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Harnessing GPS Technology for Sustainable Livelihoods: Evidence from Small-Scale Fisheries in Car Nicobar Island, Bay of Bengal

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Abstract

This study aimed to assess the impact of Global Positioning Systems (GPS) devices distributed as fishing inputs and their noted improvements in fishing efficiency among the tribal fishermen of Car Nicobar. A questionnaire was designed to collect data on socio-economic factors, fishing practices before and after the intervention, and perceptions towards the technology (N= 32). A paired Student's t-test was employed to evaluate significant changes attributable to GPS adoption. The results revealed that use of GPS devices enabled the fishermen to navigate a significant additional 3.20±1.36 kilometers from shore and operate at depths up to 200 meters, representing a 64% improvement over conventional methods. The average number of fishing trips increased significantly from 11±1.85 to 18±2.36 per month, with 88% of fishermen reporting enhanced confidence in navigating and returning safely. Economic analysis showed a significant net profit gain of ₹16,244± 90.15 per trip, nearly threefold higher than prior earnings, with a benefit-cost ratio (2.6), indicating strong economic viability. Beneficiaries also recognized increased fishing efficiency, and ease of navigation as key benefits. The results of the study demonstrate that integrating GPS technology with targeted training and user-centered improvements can substantially enhance the productivity, safety, and livelihoods of Nicobarese tribal fishermen in remote Car Nicobar Island.

Key words: *GPS technology, fishing efficiency, Car Nicobar, small-scale fisheries, economic impact*

Introduction

The tropical archipelago of Andaman and Nicobar harbours some of the abundant fishery diversity (ANDFISH 2005; Roy and George, 2010; Advani *et al.,* 2013) that is vital to the livelihoods of island fishing communities of Andaman and Nicobar (George *et al.,* 2011; 2014; Kiruba-Sankar *et al.,* 2021; 2013). Technologies to augment the marine fish catches, such as Potential Fishing Zones (PFZ) (Geroge *et al.,* 2011) and improvised PFZ advisories (Roy *et al.,* 2009; Arur *et al.,* 2020) were validated in the Andaman and Nicobar Islands to enhance fish catches. Among other alternatives, one such cost-effective practice is the use of Global Positioning System (GPS) technology in fisheries management that has demonstrated to reduce search time, fuel consumption, and operational expenses while significantly improving catch efficiency (Kiruba-Sankar *et al.,* 2020). Marking their traditional fishing grounds and new alternative grounds and ease in future navigation has extended benefits for the fishermen in open sea conditions. Despite growing global interest in GPS adoption among artisanal fishermen, limited studies have specifically examined the socio-economic impacts and technology acceptance in isolated island contexts, such as Car Nicobar, Andaman and Nicobar Islands (Kiruba-Sankar *et al.,* 2020). This Island is characterised by diverse marine ecosystems and traditional fishing practices, making it an ideal setting to assess the potential benefits and limitations of GPS-enabled fishing (Kiruba-Sankar *et al.,* 2019; Ravikumar *et al.,* 2015;2016).

With in context, the present study examines the adoption of Global Positioning System (GPS) devices provided as fishing inputs by beneficiary fishermen in Car Nicobar, focusing on changes in fishing practices, economic returns, and user experiences within a *before-and-after* intervention framework. By integrating quantitative performance metrics with qualitative insights, the study offers a comprehensive assessment of the role of GPS technology in enhancing fish catches in Car Nicobar Island among the users. The findings are intended to guide policymakers and development agencies in refining technology transfer mechanisms and promoting sustainable livelihood outcomes among island fishing communities in a fragile ecosystem like Car Nicobar (Fig 1).

