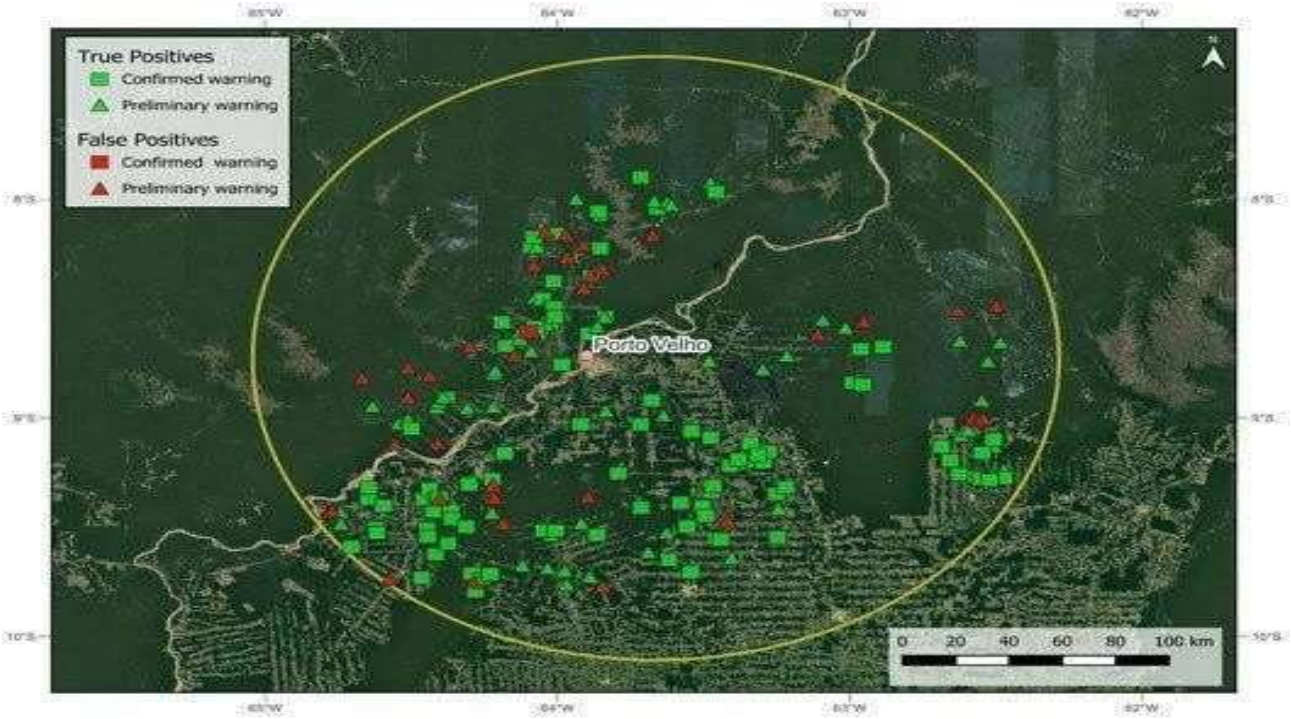

Figure 2. Detailed map of the field validation results. The outer yellow circumference corresponds to the limits of the monitored special area. [2]. (Copyright © 2022. Reproduced with permission from Mdpi)

The inspected confirmed warnings linked to newly deforested regions in 99 out of 100 cases, according to the results. Less than 70% of the initial warnings were confirmed, with the remaining alerts being erroneous ones brought on by convective clouds. These findings emphasised the need for two-image confirmation and the dependability of the system's automatically generated confirmed warnings.

3.1. Forest Disturbance Warnings:

During its first year of operation (April 21, 2022–April 20, 2022), the DETER-R system identified 88,572 warning polygons in total, or a mean detection rate of 242 warnings per day. Anticipatedly, alerts were focused on the "arch of deforestation" (Fig 3). As this is going on, certain disturbed hotspots seem to be moving farther into areas that were previously protected, such as the southern part of the state of Amazonas (AM), which shares borders with Rondonia (RO) and Acre (AC). It is outside the purview of this paper to analyze the current dynamics of deforestation in the Brazilian Amazon.

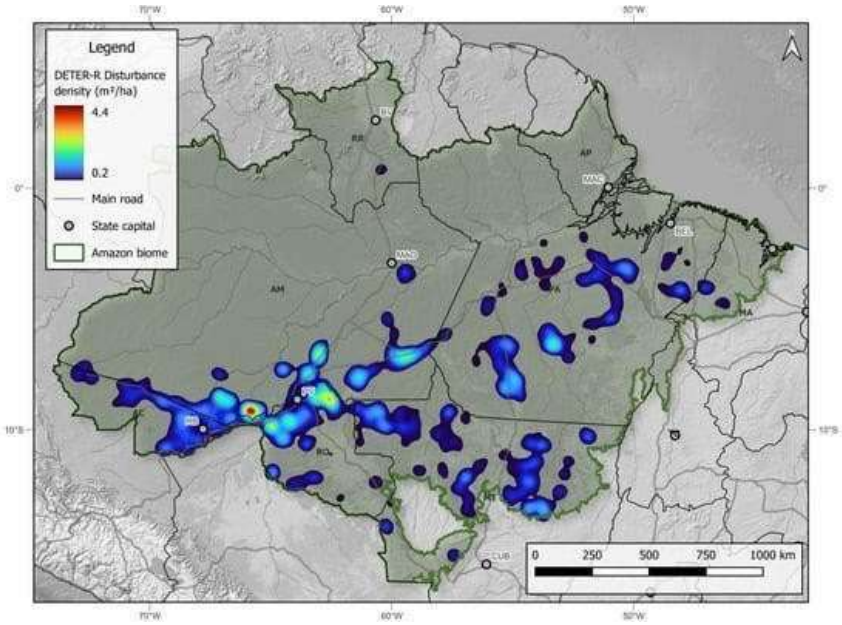

Figure 3: Heatmap of the DETER-R system's first year of operation's forest disturbance alerts. The area in m² disturbed per hectare, integrated along a circular kernel of 50 km, is referred to as disturbance density. Areas with a disturbance density of less than 0.2 m2 /ha were masked out for clarity's sake. [3]. (Copyright © 2022. Reproduced with permission from Mdpi).

Temporally, the warnings were distributed unevenly during the year (Figure 4),with the central months of the year being the most prolific for warnings. These results support the assumption that deforestation tasks are reduced during the wetter months of the year (November to March), which were months with reduced observations from the optical-based Systems.

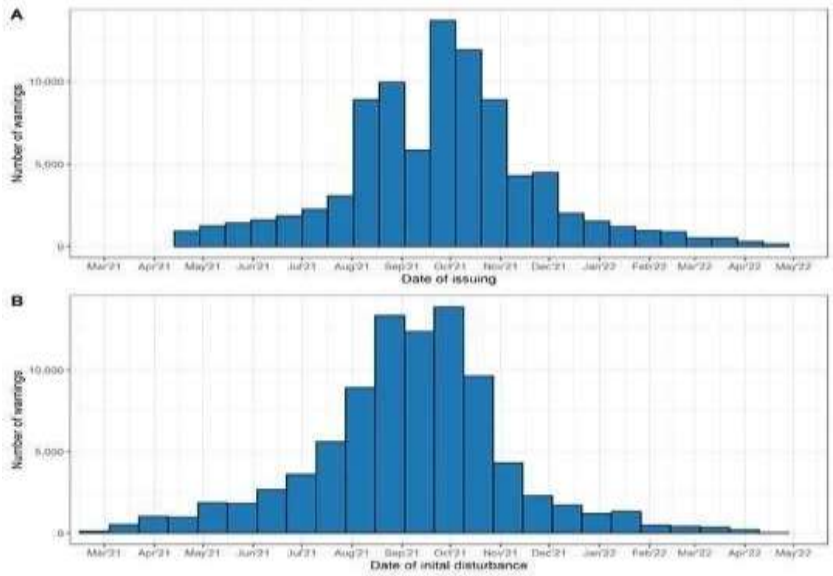

Figure 4 . Timeline of the DETER-R detections. (A) The horizontal axis represents the date when the warning was issued (B) The horizontal axis represents the date of the detected disturbance. [4]. (Copyright © 2022. Reproduced with permission from Mdpi).

To validate a warning, DETER-R requires two anomalous SAR observations across a two-month pre-processed S1 time series. This suggests that there may be a lag between the day the forest disturbance occurs and the day the law enforcement agencies and other relevant parties receive the notice. This delay also includes the period that elapses between the data's capture and its accessibility on the GEE servers. Following a full year of consistent operation, the average issuing delay is 24 days, with a median of 23 days. Eighteen days is the maximum of the probability density distribution (Figure 5). It is noteworthy that the density distribution does not follow the predicted symmetric, normal distribution; rather, it has a lengthy right tail. This asymmetry is most likely the result of cautions that were issued following the delayed ingestion of certain S1 photos on the GEE platform, which may cause delays longer than sixty days.Therefore, there should be an 18-day nominal issuing delay while the system is operating normally.

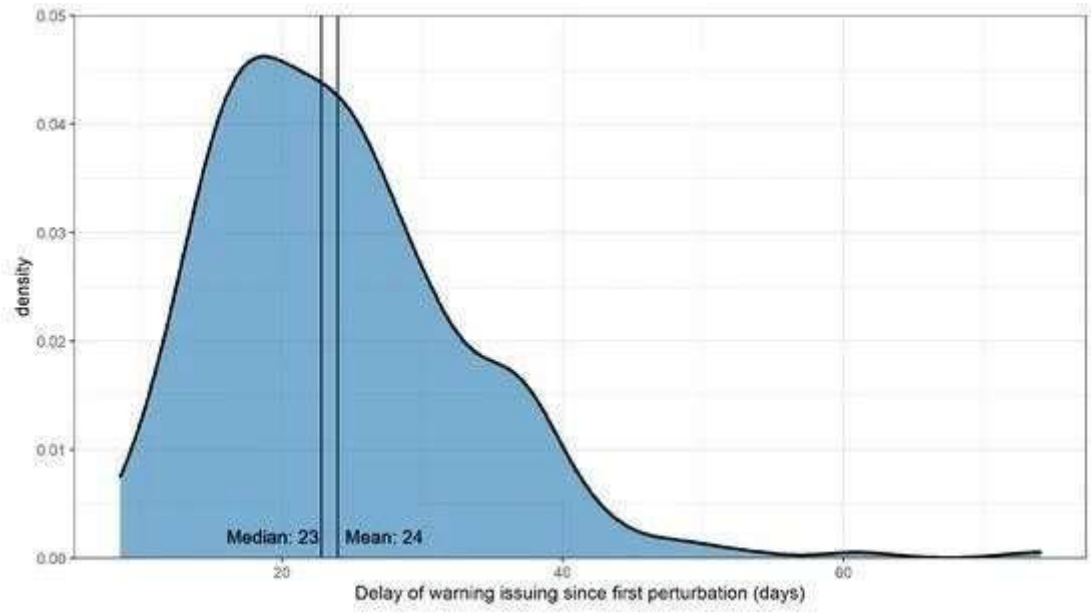

Figure 5. Density distribution of the issuing delay (the difference in days between the date of the actual forest disturbance and the date of the issuing of the corresponding warning).[5]. (Copyright © 2022. Reproduced with permission from Mdpi)

3.2. Warnings Delivered:

DETER-R provided 83,332 forest disturbance notifications to IBAMA in its first year of operation. Of them, 33,096 (or 39.7%) did not show a superposition of 50% or greater to the warnings that the optical DETER provided to IBAMA over the same time frame. These figures translate to an area of 105,238.5 hectares of forest disturbances that DETER-R eit her

detected initially or exclusively, or almost 5% of the total area for which IBAMA received warnings during that time. This percentage rises to 8.1% if we limit our analysis to the rainy season, which runs from November through March. Figure 14 shows the distributions of the warnings of interest that were only picked up by DETER-R.

