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Harnessing AI for Oceanographic Research and Sustainable Management

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ABSTRACT

The ocean economy would provide approximately 40 million individuals with employment opportunities by 2030. Protecting the sea and marine resources has become a need of the future. Humans have limitations in monitoring and protecting such an immense sea. India's blue economy project paves the way for opportunities for deep-sea exploration to boost the country's economy and raise the potential impact on the livelihood of local people. Effective integration of technologies is needed to reshape the future of ocean conservation and exploration. Many technologies based on AI for the ocean have contributed to marine ecosystem conservation, but these technologies are now in their early stages. AI can significantly protect the sea and marine resources through real-time fish stock status monitoring, ocean cleanup, ocean literacy, ocean exploration, ecosystem conservation and climate prediction. Effective integration of AI enables scientists to analyse collected data more efficiently, leading to a deeper understanding of ocean processes and a more informed approach to marine conservation. These insights can inform policymakers and scientists to take proactive measures to protect marine ecosystems. This article discusses various problems faced by the ocean and its ecosystem and the possibilities of integrating AI for sustainable coastal development in connection with India's blue economy project.

Keywords: Ocean Conservation; Ocean AI; Ocean Governance; Oceanographic Research; Blue Economy; Global Sustainable Development

1. INTRODUCTION

The 2024 World Oceans Day theme, "Oceans: Life and Livelihoods," highlights the critical link between healthy oceans and the well-being of those who depend on oceans. This interconnectedness extends beyond the sea, encompassing terrestrial ecosystems like forests, rivers, and mangroves, significantly influencing coastal and marine environments. Recognising the impact of land-based activities on ocean health, a holistic approach to environmental management is crucial for protecting our interconnected ecosystems. Humanity has always depended on the land and sea, but the increasing pressure on our oceans demands a shift towards sustainable practices to ensure our well-being and economic prosperity [1]. The changes that have taken place in the oceans and coastal environment are affecting the lives and livelihoods of coastal people, especially seafarers. Population growth, unsustainable and unscientific coastal development, overexploitation and biodiversity loss, coastal erosion, climate change, and pollution are the main factors driving changes in India's marine and coastal ecosystems.

Coastal communities, particularly those reliant on fishing, face a growing threat from human development and natural disasters. The increasing frequency and intensity of events like tsunamis and severe storms exacerbate the damage from armouring and development, leading to accelerated erosion and jeopardising the health of the coastal ecosystems upon which these communities depend.

On the coast of India's southern state, Kerala, a highly productive fishing ground supporting 39,000 fishing vessels, including over 5,000 mechanised vessels, saw a trawling ban enacted in 1988 to combat overfishing, significantly

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diminishing marine fish stocks, as presented in Table 1. Although the ban is still in effect, there has been a decline in marine fish availability and exports in the last few years. Degradation of habitats, pollution, decline in large predatory fish, increasing 'by-catch' and unscientific fishing practices also threaten the sustainability of the resource. The decline in fish stocks and environmental changes have facilitated the entry of opportunistic species, including jellyfish. The intrusion of foreign vessels into our special economic zone is also a significant problem [2].

The unchecked exploitation of the ocean for economic gain poses a grave threat to the marine environment. International collaboration is essential for adequate ocean protection; some nations, including China and India, prioritise large corporations' profit interests over environmental sustainability. This approach risks severe environmental damage with potentially global consequences.

Table 1: Annual marine fish production

Fish Production in Kerala & India During the Last Five Years (Lakh tonnes)						
	Kerala			All India		
Year	Marine	Inland	Total	Marine	Inland	Total
2015-16	5.17	2.1	7.27	36	71.62	107.62
2016-17	4.88	1.88	6.76	36.25	78.06	114.31
2017-18	4.86	1.89	6.73	36.88	89.02	125.9
2018-19	6.1	1.92	8.02	41.5	95.8	137.5
2019-20	4.75	2.05	6.8		Not Available	

Source: GOK; Handbook on Fisheries Statistics- 2019, Department of Fisheries, GOI