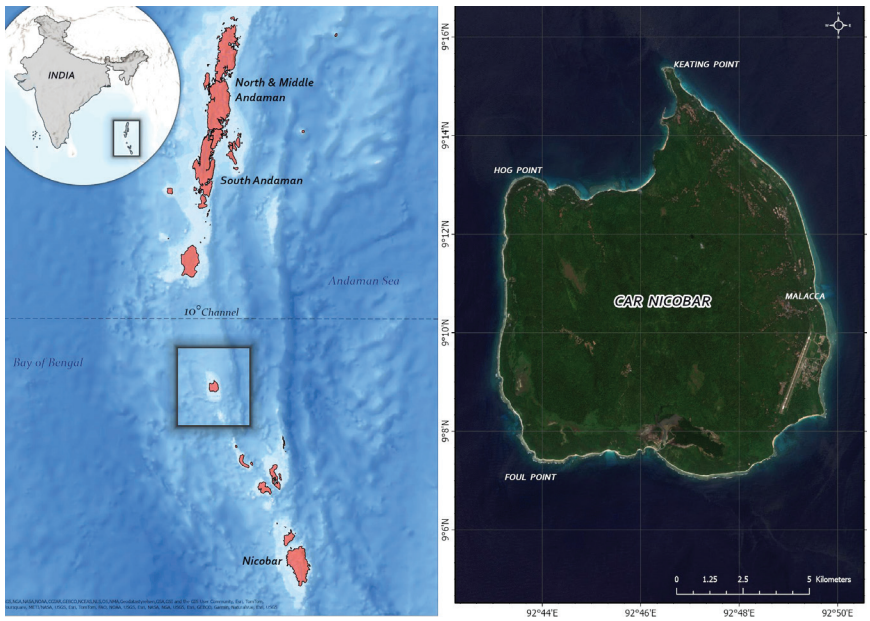

Fig. 1: Location of Car Nicobar Island in the Nicobar archipelago, Bay of Bengal

Methodology

A survey involving 32 beneficiary fishermen from Car Nicobar was conducted between June and August 2025 to evaluate the impact of GPS device utilisation provided under an intervention scheme. Beneficiary fishermen were defined as individuals who received GPS devices as inputs aimed at enhancing their fishing and navigational efficiency. Data were collected using a *before-and-after* framework to capture changes directly attributable to the intervention. Information on socio-economic characteristics, fishing practices prior to and following GPS adoption, and fishermen's perceptions of the technology's contribution to fishing efficiency was gathered through a structured questionnaire. Necessary trainings and field demonstrations were also initiated among the tribal fishermen to understand the application of GPS in marking way points and navigation in open sea conditions. The paired Student's *t*-test was employed to determine the statistical significance of observed differences before and after the intervention.

Results and Discussion

Enhanced Fishing Efficiency and Economic Gains

The comparative analysis between fishing practices before and after the adoption of GPS technology, highlighted in Table. 1 reveals a striking transformation in both operational efficiency and economic performance of beneficiary fishermen in Car Nicobar. The results indicate that the introduction of GPS significantly enhanced the tribal fishermen's navigational capability, enabling them to venture farther from the shore (from 4.7 km to 7.9 km) and undertake fishing at greater depths (from 133.12 m to 218.75 m). Correspondingly, the average number of fishing trips per month increased substantially from 11 to 18, reflecting a higher level of fishing activity and better utilization of time due to reduced search efforts. Although the fishing duration per trip increased marginally, it was offset by the efficiency gained through precise location tracking and associated reduction in operational costs.

From an economic perspective, the adoption of GPS led to significant improvement in returns and profits, despite a marginal rise in operational costs. Monthly income nearly doubled (Rs. 12,208 to Rs. 28,826), while net profits rose almost threefold (Rs. 8,270 to Rs. 24,514), underscoring the strong economic advantage of GPS-assisted fishing. The slight increase in craft size further suggests adaptive investment behaviour among fishermen, who were willing to upgrade their vessels to exploit offshore opportunities.