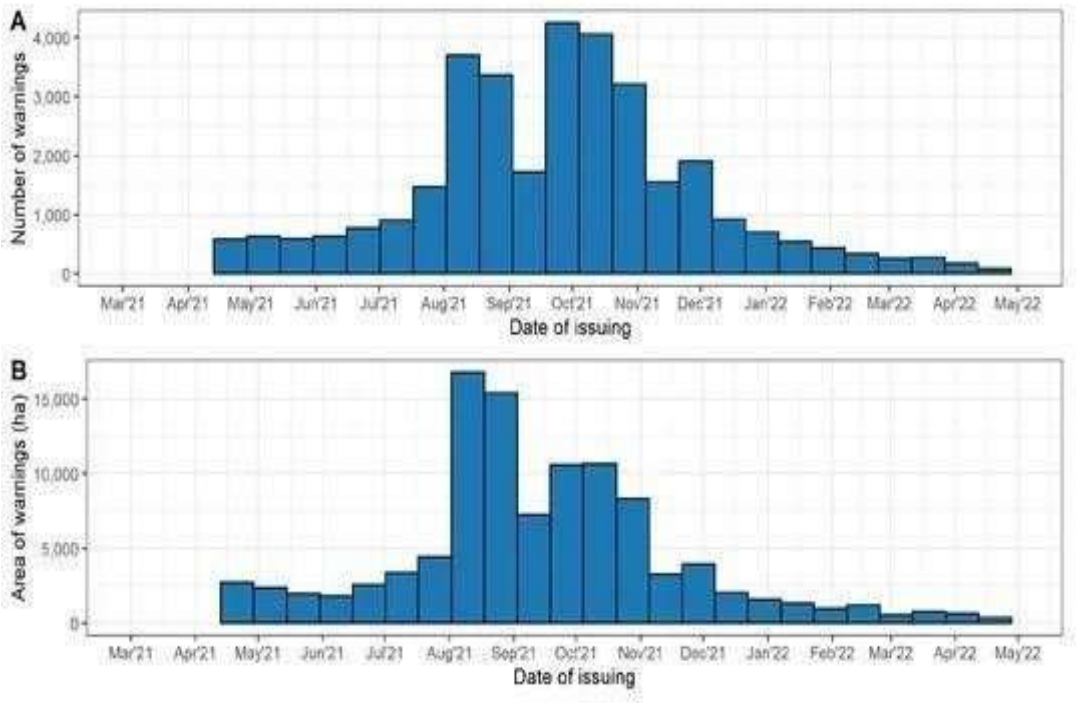

Figure 6 shows the timeline of DETER-R alerts that were submitted to the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) for field research but were not detected by the optical DETER during the same period (A) Warning Area (B): A total number of warnings.[6]. (Copyright © 2022. Reproduced with permission from Mdpi).

3.3 Conclusion:

In addition to the data produced during the DETER-R system's prototype phase and its first year of operation, this study showed the system's early and current routines. Few false positive findings were produced by the proposed method, which was intended to assist the optical DETER in sending warnings about forest disturbances in the Brazilian Amazon during periods of continuous cloud cover (less than 0.5% of the identified polygons as false positives). With minimal assistance from humans, DETER-R was able to alert monitoring teams to regions of deforestation that PRODES("Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite", which in English means "Monitoring of Deforestation in the Legal Amazon by Satellite Project")had not previously identified and

that its optical equivalent DETER had not discovered within the same time frame. Additionally, our findings demonstrate that DETER-R's benefits are more noticeable during the wet season. We also looked at the system's limitations, including the time lag between the disturbance's first detection and the warning being sent out, the reason for the discrepancies that were seen, and general warnings about other NRT systems that were currently in use. These findings imply that the DETER-R system's actual parametrization is causing a significant incidence of omissions, with the system failing to detect about half of the deforested regions. For example, using our detection results as a deforestation accounting system for a certain area and period is hampered by this type of arrangement. It is crucial to remember that this is not a system defect in and of itself, but rather the result of a design choice made for a specific application. The system user must ultimately determine which detection parameters—the minimal mapping unit and the false alert ratio—are most suited for the problem under study.

These results, along with the analysis provided here, demonstrate the value of DETER-R in the Brazilian Amazon monitoring program and point to key directions for future development. These include expanding the algorithm's feature space to include textural or precipitation data or investigating the potential of deep learning to boost system performance and more accurately identify subclasses of disruption of the forest. In addition, we think DETER-R might be used in other tropical areas, serving as a valuable instrument for identifying and managing forest disturbances.

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Economic Implications and Bioethical Reflections: Examining the Cost-Benefit Analysis of Electric Vehicles

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Abstract

This article explores the intricate relationship between economic considerations and bioethics in the context of electronic vehicles (EVs). Examining the cost-benefit analysis of EVs, it delves into ethical reflections on economic implications, emphasising the need for harmonious integration of sustainable transportation technologies while addressing ethical concerns associated with their widespread adoption.

Keywords

Electronic vehicles; bioethics; cost-benefit analysis; sustainability; transportation innovations

1. Introduction

The global automotive industry is transforming towards sustainability, driven by the urgent need to address environmental concerns and reduce dependence on fossil fuels. Electric vehicles (EVs) have emerged as a promising solution, offering a cleaner alternative to traditional internal combustion engine vehicles. While the environmental benefits of EVs are widely acknowledged, it is crucial to conduct a comprehensive cost-benefit analysis to understand their economic implications and bioethical reflections. This article aims to explore the intricate relationship between economic implications and bioethical reflections concerning the adoption of EVs, focusing on the cost-benefit analysis of these vehicles and the ethical challenges they entail. The economic implications of electric vehicles extend beyond the purchase price and operational costs. The raw material extraction, manufacturing processes, and battery production contribute to the overall ecological footprint. A thorough cost-benefit analysis must consider not only the direct financial impact on consumers but also the broader economic effects on industries, employment, and government revenue. Cost-benefit analysis (CBA) is a method used to assess whether the benefits of a particular action outweigh its costs. This method is commonly associated with utilitarianism, an ethical theory that aims to achieve the greatest good for many people [2].

2. Benefits and Challenges of Widespread Electric Vehicle Adoption

The widespread adoption of electric vehicles is driven by their potential to reduce greenhouse gas emissions and combat climate change. By replacing traditional vehicles with electric ones, countries can significantly decrease their carbon footprint, aligning with global efforts to achieve sustainability targets outlined in the Paris Agreement. From an economic perspective, the transition to electric vehicles presents numerous opportunities. The growing demand for EVs stimulates innovation and creates jobs in the green technology sector. Moreover, as governments worldwide invest in EV infrastructure, including charging stations and incentives for consumers, there is a potential for economic growth and the development of new industries. However, the economic benefits are not without challenges. The initial cost of electric vehicles remains relatively high, although ongoing advancements in technology and economies of scale are expected to drive down prices. Additionally, concerns about the environmental impact of manufacturing electric vehicle batteries, which require rare earth metals and minerals, raise ethical questions regarding resource extraction and fair labour practices.

3. Cost Efficiency and Environmental Advantages of Electric Vehicles

Electric vehicles (EVs) have lower maintenance and running costs than petrol and diesel vehicles. However, they have a higher upfront cost than fossil-fuelled vehicles [1].

3.1. Maintenance

Electric vehicles have a simpler design with fewer moving parts compared to internal combustion vehicles. This results in less maintenance and servicing requirements, making them a more convenient and cost-effective option for drivers

3.2. Running costs

By choosing an electric vehicle, you are not only making a smart financial decision but also contributing to a cleaner and more sustainable future for all.

3.3. Fuel costs

EVs can significantly reduce fuel costs due to the high efficiency of their electric-drive components.

3.4. Emissions

Electric vehicles (EVs) are emission-free and produce less noise pollution compared to traditional gasoline-powered cars.

3.5. Convenience

Experience the convenience of driving an electric vehicle (EV), and enjoy the ease of charging it right at home, while also benefiting from more storage space. EVs may have tax benefits and EV owners are not affected by fuel price hikes. The Economic Survey 2023 brings great news for India's future. It predicts a remarkable growth of 49% in the Electric Vehicle (EV) market between 2022 and 2030, which is expected to create an abundance of job opportunities. The EV industry has immense potential to shape the future of India and contribute towards building a sustainable environment.

4. Economic and Environmental Benefits of Electric Vehicle

Many people who support the use of electric vehicles (EVs) point out the following economic benefits:

4.1. Job creation

The EV industry is creating new jobs in manufacturing, installation, and maintenance, which could help offset the job losses in the traditional fossil fuel sector.

4.2. Reduced fuel costs

EVs use electricity, which is often cheaper than gasoline, leading to significant cost savings for consumers in the long run.

4.3. Improved energy security

The use of domestic electricity sources reduces the dependence on imported fossil fuels, which can improve energy security and reduce energy costs.

4.4. Economic growth

The growing market for EVs opens up new opportunities for investment and economic growth, especially in countries like India that are looking to become EV manufacturing hubs.

4.5. Some environmental benefits of EVs

EVs are more efficient than fossil-fuelled vehicles, the use of renewable energy sources can make EVs more eco-friendly and the EVs have a relatively small impact on the environment [3]. However, the economic advantages of EVs do not come without ethical

considerations. Bioethical reflections on the economic implications of EVs encompass concerns related to the entire life cycle of these vehicles. The extraction of materials for EV batteries, particularly the environmental impact of lithium mining, poses ethical dilemmas. Additionally, the disposal of electronic waste and questions surrounding the ethical sourcing of rare earth metals used in EV components must be addressed. Striking a balance between economic benefits and ethical responsibilities is paramount to ensure the sustainable development of EV technologies.

5. Challenges in the Adoption of Electric Vehicles

Despite these benefits, the following challenges need to be taken into account, such as:

5.1.High upfront costs

EVs, especially the more advanced models, can be more expensive to purchase initially compared to gasoline cars, which may prevent some consumers from buying them [4].

5.2 .Infrastructure development

The widespread use of EVs requires significant investments in charging infrastructure, including grid upgrades and the installation of charging stations.

5.3. Battery concerns

The environmental impact of battery production and disposal, as well as concerns over range limitations and battery life, need to be taken into careful consideration.

6. Conclusion

The adoption of electric vehicles is a pivotal step toward a more sustainable and environmentally conscious transportation system. However, a holistic examination of the economic implications and bioethical considerations surrounding electric vehicles is essential for a responsible and ethical transition. Striking a balance between economic growth and environmental responsibility requires ongoing collaboration between policymakers, industry leaders, and the public to address the challenges and capitalize on the opportunities presented by electric vehicles. By embracing a comprehensive approach, society can move toward a future where transportation aligns with both economic prosperity and bioethical integrity.

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Sustainability in Agriculture to Combat Environmental Degradation-An Indian Traditional Knowledge Perspective

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Abstract

This research article aims to examine the significance of lesser-known yet sustainable agricultural practices belonging to the island communities of India, and how they can be practically applied in other parts of India, using scientific methods to overcome their limitations. Unchecked agricultural practices in India result in many detrimental effects on the environment, and incorporating techniques such as the coir pith compost method can result in higher quantity and quality of yields from the same area.

Keywords

Lakshadweep Islands; Industrial agriculture; Indigenous Agricultural Practices; Soil Quality; Coir pith composting; Andaman and Nicobar Islands; Sustainable Agriculture; Broad Bed Furrow method

Nestled in the warm waters of the Arabian Sea, Lakshadweep Islands, one of India's two major islands, is a rich source of culture, tradition, and practices unique to this community consisting of diverse sects of people, including the Amindivi, Koyas, Malmis, and Melacheries. Indigenous agricultural practices were formulated to meet the economic requirements of the community while always keeping in mind the importance of living in harmony with Mother Nature. In India, industrial agriculture is harming soil fertility and depleting its nutrients.