Table 1 shows that effective coastal management worldwide necessitates a more holistic and integrated approach, moving beyond the current regulatory framework due to the total landing of fish production falling by 15.4% [3]. Despite regulations such as the 50-meter development setback mandated by the Coastal Management Act of 2018, violations and encroachments remain widespread. Furthermore, the limitations of relying solely on complicated engineering solutions like seawalls for coastal protection underscore the need for diversified strategies that prioritise natural defences and foster community engagement. Critically, recognising fishing communities as "ecosystem people" and integrating their traditional knowledge and practices into coastal management plans is essential for long-term sustainability. Further research is needed to understand the socio-economic and health consequences of these climate-related changes on coastal communities, particularly those dependent on fishing.

2. INDIA'S BLUE ECONOMY AND MARINE ECOSYSTEMS: THE ROLE OF AI TECHNOLOGY

India's recently released Blue Economy policy raises concerns regarding its potential impacts on the livelihoods of the nation's fishing communities. The policy prioritises exploiting marine resources, including hydrocarbons and deep-sea minerals, across coastal and offshore areas to contribute to India's GDP growth. While the policy acknowledges the need for fisheries sector development, its emphasis on attracting investment and intensifying deep-sea fishing technologies raises concerns about the sustainability of this approach, particularly given the existing pressures on fish stocks due to overexploitation.

The Blue Economy Policy encompasses many maritime sectors, with marine mining prominently alongside marine tourism, coastal industrial development, and port infrastructure expansion. The potential impacts of marine mining, port development, industrial expansion, and associated pollution are of particular concern for fishing communities and coastal residents. The policy document explicitly identifies the presence of economically valuable mineral resources within India's maritime jurisdiction, including seabed deposits of nickel, uranium, copper, thorium, polymetallic sulfides, polymetallic manganese nodules, and coastal placer deposits of ilmenite, garnet, and zircon [4].

The seabed plays a crucial role as a habitat for fish populations. Extensive mining activities in coastal and deep-sea environments pose a significant threat to the sustainability of these resources. Scientific assessments of fish stocks typically utilise depth-based zonation rather than distance from shore. In contrast to temperate waters, where fish abundance is often higher in deeper offshore regions, India's tropical waters exhibit a pattern of decreasing fish abundance with increasing depth. This distinction has implications for fisheries management and resource exploitation. Fish species are categorised as pelagic (inhabiting the water column) or demersal (associated with the seabed). Estimates of potential yield (PY) or maximum sustainable yield (MSY), as presented in Table 2, provide crucial guidance for sustainable fisheries management. While acknowledging the dynamic nature of marine ecosystems and the potential for natural fluctuations in fish stocks, it is essential to recognise the finite nature of

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these resources. Overexploitation can lead to stock depletion and jeopardise the long-term viability of fisheries, underscoring the importance of adhering to scientifically determined sustainable harvest levels.

Table 2: Fish stocks' potential Yield (PY) in India's EEZ.

Depth (m)	Resource	Potential yield (Tonnes)	Share (%)
0-100	Demersal	18,25,115	41.37
	Pelagic	19,96,393	45.25
	Total	**38,21,508**	**86.62**
100-200	Demersal	2,05,104	4.65
	Pelagic	53.935	1.22
	Total	**2,59,039**	**5.87**
200-500	Demersal	98,205	2.23
	Pelagic	16,435	0.37
	Total	**1,14,640**	**2.60**
>500	Oceanic	2,16,500	4.91
0-500+	**Total**	**44,11,687**	**100.00**

Source: Deep Sea Fishing Policy and Guidelines 2014, Department of Fisheries, GOI

India's extensive coastline presents a significant opportunity to harness the potential of its blue economy. Artificial intelligence (AI) can play a transformative role in realising this vision by enabling optimisation across various maritime sectors. AI applications hold the potential to revolutionise fisheries management, facilitate comprehensive monitoring of marine pollution, enhance predictive capabilities for climate change impacts, bolster naval security, and advance the exploration of offshore energy resources. By strategically leveraging AI, India can promote sustainable development within its maritime domain, unlock new economic opportunities, and establish itself as a global leader in the blue economy.