Table 1: Impact of GPS technology on fishing efficiency in Car Nicobar

Parameter	Without GPS Mean ± Std. error	With GPS Mean ± std. error	Change/Trend Mean (% change)	Remarks
Fishing Distance from Shore (km) *	4.70±1.46	7.90± 1.82	↑ 3.20±1.36 km (+68%)	GPS-enabled navigation allowed fishermen to explore distant fishing grounds confidently.
Depth of Fishing (m) *	133.12±11.30	218.75±14.06	↑ 85.63±8.51 m (+64%)	GPS facilitated access to productive fishing zones.
Fishing Time (hours/trip)	4.17±1.51	4.61±1.76	↑ 0.44±1.56 hr (+11%)	Minor increase due to extended navigational range and exploration time.
Fishing Trips (per month) *	11±1.85	18±2.36	↑ 7±2.06 trips (+64%)	Improved efficiency and reduced scouting time
Costs (Rs/ month) *	3,938±48.25	4,312±47.92	↑ Rs. 374±17.21 (+9%)	Slight operational cost rise due to longer trips and fuel use.
Returns (Rs/ month) *	12,208±87.66	28,826±117.23	↑ Rs. 16,618± 89.87 (+136%)	A substantial increase in income reflects better catches
Profits (Rs/ month) *	8,270±82.21	24,514±111.03	↑ Rs. 16,244± 90.15 (+196%)	Nearly threefold rise in profit- demonstrating strong economic gains post-GPS adoption.

*Indicates significant difference at 5 percent level of significance

The implementation of GPS technology resulted in a notable surge in fishing activity, with the average frequency of fishing trips escalating from 11 to 18 per month. This increase meant that 88% of fishermen felt surer about finding good fishing spots and getting back safely, showing how GPS improved their navigation and safety while fishing. Thus, the adoption of GPS enhanced catch efficiency, allowing fishermen to optimize their harvest per trip, minimizing wasted effort and search time for fish-abundant areas. Fig. 2 shows the variation in monthly profits of fishermen before and after the adoption of GPS technology from Car Nicobar. A positive trend in profit levels is evident across almost all respondents, demonstrating the substantial economic benefits brought by GPS-assisted fishing. Before the intervention, profits remained modest and relatively stagnant, averaging around Rs. 8,000 per month. After adoption, profit levels rose sharply, with several fishermen earning more than Rs. 30,000–60,000 per month. Although a few respondents exhibited moderate increases, the overall trend reflects a significant enhancement in economic performance, reduced variability in returns, and improved fishing efficiency attributed to the technology intervention.

Fishermen's Perception and Capacity Building towards Effective Use of GPS Technology

Family (50 %) and peer networks (33%) served as the dominant channels of awareness, while institutional sources contributed marginally to technology dissemination. The beneficiaries recognised that GPS technology had a significant positive impact on their fishing efficiency and opened new avenues for income enhancement. Most of the fishermen (66%) had a general awareness of GPS technology prior to this intervention (Kiruba-Sankar et al., 2020); however, hands-on training played a crucial role in improving their understanding of its specific applications in fishing operations. This observation aligns with the findings of Tilley *et al.* (2019), who emphasized the importance of capacity building in maximizing the benefits of GPS use for efficient and sustainable fishing. The present study also revealed that the beneficiaries perceived GPS as a user-friendly and reliable technology that enhanced safety, navigation accuracy, and overall operational confidence during fishing excursions.