By studying and adopting traditional practices followed by these communities we can work towards improving the situation. Soil dryness is a relatively new issue in India, due to a variety of causes which include climatic constraints, and the fragmentation of coral limestone

rich in carbonate but poor in plant nutrients, thus coconut is the only major crop which is cultivated in Lakshadweep. It is a tropical plant, which thrives in the hot and humid weather

of these islands. Apart from a large number of economic benefits of coconut farming, which include the revenue generated from the manufacture and selling of coconut oil, milk, water, cream, and fruit itself, a unique and resourceful environmental benefit of coconut farming is gaining importance in the present day.

The coir pith composting method is a type of compost that primarily consists of coir, which is the fibre present in the outer husk of coconut, and pith, which is a spongy substance binding the fibre to the husk of the coconut. Once the coconut is harvested from the palms, it is further separated into the kernel and husk, and while the kernel is taken for further processing, the husk, which was earlier discarded as organic waste, is processed for around a year using anaerobic bacterial fermentation to obtain the coir pith. After soaking it to soften its texture, the husk is removed and the fibre is manually loosened, cleaned, and the coir pith is extracted. Coir pith composting is an aerobic composting method, in which the pith is spread above the soil at 3-4 inches in width. After hydrating this, it is further mixed with any organic nitrogenous source and bacterial inoculants. This manner of using the composted coir to fertilise soil improves the texture of dry soil, due to the high water retention of the pith and its ability to slowly discharge the stored-up water gradually for plant use. Due to this property, the compost improves the overall moisture content of the soil, thus potentially eliminating the need for harmful fertilisers in order to increase its fertility in an eco-friendly manner. Inorganic fertilisers contain extremely harmful substances like elevated amounts of lead and cadmium , which could possibly lead to the eutrophication of water.

This compost which contains nitrogenous substances also supplies essential nutrients to the crops. It has been proved that coir pith composting is also responsible for a significant increase in the cation exchange property of the soil, which is an indicator of the soil's capacity to supply nutrients like calcium and potassium(cations). A major limitation associated with this method is the high content of lignin which is present in the pith , which is hard to break down. However, modern science has offered a solution for this issue as well, i.e, by using alkaline solutions like sodium hydroxide, the lignin can also be recycled as a powerful fuel source for combustion, thus reducing the over-exploitation of natural resources.

Similar to the Lakshadweep Islands, the Andaman and Nicobar islands also have unique methods of sustainable agriculture, major among them being the broad bed furrow method. In this method, the run of water is redirected into the furrows of the fields. It is an excellent method to drain excess water in situations like incessant rainfalls, where water logging can cause large-scale devastation. In the Andaman and Nicobar Islands, fish cultivation was also implemented in these furrows, thus offering a resourceful new means of livelihood to the farmers of the islands.

There exists many such resourceful, sustainable, and lesser- known methods in various parts of India, time tested and passed down centuries, rich with the innate wisdom of its indigenous masters. However, one of the greatest challenges in implementing these methods in India is the difficulty in communicating with these isolated communities, both due to the physical limitations and the cultural barriers to communicating with these people helping to bridge this gap, including the invention of the Submarine Optical fibre connection. The submarine cable will highly enhance internet speeds and lead to increased quality of services like government facilities, medical treatment, education, and digital banking. Thus ,we can always rely on new methods in order to bridge this gap, but bridging this gap needs time and effort from people responsible for implementing laws, rules and regulations in the nation along with appropriate exposure for the people who carry on these sustainable methods.

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India's Battle with Environmental Degradation - A Constant throughout History

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Abstract

Contrary to modern belief, environmental degradation is not a crisis exclusive to the 21st Century. This paper will present a timeline of one of India's major civilization's struggles With an ever-shifting environment, how they overcame them, and the parallels they draw With the crises we face today.

Keywords

Climate change; Harappan; Environmental degradation; Indus; Saraswati River; Tectonic changes

Introduction

'Climate Change' is a buzzword that has been thrown around loosely for a good half of the last two decades, leading most people to assume that these were issues that were foreign to our ancient generations. However, nature has always played its best card when it comes to testing humanity's endurance and will to survive. The ruling hand of the natural world plays a sizable role in the death of any civilization, and India is no exception.

India's rich history can be classified into 5 categories.

- Neolithic Age (8000-3500BCE)
- Bronze Age (3500-1700 BCE)
- Iron Age (1750-345BCE)
- Pre-Classical Period (600BCE – 250CE)
- Classical Age (250-500CE)

India's first major civilization, the Indus Valley Civilization, more popularly known as the Harappan Civilization, dates from 2500 to 1700 BCE, making it belong to the Bronze Age. Currently located in modern Pakistan and northwestern India, Harappa was one of the largest urban societies of the Old World and is recognized by historians for its revolutionary town planning, water management, and sewage systems. Harappans were a thriving population; they were the first to develop a standardized system of weights and measures and popularized the concept of urban centres. The Great Bath of Mohenjo Daro not only served as the first public tank of the ancient world but also as a focal point for communal activities and socialization.

Yet by 1800 BCE, the Indus Valley Civilization found itself slowly dwindling away, as made clear by the end of its trade with Mesopotamia and its baths being built over. Its decline began nearly 900 years before its official death. While its exact cause for demise is a topic of argument amongst many historians, it has been universally agreed upon that climate change and environmental degradation were relevant enough to accelerate it. After having abandoned the Indus, the Harappans ended up migrating to the Ganges basin in the east, they found out they could not sustain their original way of living, and as a result, the Indus Valley Civilization officially died out.

Besides the Aryan Invasion, the possible topographical reasons for its decline are:

- Drying of Saraswati river
- Flooding of the Indus
- Eastward moving monsoons
- Tectonic changes
- Climate Change

1. The Drying of the Saraswati River

It is believed that climate change might have caused the drying of the Saraswati River, which flowed in current day Rann of Kutch, Gujarat. This event led to the collapse of Dholavira, which was one of the most prominent cities of the civilization The research, led by IIT Kharagpur, suggests that the drying up of the Saraswati River, on which Dholavira depended for freshwater, likely caused the city's collapse. Analysis of oxygen isotopes in shells of snails consumed by the inhabitants indicated seasonal mixing of river water in

summer and seawater during monsoons. Settlements at Dholavira began around 5,500 years ago during the pre-Harappan era and persisted until about 3,800 years ago. The disappearance of glacial meltwater around the onset of the Meghalayan Age is thought to be a contributing factor. (Sengupta, Torsa, et al. ,Journal of Quaternary Science, vol. 35, no. 3) . Dr. Arati Deshpande Mukherjee from Deccan College, who contributed to the study, describes Dholavira as a prime example of how climate change could amplify the threat of future droughts.

2. The Flooding of The Indus

The Indus River was heavily relied on for crop irrigation and agriculture. One of the biggest reasons for the fall of the Harappan Civilization, is the speculated catastrophic flooding of major farming and agricultural zones by the Indus, which led to villagers deserting their settlements. Records have been found describing the effect of flooding in the civilization.

'sakta vāsa samudrah
dāśśuse-śrudhi agho
vai astojan
śaktikah vrā hanāyattah'

When deciphered, it roughly translates into "The sea has entered dwelling places. Oh Gods! Hear our prayers as we make our offerings to you in your yajnas. We see before us floods in eight directions. Powerful people find themselves at the mercy of death." With 16 inscriptions, it is one of the longest Harappan inscriptions on record. George F. Dales, who was the lead excavator at Mohenjo-Daro, mentions that archaeological evidence strongly suggests the community often banded together to undertake large scale projects at Mohenjo-Daro for the purpose of protecting the city from river floods. As an example, massive mud-brick platforms were erected and faced with fired brick, with the objective of raising the level of the city safely above lake waters. One such embankment, partially excavated by the expedition, was over 70 feet wide and well over 25 feet high. According to Dales, after each immersion, the inhabitants of Mohenjo-daro found it necessary to rebuild or reinforce most of the city's buildings. Although they usually rebuilt directly on top of the older foundations and walls, they eventually encountered serious problems of decay and sinking (Dales, George ,"Expedition Magazine - Penn Museum ,1965).

3. Tectonic changes

One study that combined seismic data, three-dimensional elastic dislocation modelling, and archaeological findings examined the role of earthquakes on the demise of the Harappan Civilization. One possible theory is that large parts of the plain were flooded due to tectonic changes along the Makran coast of Pakistan. Earthquakes of tremendous magnitude could have disrupted vital land and sea trade networks due to the proximity of major trade routes like Sutkagen Dor and Sutka Koh. These seaports are now located 10 km inland, insinuating tectonic uplifts or changes in sea level.

There is strong archaeological evidence that suggests at least one large earthquake at Dholavira in 2200 BCE. The decline of Harappan settlements along the dry SaraswatiGhaggar-Hakra-system coincides with the latter's divergence to the Indus and Ganges basin. Most likely, a succession of earthquakes and a period of aridity led to the disappearance of this system. Though the region has not had any historic occurrences of earthquakes, there is archaeological evidence of at least two major events at Kalibangan between 2900 and 2700 BCE (Grijalva, K. A , NASA ADS, vol. 2006, 1 Dec. 2006).

In Gujarat, the Rann of Kachchh formed a delta for three rivers, becoming an inland sea during Alexander the Great's era and eventually a salty marsh. This sequence of events was likely brought about by sea level changes, tectonic changes, and the deepening of Rann by earthquakes (Kumar, Sanjeev, International Journal of History, vol. 1, no. 1,

2019)

Conclusion

Environmental degradation has always been cited as a propellor for any civilization's decline. Despite the Harappans' resilience, even a civilization as successful as theirs was unable to withstand an unstable environment. While environmental deterioration can be natural or man-made, the result remains the same; it could potentially wipe out a population. Ergo, it is crucial that appropriate steps be taken to ensure that human activity does not come at the cost of its habitat. The purpose of this paper is to illustrate the effect of an ever-changing climatic situation on the Harappans; the archaeological discoveries concerning these events, and the potential reasons behind them.

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From Cigars to CPUs: An Analysis of Efficiency and Global Warming

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Abstract

The article "From Cigars to CPUs: An In-depth Analysis of Efficiency and Global Warming" explores the growing inefficiencies in modern computing systems and their contribution to resource wastage and global warming. The analysis highlights how increasing inefficiency in computing hardware leads to substantial energy consumption and carbon emissions. By examining the underlying causes of these inefficiencies, the article sheds light on the urgent need for more sustainable computing practices. The loss of efficiency not only leads to increased emissions but also increased running costs. Modern improvements in technology are working hard in bridging the gap between efficiency and performance.

Keywords

Computing efficiency; Resource wastage; Global warming; ARM architecture; x86 architecture; Energy consumption; Carbon emissions; Sustainable computing; Technological advancements; Cost savings

Introduction

The world of technology is undergoing frequent and dramatic changes, inching closer to the fictional worlds depicted in movies and novels. Today, we have robots that clean our houses and AI that can mimic human behaviour. However, many current innovations and ideas are driven primarily by the pursuit of profit rather than the broader goal of advancing humanity's well-being. Companies achieving billion-dollar profit margins often do so at the expense of significant environmental impact. The universe of computing also plays a considerable role in emissions, contributing to global warming similarly to how smoking affects the environment.

Computers operate on electricity, and like any electrical equipment, their efficiency can be measured by dividing the amount of energy consumed by the amount of energy wasted

as by-products. To draw an analogy, consider a light bulb: its intended purpose is to convert electrical energy into light. However, it also produces heat as a by-product, leading to some energy wastage. Similarly, computers use electrical energy for calculations, which involve flipping microscopic transistors and MOSFETs inside the processor. These operations also produce heat as a by-product, representing wasted energy.