3.AI AND SOCIAL RESPONSIBILITY FOR SUSTAINABLE DEVELOPMENT GOALS(SDG)

The United Nations has established Sustainable Development Goals (SDGs) to be realised by 2030, aiming to ensure a sustainable future for future generations. These goals were built upon three core elements: economic development, social inclusion and participation, and environmental protection. Notably, SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 14 (Life Below Water) have direct linkages with marine and coastal ecosystems. Recognising the crucial role of oceans in economic security, particularly in sectors like fisheries, shipping, aquaculture, energy, marine biotechnology, and mineral resources, nations worldwide, including India, are formulating comprehensive strategies to promote a Blue Economy. Sustainable Development Goals entail the sustainable utilisation of ocean resources to drive economic growth, enhance livelihoods, and generate employment opportunities while preserving the health and integrity of marine environments.

International collaboration is essential for the sustainable development of oceanographic research. Numerous international organisations like the Intergovernmental Oceanographic Commission (IOC/UNESCO), Oceana, International Maritime Organization (IMO) and the Indian Ocean Tuna Commission (IOTC) are already working together across various domains. However, delays in data sharing by some countries within these collaborations hinder effective policy-making at the global level [5].

AI can significantly stream member countries' and organisations' social responsibility and SDGs. Artificial intelligence rapidly transforms the social responsibility landscape, offering powerful tools to enhance decision-making and risk mitigation. AI's predictive capabilities enable organisations to anticipate and mitigate potential social and environmental risks, such as climate change or human rights violations. Organisations can proactively identify vulnerabilities, develop targeted strategies to minimise negative impacts and foster a more sustainable and equitable future.

Transparency and explainability of AI integration to oceanographic research are essential for fostering accountability among member countries. AI decision-making processes should be interpretable, allowing for scrutiny and understanding of outcomes necessary for social responsibility as socio-economic situations vary among member countries. AI can automate numerous tasks, but human intervention is necessary to prioritise ethical considerations and mitigate potential harms. Maintaining organisational oversight is critical to establishing clear lines of responsibility and accountability for AI-driven decisions. By addressing these considerations, international collaboration can harness the transformative potential of AI while safeguarding against unintended consequences.

The next part of this article discusses some ocean domains where AI can witness initial forays into automation, but more research is needed for optimal outcomes. The early stage of accelerated integration of AI is crucial to fully realising their potential for ocean conservation and sustainable development.

3.1 AI-Driven Real-Time Fish Detection and Stock Assessment

Sustainable fisheries management and marine conservation depend on comprehensive information on fish stocks. Fish stocks are maintained with a continuous data collection, analysis, and monitoring cycle. Scientists and fisheries managers employ diverse methods to gather information on fish populations, including surveys, catch reporting, and observational data [6]. Collected data are then analysed using mathematical models to assess stock status and health, providing insights into population dynamics. Monitoring fish stocks enables the detection of temporal trends and facilitates adaptive management strategies. Effective dissemination of this information among stakeholders, including the scientific community, policymakers, and the fishing industry, is crucial for informed decision-making. Maintaining accurate and current fish stock information is essential to ensure the long-term health of marine ecosystems and support the economic viability of fisheries for future generations.

An AI 3D deep learning model that can accurately and efficiently estimate the volume and length of objects from developed robust 3D datasets. Exploring and evaluating deep learning architectures, including voxel-based, point cloud-based, and mesh-based networks, trained on large, labelled 3D datasets. The AI model can be designed to overcome the limitations of traditional methods by automating the segmentation and measurement process, ultimately providing a more precise and efficient solution for sustainable fisheries management[7].

3.2 AI-Powered Ocean Cleanup

The ubiquitous presence of plastic waste in marine environments necessitates innovative solutions. Integrating robotics and AI presents a promising pathway to address this global challenge. These technologies are being deployed in a multifaceted approach encompassing the detection, collection, and analysis of plastic pollution, facilitating efficient and scalable remediation efforts. A key strength of this approach lies in integrating sophisticated AI-powered vision systems within robotic platforms. Robots with high-resolution cameras and advanced sensors can identify plastic debris in aquatic environments, even under challenging conditions characterised by poor visibility or complex backgrounds. AI-powered image processing can scan vast areas, identify plastic hotspots, and guide the deployment of cleanup robots to regions with the highest concentrations of debris [8].