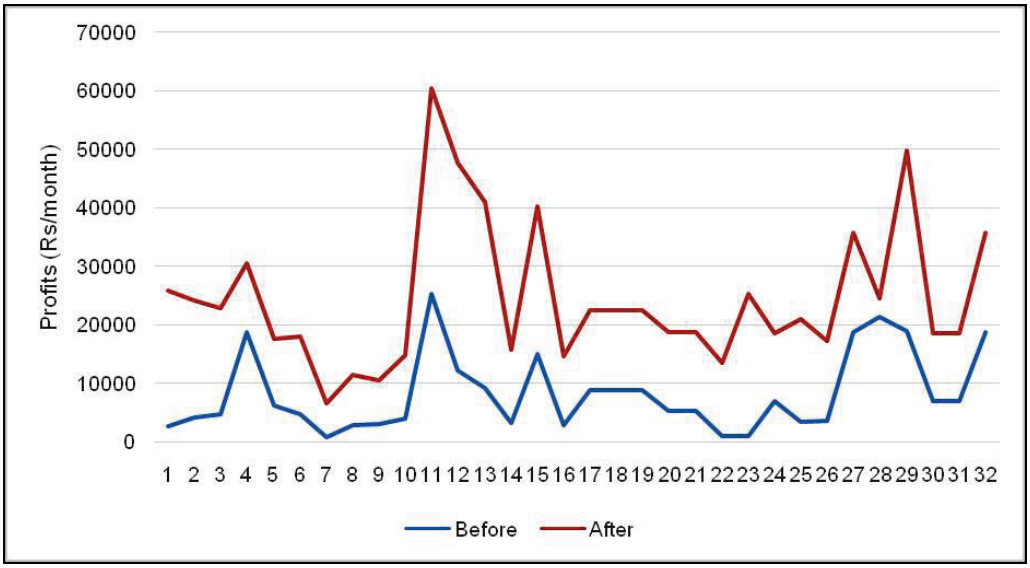

Fig. 2: Monthly profits of fishermen before and after adoption of GPS technology (N = 32).

Enhancing GPS Utility and Promoting Sustainable Fisheries through Technological and Institutional Support

Among the several advantages in use of GPS, tribal fishermen highlighted fuel savings owing to optimized and accurate navigational routes and the ability to access historical fishing data as the most valuable features. Similar benefits were noted by Kiruba-Sankar *et al.,* 2020 in their previous interventions at Car Nicobar Island and found that GPS use minimizes search time and total fishing time, thereby conserving energy and improving economic returns. Nicobarese fishermen also provided several practical suggestions to further enhance the utility of GPS devices, such as incorporating depth measurement and area scanning features, improving information delivery in local languages, and ensuring longer battery life with rechargeable options and larger display screens for ease of use. The study in Car Nicobar Island highlights that collaborative efforts among government agencies, international research organisations, NGOs, and the private sector are crucial to promoting the wider adoption of GPS and similar low-cost technological innovations that can enhance the marine fishing sector. Targeted interventions focusing on infrastructure development, capacity building, localized training, and financial incentives will help overcome existing financial, technical, and institutional barriers, thereby promoting sustainable fisheries development and enhancing the livelihoods of small-scale fishermen in developing coastal regions.

Conclusion

Our results demonstrated that the provision of GPS devices significantly enhanced the fishing efficiency, safety, and navigational capability of tribal fishermen in Car Nicobar, enabling them to extend their operational range and achieve higher catch rates. Tribal beneficiaries expressed positive perceptions of the technology, attributing improvements in navigation accuracy, fuel savings, and overall fishing reliability to the use of GPS. Overall, the findings underscore the importance of combining technological inputs with hands-on training and institutional support to sustainably improve productivity, profitability, and livelihood resilience in remote island fishing communities of Car Nicobar.

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Ethics statement

Entry into the Car Nicobar Island is regulated under The Andaman and Nicobar Islands (Protection of Aboriginal Tribes) Regulation, 1956. The authors fulfilled the requirements to visit Car Nicobar Island to undertake surveys. Informed verbal consent was obtained from the respondents before the surveys, and explained the purpose, the type of questions they would encounter, and how their responses would be used, including the confidentiality of the respondents who provided the information. Considering the low literacy levels of the respondents, written consent was not obtained, whereas verbal consent was taken from the respondents before the personal interviews. All engagements were carried out respectfully, following local customs and community protocols.

References

Advani S, Sridhar A, Namboothri N, Chandi M, Oommen MA (2013) Emergence and transformation of marine fisheries in the Andaman Islands. Dakshin Foundation and ANET, p 50

ANDFISH (2005) Draft roadmap for the development of Fisheries in Andaman and Nicobar Islands, p 87

Arur A, Krishnan P, Kiruba-Sankar R, Suryavanshi A, Kumar KL, Kantharajan G, Choudhury SB, Manjulatha C, Babu DE (2020) Feasibility of targeted fishing in mesosclae eddies: a study from commercial fishing grounds of Andaman and Nicobar Islands, India. *International Journal of Remote Sensing.* 41:14, 5011-5045