Unlike a light bulb, which has a relatively straightforward efficiency calculation, a computer consists of various components, each with different efficiencies. Even when focusing solely on the power supply unit (PSU), which is typically around 80% efficient, this translates to 20 watts of wasted power for every 100 watts consumed. Modern PSUs range from 600 to 1000 watts, resulting in significant energy wastage just in converting AC to DC for other components. Moreover, individual components within the computer further contribute to energy wastage. Overall, abstract computer systems are approximately 30-50% efficient, with significant variations between desktops, laptops, and servers. In the domestic market, where electricity costs are relatively low, efficiency might not be a primary concern. However, in the server industry, where electricity constitutes a major expense, efficiency is crucial. This is why server CPUs are designed to be efficient when idle but power-hungry when in use.

A major source of energy loss in computers is heat generation. When performing calculations, computers produce heat, necessitating additional energy for cooling through fans or water cooling systems. This not only decreases efficiency but also increases operational costs. The primary heat-producing components are the CPU and GPU. Recent innovations have improved CPU efficiency significantly. For instance, ARM CPUs have demonstrated notable efficiency improvements compared to traditional x86 CPUs.

A direct comparison of CPU efficiency across different architectures is challenging, akin to comparing languages by the number of alphabets. A practical example can be seen in our devices: laptops typically use power adapters ranging from 40 to 300 watts, while phones use adapters ranging from 60 to 120 watts. Although both devices perform calculations, it’s not accurate to claim that phones are more efficient than desktops solely based on power consumption due to differing architectures.

The introduction of Apple's M-series chip marked a significant advancement in ARM technology, demonstrating that ARM chips could offer both high performance and lower power consumption compared to x86 counterparts. Qualcomm's recent release of the Snapdragon Elite X series chip brings ARM technology to Windows laptops, enabling power-efficient tasks like video editing previously handled by more power-hungry components. ARM chips offer twice the battery life compared to x86 chips while delivering superior performance. The performance-to-battery-life ratio is widely regarded as a key indicator of efficiency within the tech community.

Just as smoking has contributed to environmental degradation, inefficient and power-hungry computers contribute to global warming. Energy wasted is energy not utilized effectively, underscoring the importance of improving computing efficiency.

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Sustainable Energy From Beyond the Earth by Dyson Spheres and Asteroid Mining

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Abstract

Global growth requires sustainable resources and energy. Current mining and fossil fuels harm the environment. Alternatives like asteroid mining and Dyson spheres offer solutions. Asteroid mining can yield vast resources from space. Dyson spheres could harness solar energy. This article explores these concepts, emphasising their potential for sustainable development and environmental conservation.

Keywords

Dyson sphere; Megastructure; Civilisation; Energy; Asteroid mining

1. Introduction

In a growing world economy, resources for technological, scientific, infrastructural, and humanitarian developments, along with the energy to utilize these resources, are essential for improving the human condition and enabling further growth.. Humanity has relied on Earth for resources and energy to achieve significant development. Nearly every mineral and metal in use today comes from mining, and the demands are rising due to population growth and increased infrastructure.. Mining, in its various stages, has a high water footprint, with only a few stages utilising reused and recycled water. Leakages of mining toilings are quite harmful because they are often radioactive, toxic or acidic and extraction processes use cyanide, mercury or arsenic.

In many developing countries, illegal small-scale operations, known as 'artisanal mining,' are prevalent. These operations typically employ low-tech methods and suffer from poor management practices. Mining also releases carbon dioxide and other greenhouse gases, (a certain quantity is released per unit mass of mined material). Furthermore, infrastructure created by mining operations in remote, untouched landscapes can lead to improved access to these regions which results in further- human caused disturbance to the local ecological

systems. Regarding fossil fuels, their combustion releases enormous amounts of toxic air pollutants and carbon dioxide, leading to air pollution, global warming, and various health problems, especially in children. In such adverse circumstances, instead of harvesting energy from earth itself and causing its slow deterioration it is necessary to turn to space for alternative sources of energy and resources harvesting. This is where the idea of asteroid mining and the Dyson sphere comes in. These are also prime examples of how astronomy and astrophysics can play a greater role in sustainable development.

2. Dyson sphere

A Dyson sphere is a theoretical mega-structure that encircles a star with platforms orbiting in tight formation. It is the ultimate form of directly harvesting energy from the sun. Even one percentage of the sun's energy would be enough to solve the energy crisis and also make Interstellar travel possible, helping the civilization evolve. Dyson spheres are not only extremely useful, but also could be feasible for a type 1 civilisation, which is on the Kardashev scale (scale proposed by Soviet astronomer Nikolai Kardashev which ranks alien civilization by their energy consumption, using laws of thermodynamics, stable matter, laws of planetary evolution etc.). British American theoretical physicist, Freeman Dyson who first speculated about these megastructures in 1960, speculated that an advanced alien civilisation would utilise such a structure to sustain themselves, and to colonise other worlds for further growth.

If advanced alien civilizations did not destroy themselves in the process of achieving type 1 level of progress, they would move on to becoming type 2, which is a civilization consuming a star's energy, most likely through the use of a Dyson sphere. This structure, although hypothetical due to the resource and energy deficiency in our civilization, could become possible in the near future by efficient planning. The aspects which we need to pay attention to are the material, design and energy.

2.1 Material harvesting

As Earth is already deteriorating, it's more efficient to build a resource harvesting station on mercury. Mercury, because it is the closest planet to the sun, has an abundance of resources, and has a gravitational pull that is only one-third that of Earth, which facilitates launch and requires less fuel and energy.

2.2 Most efficient design choice for satellites

An actual Dyson sphere is a solid structure completely enveloping the sun that is vulnerable to impacts and may rupture or get damaged quickly. Thus, a set of lightweight solar energy utilising panels which orbits the sun- a Dyson swarm is more intelligent. Since satellites are expensive, we need something that is cheaper, but also works for longer periods of time before needing maintenance. Enormous polished mirrors which focus the solar energy to its centre and direct it back to base would be the most effective choice.

2.3 Energy for more energy

Manual labour is not a choice since the atmosphere of both Mercury and outer space is not human friendly. Technological automation, which can be controlled from earth and doesn't require much maintenance would be required. Solar collectors, miners, refiners and launch equipment are essential for this mega project. Approximately one square kilometre of solar collectors can harvest energy from the sun in order to power the resource collectors and miners on Mercury. Once the lightweight satellite structure is constructed, instead of using rockets which are much harder to maintain, we can use an electromagnetic track or electric track to launch it into outer space, with only a little bit of atmospheric resistance . Once the compactly packed satellite is in space, it can unfurl itself to become panels; ready to harvest energy from the sun. If one panel is successfully built and working, then the growth would be exponential from that point onwards since the energy harvested by the said panel can contribute to building the new one.

2.4 Future with a Dyson sphere

If a Dyson sphere is built and working successfully, then we can convert solar energy to any other form and use it for all kinds of ambitious projects for the betterment of humanity, even colonising further areas in the solar system and beyond. One such project is terraforming, which is the process of deliberately modifying the atmosphere, temperature, surface topography or ecology of a planet making it habitable for humans. We can protect the ecosystem and use more feasible ways to conserve the environment.

3. Asteroid Mining

Asteroid mining is the hypothetical extraction of materials from asteroids and other minor planets, including near earth objects. Asteroids are rocky objects primarily found on the asteroid belt, which lie more than two and a half times as far from the sun as Earth does, between the region of Mars and Jupiter. It is speculated that these are leftovers from the early formation of the solar system after all the bigger celestial bodies have been formed. Asteroids are full of possibilities. There are enough metals and resources in them which are unobtainable from the minerals on earth. Studying their composition may even shed some light on what the early solar system was like, before life originated on earth. There is also a prevalent theory that water on earth was actually formed from impacts of asteroids on the surface, because of all the water content asteroids have. They are also possible candidates for the reason dinosaurs are extinct.

3.1 Types of asteroids

Based on their broad composition, asteroids are classified into three types. C-, S-, and M- type. The C-type (Chondrite type) asteroids are the most common ones. Consisting of clay, silicate rocks and known as carbonaceous asteroids, these asteroids are dark in appearance and among the most ancient objects in the solar system. The S-type (Stony type) are made of silicate materials and nickel-iron. The M-types are metallic (nickel-iron). The variations in composition are associated with their distance from the sun as a result of temperature exposure. Based on the position of these asteroids, they are classified as Main asteroid belt, Trojans, and Near Earth Asteroid. The Main asteroid belt is where the majority of the known asteroids orbit within the asteroid belt between Mars and Jupiter, generally with not very elongated orbits.

Early in the history of the solar system, the gravity of newly formed Jupiter brought an end to the formation of planetary bodies in this region and caused the small bodies to collide with one another, fragmenting them into asteroids we observe today. Trojans are asteroids which share an orbit with a larger planet, but do not collide with it because they gather around the L4 and L5 Lagrangian points. There, the asteroid's propensity to spiral out of orbit balances the gravitational pull of the sun and planet.. NASA discovered an Earth

trojan in 2011. Asteroids that actually cross earth's orbital path are known as earth-crossers which are included in Near-Earth Asteroids.

3.2 Near Earth Asteroids (NEA)

Near earth asteroids are asteroids with an orbit that brings it to within 195 million kilometres from the sun. They contain water, volatiles, and other high value materials. NEA will support construction life, agriculture, metallurgy, semiconductors and precious metals. They are very diverse in spectral properties, ranging from metallic iron (M-type) and stony (S-type) to very block carbonaceous (C-type) material. The process of holding a small asteroid in space is being considered by NASA Asteroid Redirect Mission (ARM).

3.3 The process of asteroid mining

Numerous asteroids provide an incredible amount of resources for human civilization. Psyche, an asteroid which contains enough metal content to cover the earth's metal. NASA has sent out a six year mission to investigate this asteroid. To make asteroid mining feasible, we need to switch from classical rockets to electric spaceships. There have been electric spaceship missions, like Hayabusa2, which has an ion engine that powers the spacecraft in the form of an electric propulsion system. Once the asteroid suitable for mining has been located, to stop its movement, we can vapourise the material with a laser, or stop its rotation by applying thrusters. Now that the asteroid has been captured, we have to bring it near earth. To save energy and valuable fuel, we can utilise the rules of orbital mechanics. If pushed in exactly the right direction, we can move colossal objects with very little force in space, because of the influence of gravitational force present from nearby heavenly bodies. For example, we can utilise the moon’s gravitational field to push the captured asteroid into the orbit of earth.

Giant mirrors focus laser energy on the asteroid surface and using centrifugal technology, heavier particles are separated from lighter ones. To take these resources back to earth, we can utilise heat shielded 3D printed capsules filled with gas bubbles to prevent damage from landing. There can be specialised mechanisms for each kind of resource being extracted. Water is abundant on C-type asteroids, although it can be used for exploration purposes beyond the asteroid. At the moment, mining is not feasible with these asteroids.

Water can be split into hydrogen and oxygen by electricity to make rocket propellant, the key ingredients for rocket fuels. So this indirectly supports the process of mining by enhancing the equipment.

3.4 Asteroid Renaissance Probe (ARProbe)

Asteroid Renaissance Probes are probes which are sent out on the mission to collect samples from the asteroid surface to identify its composition. The parent spacecraft containing these probes spend weeks to months orbiting the asteroid and analysing it with remote sensing equipment. A suitable landing site is also investigated on which the probe lands, calculating the impact velocity and other factors for descent. It is also for analysis and determination of the regolith mineral grade, and uses visual and spectrographic imaging of the asteroid surface by the parent spacecraft to determine the surface characteristics. For obtaining a sample, if the asteroid consists of fine particles, the velocity of probe would be low and if the asteroid is dense, higher velocity is required for penetrating the asteroid. There are specialised robots called ‘Spiders’ which will follow the probe returning to the mother spacecraft to acquire loose regolith and process it directly or indirectly. Regoliths serve as a source of geologic resources, such as aluminium, iron, clays, diamonds, and rare earth elements.