3.3 AI-Enhanced ROVs: A New Frontier in Ocean Literacy

AI is revolutionising the field of underwater robotics, particularly in the application of Remotely Operated Vehicles (ROVs). By imbuing ROVs with AI capabilities, scientists and engineers are expanding the horizons of ocean exploration. A significant advancement in this domain is the development of autonomous ROVs. These AI-powered vehicles can navigate complex underwater terrains, identify targets of interest, and collect data without continuous human intervention. These ROVs are equipped with advanced sensors and cameras to capture high-resolution images and videos, providing valuable insights into marine ecosystems [9].AI algorithms can analyse this visual data in real-time, enabling the identification of aquatic species, detecting underwater anomalies and monitoring environmental changes. This capability has far-reaching implications for diverse applications, including coral reef monitoring, underwater archaeology, and search and rescue operations.

3.4 The Power of AI: Revolutionizing Ocean Exploration

AI-powered remotely operated vehicles (ROVs) are revolutionising underwater exploration and operations across diverse domains. In marine archaeology, these ROVs employ advanced sensors and cameras to document cultural heritage sites, generating high-resolution imagery and 3D models, while AI algorithms accelerate analysis by detecting. Patterns and anomalies in collected data. They enhance search and rescue missions by navigating turbid waters, identifying submerged objects or individuals, and utilising real-time AI-driven video analysis to detect signs of life [10]. In the oil and gas sector, AI-integrated ROVs autonomously inspect and maintain subsea infrastructure, identifying structural defects and performing repairs, thereby reducing costs and improving safety [11]. Additionally, they advance marine ecosystem research by monitoring biodiversity, collecting biological samples, and analysing ecological trends through AI to assess threats to aquatic life [12]. These versatile systems reshape ocean exploration, offering unprecedented efficiency and adaptability in challenging underwater environments.

3.5 AI-Powered Drones: Revolutionise Whale Research

Crewless aerial vehicles (UAVs), or drones, are emerging as a valuable tool for non-invasive cetacean research. By piloting a drone over a whale and timing its descent to coincide with the animal's exhalation, researchers can collect

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"blow" samples containing a wealth of biological information. This method offers significant advantages over traditional approaches, providing access to data such as DNA, pregnancy and stress hormones, and microbiome composition, enabling scientists to assess whales' health and reproductive status. Furthermore, integrating high-resolution videography with blow collection allows for precise habitat mapping and individual identification, enhancing the accuracy and scope of ecological studies [13]. Integrating AI further enhances the efficacy of this technique. AI algorithms can analyse real-time video feeds to predict whale surfacing behaviour and optimise drone positioning for accurate sample collection. This synergy of aerospace technology and AI represents a significant advancement in cetacean research, facilitating safer, more efficient, and data-rich investigations.

3.6 AI-Powered AUVs: Diving Deep into Ocean Exploration

AI empowers AUVs to navigate complex underwater environments, adapt to dynamic conditions, and make real-time intelligent decisions. This enhances their ability to conduct intricate tasks such as mapping the seafloor, monitoring marine life, and collecting oceanographic data with minimal human intervention. AI algorithms enable AUVs to analyse sensor data, identify patterns, and learn from their experiences, leading to more efficient and effective data acquisition. This advancement promises to accelerate our understanding of the ocean's complex ecosystems, improve marine conservation efforts, and unlock the vast potential of the underwater world. The advancement of artificial intelligence and autonomous technologies is propelling ocean exploration into a new era of discovery [14]. AI-driven underwater vehicles and platforms are poised to revolutionise our understanding of ocean depths, enabling comprehensive mapping of underwater ecosystems, detailed studies of marine biodiversity, and critical oceanographic data collection.