Behivoke, F., Etienne, M. P., Guitton, J., Randriatsara, R. M., Ranaivoson, E. and Léopold, M., 2021. Estimating fishing effort in small-scale fisheries using GPS tracking data and random forests. *Ecological indicators* 123: 107321. https://doi.org/10.1016/j.ecolind.2020.107321

George, G., Krishnan, P., Kamal-Sarma, K., Kiruba-Sankar, R., Goutham-Bharathi, M. P., Kaliyamoorthy, M., Krishnamurthy, V. and Kumar, T. S., 2011. Integrated potential fishing zone (IPFZ) forecasts: a promising information and communication technology tool for promoting green fishing in the islands. *Indian Journal Agricultural Economics*, 66(3): 513–519.

George, G., Sarma, K., Bharathi, G., Kaliyamoorthy, M., Krishnan, P. and Kiruba-Sankar, R., 2014. Efficacy of different modes in disseminating potential fishing zone (PFZ) forecasts-a case study from Andaman and Nicobar Islands. *Indian Journal of Fisheries*, 61(1): 84–87.

Kiruba-Sankar, R., Krishnan, P., George, G., Kumar, K. L., Angel, J. R. J., Saravanan, K. and Roy, S. D., 2021. Fisheries governance in the tropical archipelago of Andaman and Nicobar—opinions and strategies for sustainable management. *Journal of Coastal Conservation* 25,16. https://doi.org/10.1007/s11852-021-00808-5

Kiruba-Sankar, R., Kumar, K. L., Angel, J. R. J., Salim, S. S., Saravanan, K., Krishnan, P., Ravikumar, T. and Roy, S. D., 2020. Impact evaluation of marine fisheries interventions among tribal fisher commune of Car Nicobar Island, India. *Journal of the Marine Biological Association of India*, 62(1): 84–89. https://doi.org/10.6024/jmbai.2020.62.1.2065-11

Kiruba-Sankar, R., Kumar, K. L., Saravanan, K. and Praveenraj, J., 2019. Poaching in Andaman and Nicobar coasts: insights. *Journal of Coastal Conservation*, 23: 95–109. https://doi.org/10.1007/s11852-018-0640-y

Kiruba-Sankar, R., Haridas, H., Pandey, S.K., George, Z., Saravanan, K., Gladston, Y., Praveenraj, J., Ajina, S.M., 2023. The Nicobarese tribes and their coastal fishing activities during the COVID-19 pandemic-related restrictions- preliminary findings. *Journal of Coastal Conservation,* 27,11. https://doi.org/10.1007/s11852-023-00942-2

Ravikumar, T., Krishnan, P., Ram, N., Sankar, R. K., Roy, S. D., Ahmed, S. K. Z. and Neethiselvan, N., 2015. Hodi, a traditional craft of Nicobari tribe. *Indian Journal of Traditional. Knowledge*, 1(1): 161–168.

Ravikumar, T., Ram, N., Krishnan, P., Sankar, R. K., Sachithanandam, V. and Roy, S. D., 2016. Subsistence fishing methods of Nicobari tribes using traditional knowledge. *Journal of Marine and Island Cultures*, 5: 79–87. https://doi.org/10.1016/j.imic.2016.05.002

Roy SD, George G (2010) Marine resources of islands: status and approaches for sustainable exploitation/ conservation with special emphasis to Andaman and Nicobar. *Indian Journal Animal Sciences* 80(4):57–62

Roy SD, Krishnan P, Sarma K, George G (2009) Development of island fisheries. Central Agricultural Research Institute, Port Blair, p 122

Tilley, A., Hunnam, K. J., Mills, D. J., Steenbergen, D. J., Govan, H., Alonso-Poblacion, E., Matthew, R., Pereira, M., Pedro, R., Amador, T., Duarte, A., Gomes, M. and Cohen, P. J., 2019. Evaluating the fit of co-management for small-scale fisheries governance in Timor-Leste. *Frontiers in Marine Science,*, 6: 392. https://doi.org/10.3389/fmars.2019.00392

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