3.5 Geophysical Reconnaissance Asteroid Surface Probe (GRASP)

Geophysical Reconnaissance Asteroid Surface Probe, or GRASP for short, are spacecraft designed to be a less expensive way for asteroid science, as well as exploration. Several successful, low-cost, and highly capable nanosats and microsats in Low Earth Orbit (LEO) have been deployed, utilising the microspace approach. They employ two geophysical techniques, gravimetry and magnetometry. Measuring gravity vector on asteroid surface, magnetometers are in close proximity to any magnetised rocks on the asteroid’s surface.

3.6 Steps of mining applied to asteroids

The first step is prospecting. If minerals are applied to asteroids, it can be presumed that their concentrations are generally uniform, unless certain minerals are more abundant in the fine or coarse fraction of the regolith. The next is excavation. Options include excavating

and extracting in situ, excavation of ore for delivery to an extraction plant, or capturing the entire asteroid for delivery to an extraction plant. For the step of processing- magnetic materials could be extracted using a magnetic concentration process. Electrostatic separation will be able to capture fines only and leave out larger rocks. Since iron and nickel dust are hard to de-alloy, use them for metallic extraction in 3D printing, and water and mineral extraction for carbonaceous chondrite extraction. The last step is storage. Volatiles can be pressurised. Water can be stored within pressure cylinders. Processed ore could be stored in sealed containers to prevent losses.

3.7 Challenges in asteroid mining

High cost space flight, unreliable identification of asteroids which are suitable for mining, conflicts between multiple states, inequalities in benefit sharing etc.

4. Conclusion

In the developing human race, it is important to maintain our sources of energy to create more progress. Using Dyson Spheres and resorting to Asteroid mining processes for accumulation of energy can be sustainable if well maintained. If the world powers, companies of nations aiming for technological and economic growth cooperate and coordinate with one another, these missions are within reach. However, the financial decisions and equipment utilisation along with existing resource usage should be planned and maintained in such a manner that it will be beneficial for the project. For that, the aforementioned suggestions are to be considered.

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Bioethics:Ethical Challenges in Healthcare and Research

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Abstract

This article focuses on issues in healthcare, research ethics, and the impact of human activities on the environment, which addresses ethical issues in public health. Bioethicists research ethical, social, and legal issues arising in biomedicine and biomedical research. This helps draft institutional policies and provide consultation and advice on ethical issues. Kerala represents a dynamic intersection of traditional values,modern medical practices and changing health landscapes known for its advanced healthcare,high literacy rates and offers a unique environment of bioethical considerations. As the field continually evolves, vigilance and ongoing ethical reflection are essential to ensure that ethical principles align with the dynamic landscape of biomedicine and prioritise the well-being and dignity of individuals and communities.

Keywords

Bioethics; environmental ethics; bioethical dilemmas; socio-cultural; moral conundrums; Proactive; sustainability

Kerala, often referred to as "God's Own Country," has been facing an increasing number of natural disasters in recent years. Floods, landslides, and other calamities have had profound impacts on the state's population, infrastructure, and environment. The ethical implications of these disasters are explored, taking sustainability of the environment and human health into account. A focus on education and awareness is vital to ensure that both healthcare providers and the public are well-informed about bioethical principles and their application in disaster scenarios. This includes training healthcare professionals to make ethically sound decisions during emergencies and fostering public understanding of their rights and the ethical considerations surrounding healthcare delivery.

The development of robust and flexible disaster response plans that embed bioethical considerations is imperative. These plans should prioritise equitable resource distribution, culturally sensitive healthcare practices, and mechanisms for obtaining informed consent in

challenging circumstances. Finally, ongoing research and evaluation of the bioethical challenges specific to Kerala's disasters are essential for refining and adapting ethical frameworks. This continuous learning process enables the healthcare system to evolve, incorporating lessons from past disasters and ensuring a more ethical and effective response to future crises.

Kerala can address immediate bioethical issues following disasters and lay the groundwork for a more resilient and morally sound healthcare system that can handle the particular difficulties brought on by the cultural diversity of the area and the unpredictable nature of natural disasters by implementing this strategy. In the context of the disasters in Kerala, bioethics faces unique challenges due to the conflict between ethical considerations and the complexities of natural disasters. Several challenges in bioethics have emerged, reflecting the unique socio-cultural and healthcare landscape of the region. Some key challenges include:

The state is renowned for its diverse religions, customs, traditions and beliefs. When tackling topics like organ transplantation, end-of-life care, and reproductive technologies, bioethical considerations need to navigate these disparate belief systems. A major challenge is finding a balance between upholding universally recognized bioethical principles and honouring cultural values. Kerala faces difficulties with healthcare access and disparities, especially in rural areas, despite notable advancements in the field. Providing fair distribution of healthcare resources and resolving inequalities in access to medical advancements pose moral conundrums that need to be considered and resolved.

Prone to natural disasters such as floods and landslides, Kerala faces ethical challenges arising from resource allocation during emergencies, prioritising vulnerable populations, and ensuring the ethical conduct of research in crises are critical considerations. Data security, privacy, and responsible use of health information are becoming more and more of a concern as healthcare data digitization increases. To preserve public confidence and protect people's privacy, it is essential to ensure the ethical use and protection of health data.

It is crucial to address these bioethical issues as Kerala rebuilds after natural disasters to promote a robust and morally sound healthcare system. To create context-specific

guidelines that respect regional cultural quirks as well as general bioethical principles, cooperation between healthcare professionals, legislators, and the community is imperative. This approach will not only enhance disaster response effectiveness but also uphold the dignity and well-being of the people affected by such calamities.

The bioethical issues arising from the recent disasters in Kerala necessitate a thoughtful and proactive response. To develop context-specific bioethical guidelines, healthcare professionals, policymakers, and the community must work together in recognition of the cultural diversity and healthcare disparities that are specific to the area. These policies ought to cover issues with resource distribution, taking into account patient's cultures and religions when making healthcare decisions, and conducting ethical research in an emergency. To protect individual rights and promote informed decision-making, education and awareness are essential. In addition, the incorporation of bioethics into disaster response plans, in conjunction with ongoing research and assessment, will strengthen the healthcare system's resilience by emphasising justice, equity, and people's dignity in the face of hardship.

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Emerging Topological Insulators: Novel Materials and Quantum Phenomena

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Abstract

Topological insulators (TIs), defying conventional classification, exhibit insulating interiors yet conductive surfaces due to non trivial topological properties, heralding a paradigm shift in our understanding of material behaviour and electronic transport in condensed matter physics. This article aims to deliver a concise introduction to this captivating class of materials, accompanied by a brief elucidation of the underlying fundamental physics that underscores their versatile applications across diverse domains.

Keywords

Topological insulators; Band inversion; Topological surface states; Topological Berry phase.

1. Introduction

Topological insulators (TIs) are a class of materials that exhibit unique electronic properties, characterised by nontrivial topological order and protected surface states. These surface states behave as conducting states while the bulk of the material remains insulating. The topological nature of these materials arises from nontrivial band topology, where the electronic band structure exhibits nontrivial winding numbers or Chern numbers, leading to robust and protected surface states [1]. The study of TIs has opened up new avenues for understanding the interplay between topology, symmetry, and electronic properties, paving the way for breakthroughs in condensed matter physics. This is due to their potential to host robust quantum states, such as Majorana fermions, and their relevance to topological quantum computing [2]. Understanding and harnessing the exotic properties of TIs hold promise for developing novel electronic devices and advancing the field of quantum information science. The insensitivity of topological surface states to local perturbations and disorder makes TIs

promising candidates for realising fault-tolerant quantum computation. In addition to their electronic properties, TIs can host exotic magnetic phenomena, including quantum anomalous Hall effect, offering intriguing prospects for spintronics applications [3]. Researchers continue to explore and engineer novel topological materials, including higher-order TIs and topological superconductors, to unveil further fascinating quantum phenomena and technological possibilities.

The Quantum Hall Effect (QHE) was discovered in 1980, revealing a quantization of Hall conductivity in two-dimensional (2-D) electron systems. This discovery laid the foundation for the understanding of topological states of matter. In 1988, the Integer Quantum Hall Effect was extended to three-dimensional (3-D) systems by the theoretical work of Duncan Haldane, who introduced the concept of topological bands and topological insulators [4]. Subsequently, Charles Kane and Eugene Mele proposed a new class of materials, called topological insulators, based on the spin-orbit coupling (SOC) effect that leads to nontrivial band topology [5]. The initial experimental fabrication of a 3-D TI was reported in 2007 by a research group led by M. Zahid Hasan and Cui-Zu Chang, who observed robust surface states in Bi_2Se_3. In 2008, a team of researchers, including Shoucheng Zhang, predicted quantum spin Hall effect, in TIs that supports dissipationless spin currents. The experimental observation of the quantum spin Hall effect in HgTe/CdTe quantum wells was reported later, confirming the existence of 2-D TIs [6]. Further theoretical developments led to the prediction of TIs in a wider range of materials, including 3-D bismuth-based compounds and 2-D graphene-like structures. In 2013, scientists achieved the first experimental realisation of the TI phase in 3-D bismuth-based compounds, Bi_2Te_3 and Bi_2Se_3, using angle-resolved photoemission spectroscopy (ARPES) techniques [7]. Researchers later demonstrated the existence of TIs at elevated temperatures, a critical step towards practical applications in electronic devices. The year 2018 witnessed the discovery of higher-order TIs, where topological states exist only on the boundaries of the crystal, which represents another significant advancement in the field [8]. Since then, researchers have been trying both theoretically and experimentally to explore novel materials that can behave as TIs.

1. Fundamentals of TIs

TIs exhibit unique electronic properties arising from their topological characteristics, which are fundamentally distinct from conventional insulators. The theoretical basis of TIs is

rooted in topology, a branch of mathematics concerned with the properties of space that remain unchanged under continuous deformations. In these materials, a band gap exists in the bulk, preventing current flow, while robust conducting states, known as topological surface states, emerge on their boundaries. These surface states are protected by time-reversal symmetry and topology, making them highly resistant to disorder and imperfections. The key principles governing TIs involve the presence of bulk band gap, non-trivial topological invariants, and the protection of conducting edge or surface states by symmetry. Understanding these principles enables the design and exploration of novel TI materials for diverse applications.

1.1 Surface States and Edge States in TIs

One remarkable feature of TIs includes the presence of edge, surface, or boundary states, which are localised electronic states confined to the edges or surfaces of the material. These states result from nontrivial topology of bulk band structure that are characterised by their robustness against imperfections and disorder. Edge states exist in 2-D TIs and are protected by a topological invariant, such as the Chern number, ensuring their immunity to scattering by impurities. Similarly, in 3-D TIs, surface states emerge due to the nontrivial topology of the bulk electronic bands, forming robust energy states on the material's surface. These edge and surface states give rise to unique transport properties, offering potential applications in quantum devices and low-power electronics.

1.1 Unique Quantum Phenomena in TIs

Spin polarised edge states arise due to the flow of electrons with opposite spins in opposite directions on the edges of the material, known as the quantum spin Hall effect, exhibited by TIs. The topological magneto-electric effect is a unique quantum phenomenon in TIs, where an applied magnetic field induces an electric polarisation and vice versa, driven by the interplay of topology and time-reversal symmetry. TIs host exotic bound states known as Majorana fermions, which are their own antiparticles, making them a potential constituent for fault-resistant quantum computation. In 3-D TIs, the existence of Fermi arc surface states results in unique open surface Fermi surfaces that connect the projections of bulk band crossings [9].