3.7 AI-Powered Underwater Noise Monitoring

Implementing AI in underwater acoustic monitoring is revolutionising our understanding of marine ecosystems. By analysing complex sound environments with unprecedented precision, AI-powered systems can distinguish between natural marine sounds and anthropogenic noise, providing real-time insights into underwater noise levels, marine animal behaviours, and potential environmental disruptions. This technology empowers scientists and policymakers to develop more targeted conservation strategies, create more competent marine protected areas, minimise human-induced acoustic stress on marine life, and design quieter maritime technologies [15]. As AI advances, we can expect further breakthroughs in underwater acoustic monitoring, leading to a deeper understanding of the ocean's intricate ecosystems and promoting more sustainable marine practices.

3.8 Decoding the Ocean-Climate Code with AI

Oceans are critical in mitigating global warming by absorbing over 90% of excess heat and 20-30% of anthropogenic carbon dioxide emissions. While this buffering capacity significantly moderates atmospheric warming, climate change profoundly impacts the oceans. One of the most evident consequences is sea level rise, driven by thermal expansion of warming water and glaciers and ice sheets melting, resulting in a substantial increase in sea levels over recent decades. Ocean acidification, a consequence of increased carbon dioxide absorption, is another significant impact of climate change on marine environments. This increased acidity seriously threatens marine organisms, particularly calcifying organisms such as corals and shellfish [16].

Accurate weather forecasting is undeniable, especially in a changing climate. Enhancing our understanding of ocean-atmosphere interactions is crucial for improving the accuracy of weather and climate predictions. Furthermore, increased ocean data acquisition will contribute to more reliable forecasts. Therefore, oceanographic research, particularly with the integration of AI technologies, is of paramount importance in the current era. AI can facilitate the analysis of complex oceanographic data, leading to improved understanding of ocean processes and enhanced predictive capabilities [17].

3.9 AI-Powered Intelligent LiDAR: A New Vision for Ocean Research

LiDAR technology, integrated with AI, is revolutionising oceanographic research by enhancing underwater sensing and analytical capabilities. AI algorithms automatically classify objects, such as coral species, marine fauna, and underwater structures, within LiDAR point clouds while filtering noise to improve 3D model accuracy in challenging conditions like turbid waters. Real-time processing enables adaptive survey strategies, allowing autonomous underwater vehicles (AUVs) to adjust paths dynamically based on instantaneous seafloor analysis. AI-driven predictive models utilise LiDAR data to forecast coastal erosion, invasive species distribution, and climate change impacts on marine ecosystems. This integration of high-resolution LiDAR mapping with AI analytics accelerates data interpretation, supports informed conservation decisions, and advances marine resource management. The combined technologies offer transformative potential for efficient ocean monitoring, enabling deeper environmental insights and driving discoveries in underwater exploration [18].

4. CONCLUSION

In conclusion, integrating artificial intelligence (AI) into sustainable management practices for ocean and marine ecosystems offers a transformative approach to addressing these vital environments' complex challenges. The international community recognises the urgent need to prevent uncontrolled exploitation of ocean resources that could lead to significant environmental disasters. Given the interconnected nature of the marine environment, ocean protection necessitates international cooperation. Integrating artificial intelligence into marine sciences revolutionises ocean exploration, conservation, and sustainable management. AI is transforming our understanding, safety, and utilisation of marine resources, from the ocean depths to its surface. This synergy between AI and sustainability empowers stakeholders— from policymakers to local communities—with actionable insights and fosters innovative solutions such as autonomous marine monitoring systems, precision aquaculture, and ecosystem restoration strategies. However, successfully implementing AI-driven approaches requires careful consideration of ethical, technical, and accessibility challenges to ensure equitable benefits for all human populations dependent on marine resources. As we move forward, interdisciplinary collaboration and continuous advancements in AI technology will be essential to safeguarding the health of ocean ecosystems, securing their services for future generations, and reinforcing the intricate bond between humanity and the marine world.