TIs can exhibit helical edge states, where electrons with different momenta and opposite spins are strongly entangled, making them immune to backscattering. The topological Berry phase, a geometric phase acquired by electrons as they move along closed paths in momentum space, is a key ingredient in understanding the unique quantum phenomena observed in TIs [10]. It is a geometric phase acquired by electrons as they undergo adiabatic evolution in momentum space. In TIs, the Berry phase is intimately linked to the nontrivial topology of electronic band structure. This phase leads to the presence of topologically protected surface states, which are robust against disorder and backscattering, serving as essential features of TIs. Moreover, the topological Berry phase is responsible for the quantization of physical observables, such as the Hall conductance and surface states.

1.1 Theoretical Basis and Key Principles of TIs

Topological invariants are significant in classifying topological phases, a concept within condensed matter physics. These invariants are robust quantities that remain unchanged under continuous deformations of a material, making them fundamental in characterising topological states of band structure. One example of a topological invariant is the Chern number, which describes the number of edge states in 2-D systems. Another significant invariant is the winding number, applicable to 1-D systems, representing the net number of times the energy bands wrap around the Brillouin zone. Topological invariants are valuable tools for understanding topological phases in various materials, such as TIs and superconductors. They provide a deeper understanding of the electronic properties of materials and open up new avenues for engineering novel quantum devices with unique functionalities.

1.1 Topological Invariants and their Role in Classifying Topological Phases

Topological invariants serve as crucial topological fingerprints that facilitate the classification of distinct phases of matter. These mathematical quantities encode nontrivial global properties of the electronic band structure and remain unchanged despite continuous deformations, making them robust indicators of underlying topological states. By analysing these invariants, researchers can identify and distinguish different topological phases including topological insulators, topological semimetals, and topological superconductors. Examples of topological invariants include the Chern number in 2-D systems, and the

topological index, a generalisation applicable to higher dimensions. The discovery and study of topological invariants have reshaped our understanding of condensed matter physics, leading to the exploration of exotic quantum phenomena and the potential for groundbreaking applications in quantum computing and topological electronics.

1. Novel Materials, Low Dimensional TIs and their Experimental Realisation

TIs can be categorised into distinct classes based on their dimensionality. The 3-D TI materials possess insulating interiors while exhibiting conductive surface states due to non trivial topological properties. The 2-D TIs manifest as quantum spin Hall systems, where counter-propagating edge states emerge, ensuring dissipationless transport. The 1-D TIs are realised as Kitaev chains, characterised by Majorana fermions at their edges, showing potential for robust quantum computation. The electronic band structures of such materials feature band inversion and hybridization, leading to the creation of energy band gaps in a manner that defies traditional band theory. These band gaps, known as topological band gaps, are a result of intricate SOC and time-reversal symmetry. Fig. 1 represents the band inversion in Bi_2Se_3 TI in presence of SOC. The band inversion occurs between the Bi 6p and Se 4p states at the Γ symmetry point of the Brillouin zone. The topological phase transition between a trivial insulator and a TI includes an opening and a closing of a bulk energy gap, leading to the appearance or disappearance of topological surface states. Exploring these distinctive electronic characteristics holds promise for both fundamental research and the development of novel applications in quantum technologies.

Experimental realisations of TIs span diverse material classes, including both traditional semiconductors and more exotic compounds. Bismuth-based chalcogenides, for instance, bismuth selenide (Bi_2Se_3), have emerged as prominent platforms for 3-D TIs due to the presence of conductive surface states that are protected by time-reversal symmetry. The 2-D TIs exhibit edge states with opposite spins, enabling dissipationless spin transport. Furthermore, efforts have been directed toward the creation of 1-D TIs, often through specialised nanowire configurations or engineered chain structures, aimed at harnessing their potential for Majorana fermion manipulation. These experimental achievements have paved the way for probing unique transport phenomena, topological phase transitions, and the realisation of topologically protected qubits for quantum information processing. The crossroads of novel materials and experimental realisations in TIs hold promise for both

advancing our understanding of fundamental physics and revolutionising technological applications.

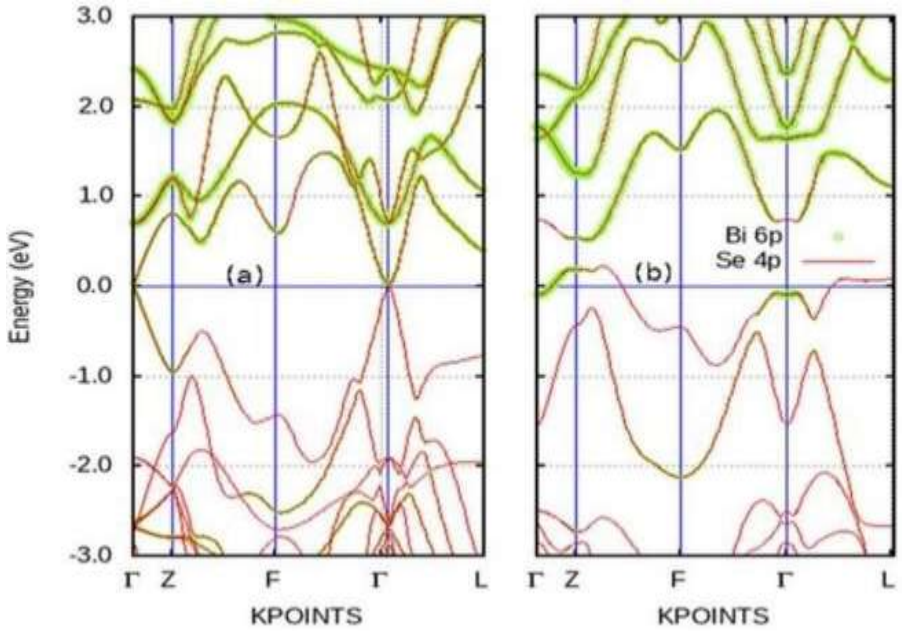

Fig. 1: Band inversion in Bi_2Se_3 TIs. Band structure of Bi_2Se_3 TIs (a) without SOC and (b) with SOC [11].

1. TIs in Condensed Matter Physics and Quantum Computing

Utilising the topological protection of surface states, researchers have proposed and pursued the creation of fault-tolerant qubits, fundamental building blocks of quantum computers. In addition to quantum computation, TIs hold promise for novel spintronics applications. Spin-polarised edge currents in quantum spin Hall systems enable efficient manipulation and detection of spins, offering possibilities for energy-efficient information storage and transfer. Their unique electronic properties have also inspired exploration in the field of topologically induced phenomena, including the quantum anomalous Hall effect.

1. TI based Sensors and Energy Conversion Devices

TIs have found applications beyond the fundamental physics in the realm of sensors and energy conversion devices, promising significant advancements in various technologies. Utilising the unique electronic properties of TIs, researchers have explored their potential in novel sensor designs. The inherent robustness of topological surface states against scattering makes TIs suitable for high-sensitivity sensors that are less susceptible to environmental noise

[12]. TIs have shown promise in sensing applications ranging from magnetic fields and temperature to radiation detection. The inherent spin-momentum locking of topological surface states finds applications in spintronic sensors, enabling efficient conversion between charge and spin currents. In energy conversion, TIs have been proposed for thermoelectric applications due to their high electrical conductivity and low thermal conductivity, a combination that is crucial for efficient thermoelectric materials [13]. These properties enable the conversion of waste heat into usable electrical energy, with potential applications in waste heat recovery and energy-efficient electronics. Furthermore, the topological properties of TIs have been harnessed in spintronic devices, where spin currents are manipulated for information processing and storage. The unique spin texture of topological surface states offers a platform for efficient spin manipulation and transport.

1. Topological Superconductivity

Topological superconductivity, an intriguing frontier in condensed matter physics, emerges from the interaction of superconducting and topological properties [14]. It is characterised by the presence of unconventional superconducting states hosting Majorana fermions at the edges or defects of materials. These Majorana fermions, acting as their own antiparticles, hold promise for fault-tolerant topological quantum computing due to their non-Abelian braiding statistics. Topological superconductors often result from the combination of strong spin-orbit coupling and proximity-induced superconductivity in materials. One approach involves using conventional superconductors to induce topological superconductivity in adjacent materials, giving rise to Majorana modes. Exotic phenomena in topological superconductors include the fractional Josephson effect and the appearance of zero-energy Andreev bound states, both connected to the presence of Majorana fermions [15]. The realisation of a topological superconducting qubit, utilising Majorana fermions for quantum information encoding, is a focal point in the field of quantum computing. Experimental evidence for topological superconductivity has been found in hybrid structures comprising semiconductor nanowires coupled to superconductors. These arrangements have shown signatures of Majorana zero-energy modes through tunnelling spectroscopy and other techniques.

1. Challenges and Future Perspectives

One major challenge lies in the precise control and manipulation of topological surface states of TIs. Achieving stable and controllable Majorana modes for quantum computing and realising braiding operations remain formidable tasks, requiring advancements in materials engineering and experimental techniques. Another challenge pertains to the development of scalable fabrication methods for TIs and their heterostructures. While remarkable progress has been made in creating small-scale devices, extending these achievements to larger systems while preserving the topological properties is a complex task. TIs show promise in fields like quantum computing, spintronics, and energy conversion, but translating these potential applications into real-world technologies requires addressing challenges related to material quality, device integration, and scalability. The future of TIs is promising, with ongoing efforts to uncover new topological phases, improve material properties, and explore their potential in various applications. Collaborations between theorists, experimentalists, and engineers are key to overcoming challenges and unlocking the transformative capabilities of TIs. As research advances, TIs have the potential to reshape the landscape of both fundamental physics and technological innovation.

Conclusions

Emerging TIs have brought forth significant contributions, prominently featuring protected surface states that resist scattering and disorder. These states have advanced the exploration of dissipationless transport and spin-polarised edge currents, paving the way for applications in spintronics and energy-efficient electronics. Moreover, the discovery of novel quantum states, exemplified by Majorana fermions localised at the edges of 1-D systems, has sparked interest in topologically protected quantum computing, offering potential breakthroughs in fault-tolerant qubits and robust quantum information processing. These developments collectively underline the transformative potential of emerging TIs, both in fundamental physics and in shaping the landscape of quantum technologies. The research field of emerging TIs unites the foundational discoveries with the promise of groundbreaking applications, thereby shaping our understanding of fundamental phenomena and catalysing advancements in quantum technologies.

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Electrode Materials for Super capacitor Applications

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Abstract

Energy production and consumption have a profound impact on both the global economy and the environment. Super capacitors (SCs) are of paramount importance and present a promising solution in the domain of energy storage devices. This review offers a comprehensive analysis of the pioneering development and utilization of an electrode material for super capacitor applications.

Keywords:

Super capacitor; electrode; Capacitance; Energy density; Power density

1. Overview

Super capacitors, also known as ultra capacitors or electrochemical capacitors, have lately garnered significance because of their high power density, fast charging - discharging rates, and exceptional cycle life compared to conventional batteries. The quest for electrode material with better energy density, capacitance, and stability has been a focal point of research and development efforts. Based on their energy storage mechanisms, these are categorised into two:

1) EDLC 2) Pseudocapacitor.

EDLCs commonly include carbon based materials like activated carbon, template carbon, aerogel, nanomaterials and mesoporous carbon which possess high surface area and good electrical conductivity, power density and stability. These store charges electrostatically through ion absorption at electrode/electrolyte interface. EDLC storage mechanism strongly depends on the surface area of electrode material and is a reversible process. Pseudocapacitors or redox capacitors mainly comprise conducting polymers like polyaniline, polythiophine,

and transition metal oxides like Fe_3O_4, NiO, RuO_2, MnO_2, $Ni(OH)_2$ and $Co(OH)_2$ wherein charge storage happens through speedy, faradaic reaction.

This introduction will delve into the key aspects of electrode materials utilized in supercapacitors. By understanding the intricacies of electrode materials, researchers and engineers can strive towards the design and optimization of supercapacitors with superior performance for varied applications, ranging from portable electronics and EVs to grid-level energy storage systems.

1. Types of Electrode Materials

The material selection holds paramount importance in the realm of supercapacitors. Various materials serve as electrodes (both anode and cathode) and electrolytes within supercapacitor systems. The properties exhibited by supercapacitors stem from the intricate interactions among these internal components.

2.1 Activated Carbon

The initial industrial production techniques for activated carbons with precise characteristics emerged in the early 20th century, primarily in powder forms. Presently, activated carbons are manufactured in fiber, pellet, felt, or even cloth format to meet the evolving demands of industrial technology. Activated carbon, renowned for its extensive surface area (>1000 m^2 g^{-1}), reasonable cost, satisfactory electrical conductivity, chemical resilience, and widespread availability, serves as the preferred material in commercial Electric Double-Layer Capacitors (EDLCs). In 1957, Becker pioneered the first capacitor utilising high surface area carbon in collaboration with General Electric Company. The surface chemistry of activated carbon in combination with the porosity governs their capacitive performance **[1]**. Chemical activation of activated carbon can be done using the reagents like $ZnCl_2$, H_3PO_4 (dehydrating agent), $AlCl_3$, $MgCl_2$, KOH(oxidant), NaOH etc and among various activating agents an ultra-high specific area of about 4000m^2/g with high pore volume of upto 2.7cm^3/g is produced by using KOH **[2]**. Also, physical parameters like temperatures have a positive influence on controlling porosity. The optimum temperature for porosity development eventually decreases due to the shrinkage of the structure **[3]**. Besides, the combined physical and chemical activation is presently used to achieve enhanced porosity.

2.2 Graphene

Graphene, an intriguing and versatile material is a 2-D carbon nanomaterial with honeycomb lattice structure, having carbon atoms in sp^2 hybrid orbitals, which is currently the thinnest 2-D substance known. This distinctive crystal lattice grants graphene remarkable properties, including high breaking strength (~42 N m^{-1}), a high Young's modulus (~1 TPa), robust physicochemical resilience, and exceptional electron mobility (~2.5 x 10^5 cm^2 V^{-1} s^{-1}). Earlier graphene was not deemed as ideal for widespread use due to its expensive manufacturing process and challenging scalability. However, lately, with the emergence of many alternative graphene production methods like redox, SiC epitaxy growth, and chemical vapour deposition (CVD), the traditional micromechanical exfoliation approach **[4]** is getting replaced. These synthetic methods endow graphene with outstanding structural and electrochemical features, like high specific surface area (~2630 m^2g^{-1}), remarkable electrical conductivity (~10^6 S cm^{-1}), stable electrochemical features, and good theoretical specific capacitance (~550 F g^{-1}), and thus render this far superior **[5]**.

2.3 Manganese Oxide

MnO_2 shows remarkable capacity in aqueous electrolyte and its affordability and minimal environ-impact renders it applicable across diverse fields like biosensors, molecular adsorption, ion exchange, and even catalysis. Moreover, it boasts of a wide electrochemical potential window, less toxicity, and good theoretical specific capacity (1370 Fg^{-1}), positioning this as an ideal choice for any electrode material **[6]**. Reversible redox reactions and multiple oxidation in MnO_2 facilitate good pseudocapacitance charge storage mechanism. This mechanism involves two reversible processes: the insertion/reinsertion of proton into electrode's bulk and adsorption/desorption of electrolyte cations on to electrode surface during transitional states between III and IV oxidation of MnO_2 **[7]**.

$$MnO_2 + C^+ + e \; MnOOC$$

2.4 Nickel Hydroxide

Nickel hydroxide, among transition metal hydroxides, has good theoretical specific capacitance of 2082 Fg^{-1}, excellent rate capability, availability, price-effectiveness, environ friendly characteristics, as well as remarkable thermal/chemical stability in any strong alkaline electrolyte **[8]**. Consequently, $Ni(OH)_2$ proves to be a formidable battery-type

material for supercapacitor applications. This serves as a positive electrode in nickel batteries and finds suitability in electrochemical supercapacitors **[9]**. Its electrochemical performance is evaluated according to redox reactions of $Ni(OH)_2$ or NiO in alkaline electrolyte.

$$NiO+OH^- \rightarrow NiOOH+e^-$$

$$Ni(OH)_2+ OH^- \rightarrow NiOOH+H_2O+e^-$$

2.5 Polyaniline

As far as capacitive behaviour of conducting polymer goes, this is attributed towards its redox reactions occurring not only at the surface but also throughout the bulk and they are usually utilized as a positive electrode. PANI is one of the most explored ones due to its good psuedocapacitance, easy synthesis, multiple redox state, distinct doping-dedoping process, good dielectric permittivity ($\varepsilon' \approx 10^2 - 10^3$), high doping dedoping rate during charge-discharge and good conductivity and environmental stability **[10]**. The existence of PANI in different oxidation states like leucoemeraldine, emeraldine and pernigarniline contribute towards its high specific capacitance. Storage in polyaniline works via doping-dedoping or redox reaction. Depending on the nature of dopant used in the synthesis it exhibits an electronic conductivity of 10 – 500 S/m **[11]**. Low self-discharging is one of the key feature of PANI based supercapacitor **[12]**. Moreover, PANI has large operational potential at positive potential and high hydrogen evolution overpotential.

2.6 Mxene

MXenes are 2D sheets of transition metal carbonitride where $M_{n+1}\ X_n\ T_x$ is their generic formula. M is for early transition metal like Ti while X represents carbon and/or nitrogen. T stands for surface functional catagory like O, F or even OH, and x denotes functional group number where 'n' is positive integer between 1 and 4 **[13]**. These are known for their good specific surface area, robust surface hydrophilicity, good electrical conductivity, and electrochemical activity. The morphology is like that of GO, as one MXene layer has 1 nm thick sheet and lateral dimension that can range from 100nm to 10's of microns. Influenced by chemical moiety among layers and shape **[14]**, their superior electrochemical properties come from the inherent conductivity and charge transfer feasibility. The transition metal M

with changeable oxidation number, and distinctive layered structure, make these ideal for any energy storage application.

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A Balance between Nature and Technology: Representation of Shintoism in the Films of Hayao Miyazaki

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Abstract

Japan is one of the most technologically progressive countries of the 21st century, yet it retains a staunch sense of tradition and culture. One of the many places we see this is in the feature films of the celebrated animator, Hayao Miyazaki. This paper aims to focus on how Miyazaki treats the theme of the relationship between Technology and Nature. To understand the underlying philosophy at play here, one must look at the major religion in Japan, Shintoism. The main teaching of Shintoism is that we share the world with spirits or kami that inhabit different spaces on the planet. With these spirits, we must live in harmony and maintain a balance between technology and nature, each with its pros and cons. This is a departure from the anthropocentric ideology of the West to ecocentric storytelling. The films taken for this research are Nausicaä of the Valley of the Wind (1984), Castle in the Sky (1986), My Neighbor Totoro (1988), Princess Mononoke (1997), Ponyo (2008) and The Wind Rises (2013).

Keywords

Japan; Shintoism; *Kami*; *Manga*; *Anime*; Hayao Miyazaki; Ecocriticism

Introduction

In the modern world of technology, one of the countries that stands out in terms of innovation and quality of products, other than Germany, is Japan. The country is at the forefront of consumer electronics, automobiles and robotics with major international companies like Canon, Casio, Sony, Nintendo, Yamaha, to name a few. Japan also has the distinction of being home to a distinctive culture and tradition due to its long history as an isolated island nation. Such isolation enabled the culture to grow without being affected by the outside world. One such example is the Japanese graphic novel and its animated counterpart, known as *manga* and *anime* respectively.

Of Miyazaki and Japan

Animation is a painstaking process, and there is a tendency to simplify its visual elements. Miyazaki, in contrast, offers complexity. His backgrounds are rich in detail, his canvas embraces space liberally, and it is all drawn with meticulous attention. We may not pay much conscious attention to the corners of the frame, but we know they are there, and they reinforce the remarkable precision of his fantasy worlds.

Roger Ebert

Miyazaki is not only a director but is also involved in screenwriting and animation where he is said to hand-draw most of the frames himself. Miyazaki has eleven feature-length films under Studio Ghibli, from *The Castle of Cagliostro* (1979) to *The Wind Rises* (2013). He rose to global prominence with his seventh animated feature, *Princess Mononoke* (1997). The film went on to win the Japanese Academy Prize for Picture of the Year (the first animated film to do so) and was later bought by Miramax Films and was widely released across North America which introduced his works to a Western audience. As of 2018, Miyazaki has gone on to win a total of 125 awards for his works.

Miyazaki's love for nature can be observed in his latest project which is not a new feature film but a Nature Sanctuary for children (Schwab). He is also considered someone who respects tradition as he prefers a hand-drawn animation process in an age of computer animation and personally draws most of the panels. Still, Studio Ghibli does not shun modern-day techniques as in *Princess Mononoke*, which layers computer-generated 3D imagery over the hand-drawn animation. This would be a prime example of Miyazaki preferring the traditional method to work with, while only slightly leaning on technology.

Miyazaki is a veteran animator with over two decades of experience leading up to his opening of Studio Ghibli. He has said that all he wants to do is to entertain. Being a veteran of the Industry, he would be well aware of the audience's desire to be entertained and would perhaps capitalise on this trend to sell his movies.

Of Nature and Miyazaki

To see with eyes unclouded by hate.

- Prince Ashitaka, *Princess Mononoke*

One of the most prevalent themes in Miyazaki's movies is the sense of ambivalence. Lady Eboshi, in the film *Princess Mononoke*, is the obvious antagonist in the story. She brings about the destruction of nature using technology, a metaphor of the big business companies that trample anything on their path. But she also employs women who were former brothel workers in her iron factories. Her chief engineers are lepers who consider her a benevolent figure. While the protagonist Prince Ashitaka confronts Lady Eboshi on her destruction of nature, one of the lepers speaks up in defence of her:

Young man, like you I know what rage feels like, and grief and helplessness. But you must not take your revenge on Lady Eboshi. She's the only one who saw us as human beings. We are lepers. The world hates and fears us, but she, she took us in, and washed our rotting flesh and bandaged us. (*Princess Mononoke* 00:40:53-00:41:15)

By giving agency and purpose in the grand narrative of progress, Lady Eboshi has empowered the marginalised of society. Although they are following her vision, there is no dissent among the ranks. The humans see Lady Eboshi and her iron as a vehicle of progress and the process of deforestation as just another necessary step in the journey to civilisation.

Similarly, the gods that defend nature in both *Princess Mononoke* and *Nausicaä of the Valley of the Wind* are far from benevolent beings. One could argue that they are merely defending their territory. But Miyazaki portrays them not just as forest animals but occasionally animates them as terrifying creatures as can be seen in Fig 1(a). The boar gods in *Princess Mononoke* shown in Fig 1(b) and the Omu in *Nausicaä of the Valley of the Wind* shown in Fig 2 have the advantage of numbers as well. All of these depictions show them to be a formidable opponent to the humans who seem outmatched and hence garner the sympathy of the audience despite their actions.