REFERENCES

[1] World Ocean Day. (n.d.). 2024 annual report. Retrieved December 12, 2024, from https://worldoceanday.org/resources/2024-annual-report/

[2] Gazette Kerala. (n.d.). Government of Kerala 2023. Retrieved December 13, 2024, from https://fisheryprogress.org/sites/default/files/documents_actions/MLS%202023%282%29.pdf

[3] Handbook on Fisheries Statistics 2022. (n.d.). Retrieved January 21, 2025, from https://dof.gov.in/sites/default/files/2023-08/HandbookFisheriesStatistics19012023.pdf

[4] India's Blue Economy: A draft policy framework. (n.d.). Retrieved December 24, 2024, from https://incois.gov.in/documents/Blue_Economy_policy.pdf

[5] SGD Progress Report 2024. (n.d.). Retrieved January 24, 2024, from https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf

[6] Dal Toé, S. G., Neal, M., Hold, N., Heney, C., Turner, R., McCoy, E., ... Tiddeman, B. (2023). Automated video-based capture of crustacean fisheries data using low-power hardware. Sensors, 23(18), 7897. doi:10.3390/s23187897

[7] Hao, Y., Yin, H., & Li, D. (2022). Using computer vision, a novel method of fish tail fin removal for mass estimation. Computers and Electronics in Agriculture, 193, 106601. doi:10.1016/j.compag.2021.106601

[8] Ji, C.-Y., Guo, J.-T., Ye, R.-C., Yin, Q.-L., Xu, W.-Y., & Yuan, Z.-M. (2022). Experimental study of an ocean surface cleaning system. Ocean Engineering, 249, 110937. doi:10.1016/j.oceaneng.2022.110937

[9] Agarwala, N. (2023). Using robotics to achieve ocean sustainability during the exploration phase of deep seabed mining. Marine Technology Society Journal, 57(1), 130–150.

[10] Joshi, R., Usmani, K., Krishnan, G., Blackmon, F., & Javidi, B. (2024). Underwater object detection and temporal signal detection in turbid water using 3D-integral imaging and deep learning. Optics Express, 32(2), 1789–1801. doi:10.1364/OE.510681

[11] S., G., & Chitra, M. P. (2015). Applications of sea gliders in ocean observation systems. In 2015 IEEE Underwater Technology (UT) (pp. 1–3). IEEE. doi:10.1109/UT.2015.7108264

[12] Cretella, A., Scherer, C., & Holm, P. (2023). Tasting the ocean: How to increase ocean literacy using seafood heritage with a visceral approach. Marine Policy, 149, 105476. doi:10.1016/j.marpol.2023.105476

[13] Bierlich, K. C., Karki, S., Bird, C. N., Fern, A., & Torres, L. G. (2024). Automated body length and body condition measurements of whales from drone videos for rapid assessment of population health. Marine Mammal Science, 40(4), e13137. doi:10.1111/mms.13137

[14] Wang, J., & Li, T. (2024). Guest editorial special issue on AI-powered planning and control of autonomous marine vehicles. IEEE Transactions on Systems, Man, and Cybernetics: Systems. doi:10.1109/TSMC.2024.3470830

2025, 10(34s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

[15] Bahmei, B., Birmingham, E., & Arzanpour, S. (2022). CNN-RNN and data augmentation using deep convolutional generative adversarial network for environmental sound classification. IEEE Signal Processing Letters, 29, 682–686. doi:10.1109/LSP.2022.3150258

[16] YesuJyothi, Y., Shaik, S., & Venkateswarlu, Y. (2024). Enhancing climate analysis with integrated data and transparent AI methods via stochastic processes. In 2024 8th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) (pp. 1570–1576). IEEE. doi:10.1109/I-SMAC61858.2024.10714600

[17] Satish, M., Prakash, Babu, S. M., Kumar, P. P., Devi, S., & Reddy, K. P. (2023). Artificial intelligence (AI) and the prediction of climate change impacts. In 2023 IEEE 5th International Conference on Cybernetics, Cognition and Machine Learning Applications (ICCCMLA) (pp. 660–664). IEEE. doi:10.1109/ICCCMLA58983.2023.10346636

[18] Sun, J., Dai, Y., Zhang, X., Xu, J., Ai, R., Gu, W., & Chen, X. (2022). Efficient spatial-temporal information fusion for LiDAR-based 3D moving object segmentation. In 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 11456–11463). IEEE