Fig 1. Stills from *Princess Mononoke*: **(a)** The Wolf God, Moro, is shown laughing at the protagonist Ashitaka. (left) **(b)** The Boar tribe swarming the human stronghold. (right)

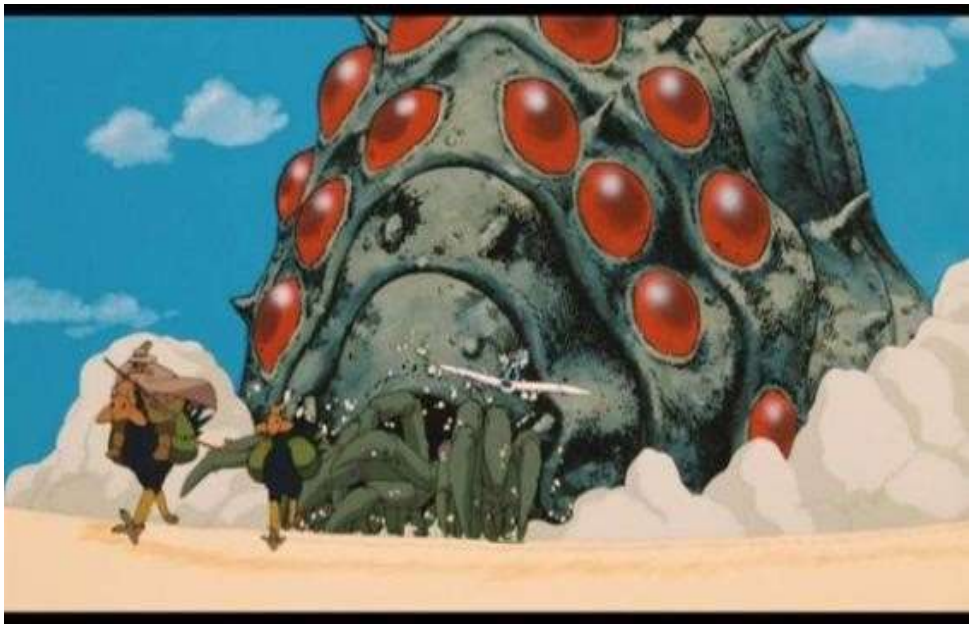

Fig 2. *Still from Nausicaä of the Valley of the Wind:* Nausicaä and Yupa being chased by an angered Omu.

Miyazaki avoids spoon-feeding the audience. He leaves the ultimate message of his films up for interpretation from his audience. Miyazaki even contests against base assumptions. In *Nausicaä of the Valley of the Wind*, the titular Valley of the Wind is safe from the toxic spores due to the wind. The denizens are shown to be living an idyllic life which is abruptly interrupted by the two warring nations of Pejite and Tolmekia over the possession of an ancient technology that caused the apocalypse. It is easy to categorise the two more technological nations as representations of human ambition (or greed) and the Valley of the Wind as the ideal balance we must maintain with nature as shown in the establishing shot of the Valley in Fig 3. But Miyazaki goes beyond such conventional pastoral imagery as he explains in an interview:

However, for the power balance between humans and animals, that was decidedly changed when humans started using gunpowder. Really, though, the biggest reason why mountain animals decreased so much is agriculture. It's human arrogance to say that the country scenery is beautiful. A farm basically takes away the chance to grow from other plants. It's more like barren land. The productivity of wasteland is higher than that of farmland. It's the same for other creatures. It's because the time (we live in today) is such that I have to even think such things. ("Interview: Miyazaki on Mononoke-hime")

Miyazaki rejects the idyllic pastoral imagery and challenges us to think beyond what we naively presume is a proper balance with nature. He is addressing the change that has occurred in Japan from a nation where 70 per cent of the landmass was covered by mountains to a country with over 5 million vending machines. Miyazaki is not addressing the nation with 100,000 Shinto shrines as he does not emphasise how we got here but is more fixated with the question of where we are heading. This is why his movies are primarily addressed to future generations as it is Miyazaki's way of saying that children have the power to make a better world for all of us and that they are intelligent enough to make the correct decisions. He does not simply end his movies in a cathartic manner with the triumph of good over evil but instead, he challenges us to think as to what can be labelled as good and evil when it comes to man's relationship with nature.

Fig 3. Still from *Nausicaä of the Valley of the Wind:* The titular Valley of the Wind reflects a stereotypical idyllic pastoral imagery with minimal pervasive technology being employed.

Similarly, Miyazaki does well to not demonise technology and progress as is the case in his *The Wind Rises*, the fictionalised biopic of Jiro Horikoshi, the designer of the

Mitsubishi A5M and A6M Zero fighter aircraft which were used extensively by Japan in World War II. In one of the many dream sequences, when Horikoshi meets his real-life role model, Italian aircraft designer Giovanni Caproni, the latter tells the former that planes are not instruments of death but rather "Airplanes are beautiful dreams, engineers turn dreams into reality" (*The Wind Rises* 00:12:06-00:12:12). Miyazaki romanticises engineers and likens them to artists as in the case of his portrayal of Horikoshi. Even in the final dream sequence when Horikoshi laments that his beloved inventions were ultimately used as weapons in World War II and "Not a single one returned" (*The Wind Rises* 02:01:18-02:01:21) as he looks at a sky filled with hundreds of his Zero fighter aircraft. At no point in the movie is Miyazaki pointing out the inherently destructive nature of technology or inventions. In fact, it is nature that creates most of the conflicts in the film like the Great Kanto Earthquake of 1923 and Horikoshi's wife eventually succumbing to tuberculosis.

By showing the beauty in Technology and the menacing side of Nature, Miyazaki moves away from his Western contemporaries and takes the discourse to a new level. While Miyazaki does well to end his movies on a more positive note, he does not provide closure to his audience as if urging them to continue the conversation well after they have seen the film. The only bit of advice which can be seen in his films is through the young protagonists. The titular Nausicaä is shown as a level-headed leader to her people but also shows the capability of calming an enraged Omu to the surprise of her elders. At the end of the film, she brings peace between the army of Omu and the soldiers of Tolmekia. In *Ponyo*, Sosuke is asked towards the end, by the Spirit of the Earth and Ponyo's Mother, if he can love Ponyo even after knowing she is a fish, Sosuke responds "I love all the Ponyos. It's a big responsibility but I really love her." (*Ponyo* 01:35:35-01:35:42) thus showing man's love and respect for nature in a very literal way. In *My Neighbor Totoro*, the sisters Satsuki and Mei are the only ones who are shown to be able to see and interact with the various *kami* of their new house. Rather than depict them as supernatural entities, the old woman who is hired as a maid in the house refers to them as if talking about local wildlife when she tells the two children "If they decide you are nice people, they won't harm you". (*My Neighbor Totoro* 00:15:03-00:15:09)

It should be noted that the design for these soot sprites is similar to the ones seen in Miyazaki's other film, *Spirited Away* (2001), therefore showing that Miyazaki intentionally Animated them in a manner that is friendly to children but still possessing an other-worldly look. To emphasise on this point, the local woman mentions that she used to see them at one point when she was a child and is not surprised that the sisters are able to see them now. The sisters, who were initially scared of the sprites, immediately have a playful attitude towards them.

Fig 4. (a) Stills from *Spirited Away* (Left) and **(b)** *My Neighbor Totoro*(Right): The protagonists first encounter the soot sprites and rather than the scene playing out as a supernatural event, Miyazaki treats the scene as whimsical and playful.

All these examples can be likened to certain rituals of Shinto, which bring about peace and harmony to not just one's own spirit but especially to the *kami* around one. Such rituals include burying the dead to bring peace to their spirit or respecting local gods and spirits and valuing their sacrifice for the benefit of mankind. Failing to do so, leads to the spirits becoming cursed, as in the case of the boar gods in *Princess Mononoke*.

This harmony between man, or more specifically, the future of mankind, and nature as a form of mutual respect is one part of Miyazaki's message. The second part can be seen as the harmony between Technology and Nature. Nowhere is this more evident than in Miyazaki's *Laputa: Castle in the Sky* (1986). The titular Laputa is spoken of as a lost city of advanced technology including automatons. One such automaton is shown to cause massive devastation to a military base. When the protagonists, Princess Sheeta and Pazu, eventually find the floating city, it is shown as dilapidated and overgrown. The automatons are the ones tending to the nature and wildlife of the city and performing rituals such as burying other automatons and paying respects to their graves by bringing flowers to the site as seen in Fig

5. Miyazaki shows that when man's creations are left alone long enough they eventually conform to the practices of Shinto and are reclaimed by nature. Even the sound the automaton makes while walking resembles the soft gongs of a temple. In essence, Laputa has become the perfect synthesis of Nature and Technology, with the point being further emphasised by the giant tree that is growing around its power source. The two children are shown to recognise this harmony in contrast to the adults who immediately start searching for treasures or items of value in Laputa. Towards the end of the film, when the government agent, Muska, tries to reach the power core of the city, he is shown violently ripping through the vegetation to reach the power source. This is the symbolic representation of man's attempt to attain power through technology while treating nature as nothing but a hindrance. It is the two children that stand in their way and initiate the self-destruction of the city so that it does not fall into the wrong hands and destroy the harmony it has achieved. The final shot of the movie shows the tree and the power core of the city soaring through the sky, still somehow intact.

Fig 5. Still from *Laputa: Castle in the Sky:* An automaton presents the children with a flower to be placed at the 'grave' of a broken-down automaton.

This cyclical manner of recovery of all things natural is the same in *Nausicaä of the Valley of the Wind.* In the film's prologue, all of civilization was said to have been wiped out

by a seven-day global war. The earth was left with a mostly toxic jungle and the surviving humans have taken a thousand years to reach the level of civilization we see at the beginning of the film. It is discovered during the course of events of the film that the toxic jungle is recycling the air and soil and forming a clean and habitable underground forest.

In both *Nausicaä of the Valley of the Wind* and *Laputa: Castle in the Sky*, Miyazaki shows that the downfall of man will be his own doing following which, nature will eventually restore the balance and it is once again up to man to either repeat his mistakes or to realize the importance of nature and maintain the balance.

Conclusion

It is undeniable that Hayao Miyazaki is a capable filmmaker and adept storyteller. He uses his films not just for profit but as vehicles for his philosophy in Shintoism. His films are addressed to the youth who have grown up with technology. While most Western studios simply seek to entertain their audience for profit, Miyazaki goes beyond the simple black-and-white perspectives and encourages his audience to think and form their own opinions regarding Nature and Technology and how they influence one another. He does not paint Nature as all-knowing and kind nor does he paint Technology as inherently evil. Miyazaki wants children to understand the simple fact that if we were to repeat our mistake of disturbing the balance of Nature or misusing Technology, then we would be the ones to pay as Nature will eventually achieve balance and harmony, with or without our help.

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Conexus Team

Proposed theme for Conexus **Volume 3**

Renewable Energy and Innovations

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Rajagiri School of Engineering & Technology (RSET) - Autonomous, Kakkanad, Kochi, is a premier educational institution offering excellence in engineering education and research. The University Grants Commission has granted autonomous status to RSET from 2020 onwards. The parent university of RSET (Autonomous) is A. P. J. Abdul Kalam Technological University, Trivandrum, Kerala. RSET is approved by the All India Council for Technical Education, New Delhi.

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RSET (Autonomous) is an endeavour of the Sacred Heart Province of the Carmelites of Mary Immaculate (CMI) – the first-ever indigenous religious congregation for men in the Syrian Catholic tradition of Christianity in India. The CMI congregation, canonically established in 1855, played a major role in revolutionizing the education scene in Kerala in the late 19th century. Heirs to the profound vision of St. Kuriakose Elias Chavara, one of the founding fathers of the congregation, the CMIs' have zealously worked towards providing value-based quality education to society at large, irrespective of religious differences, down the centuries. Today, the congregation has more than 400 educational institutions, from schools to professional colleges under its umbrella.

The Rajagiri Valley campus is a perfect blend of the urban and the rural: while the verdant and serene backdrop of the self-contained campus provides the ideal atmosphere for stimulating the creativity and intellectual pursuits of the academia, the close proximity to the industrial belt of Kerala, the Infopark, and the proposed Smart City helps in providing the students with exposure to the practical aspects of their profession. This ensures a smooth transition from the institution to the industry for our graduates.

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