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Use of Artificial Intelligence Tools for Improved Reservoir Management by Fishing Cooperative Societies

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Summary

Reservoir fisheries provide food, employment and livelihood opportunities to fishing cooperative societies, but effective management is often constrained by limited field staff, irregular monitoring, fragmented records, changing water conditions, fish mortality, illegal fishing, weak market intelligence and delays in decision-making. Artificial Intelligence (AI) tools can strengthen cooperative-based reservoir management by converting field observations, water-quality measurements, photographs, geographic information, catch records and market data into timely management information. This article presents a practical framework for using AI in reservoir fisheries management by fishing cooperative societies. The proposed methodology combines mobile data collection, geographic information system (GIS) mapping, AI-assisted water-quality interpretation, image-based fish and gear identification, catch forecasting, stocking support, anomaly detection, market intelligence and automated reporting. A model cooperative workflow is described for routine monitoring, decision-making and record keeping. The approach is designed to support, rather than replace, fisheries officers and cooperative members.

Expected results include improved monitoring coverage, faster detection of abnormal conditions, better stocking and harvest planning, improved transparency in cooperative records and more efficient marketing. The article concludes that responsible and affordable AI adoption, supported by local training, standard data formats and human verification, can transform reservoir management from reactive decision-making to data-driven, participatory and sustainable fisheries management.

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Introduction

Reservoirs are important inland fisheries resources in India and support capture fisheries, culture-based fisheries and livelihood activities. Fishing cooperative societies are often responsible for organizing fishing operations, distributing fishing rights or benefits, maintaining records and supporting the welfare of fisher members. However, reservoir ecosystems are dynamic. Water level, temperature, dissolved oxygen, transparency, nutrient conditions, fish recruitment, fishing pressure and market demand can change rapidly. Management decisions based only on periodic manual observations may therefore be delayed or incomplete.

Artificial Intelligence refers to computer-based methods that can identify patterns, classify information, generate predictions and support decisions from data. In fisheries, AI can be applied to images, time-series water-quality data, catch records, spatial information and market information. Machine learning is a branch of AI in which algorithms learn patterns from data and use them for prediction or classification. When combined with mobile applications, sensors, geographic information system (GIS) platforms and cloud-based databases, AI can provide practical decision-support services to fishing cooperative societies.

The objective of this article is to propose a simple, scalable and field-oriented AI framework for improving reservoir management among fishing cooperative societies. The framework emphasizes low-cost tools, local participation, data quality and human validation so that AI becomes a practical management aid rather than a technically complex system.

Methodology

Identification of Management Requirements

The first step is to identify the major management functions of a cooperative society. These include reservoir mapping, water-quality monitoring, fish stocking and seed management, fishing-effort recording, catch documentation, fish mortality reporting, identification of illegal or destructive fishing practices, infrastructure monitoring, marketing and preparation of monthly or seasonal reports. Each function is converted into a digital data requirement.

Digital Data Collection

A mobile phone can be used as the primary field data-collection device. Cooperative members or authorized staff can record date, location, water level, water temperature, dissolved oxygen, pH, transparency, weather conditions, fishing effort, species composition, catch quantity, gear used and unusual observations. Photographs can be attached to records. Global Positioning System (GPS) coordinates may be captured automatically, subject to privacy and administrative rules.

A standard digital form should be used throughout the cooperative. Species names should follow accepted scientific nomenclature and common local names may be retained as secondary fields. Data should be stored with unique identifiers for the reservoir, cooperative, fishing unit and observation date. This creates a consistent historical database for AI analysis.

AI-Assisted Water-Quality Monitoring

AI can analyse time-series water-quality data and identify unusual combinations or trends. For example, a sudden reduction in dissolved oxygen combined with high temperature and abnormal fish behaviour may generate an early warning for possible stress or mortality. The system can classify observations into normal, watch and alert categories. AI-generated alerts should always be verified by a fisheries officer or trained

cooperative representative before operational action is taken.

Image-Based Fish and Activity Identification

Photographs collected through mobile devices can be analysed using computer vision models. Computer vision is an AI technique that extracts information from images. It can assist in identifying commonly encountered fish groups, estimating fish size classes, documenting fish mortality, recognizing damaged nets or identifying selected fishing activities. Such systems should initially be trained and tested using locally collected, correctly labelled images because reservoir conditions, fish species and photographic quality vary between regions.

GIS-Based Reservoir Mapping

GIS can integrate reservoir boundaries, fishing zones, stocking locations, access routes, landing centres, protected or no-fishing areas and water-quality observation points. AI can then assist in identifying spatial patterns such as areas of repeated low dissolved oxygen, high fishing pressure or frequent fish mortality. A simple digital map can help cooperative societies plan patrols, sampling and fishing operations.

Catch Forecasting and Fishing-Effort Management

Historical catch data can be used to develop predictive models. Variables may include reservoir water level, season, fishing effort, species composition, stocking history, environmental observations and previous catch per unit effort. Catch per unit effort (CPUE) is the quantity of fish caught relative to a defined unit of fishing effort. AI-based forecasting can help cooperatives estimate expected catch trends and plan harvesting, labour, ice, transport and market arrangements. Forecasts should be treated as decision-support estimates and not as guaranteed production figures.

Stocking and Resource Management Support

AI can support stocking decisions by combining reservoir area, water availability, historical productivity, previous stocking and catch information, and environmental observations. The system can identify reservoirs or zones requiring closer assessment before stocking. It can also maintain digital records of species, number or biomass stocked, stocking date and source of seed. Final stocking decisions should remain under the applicable fisheries management protocol and technical supervision.

Market Intelligence

A cooperative can maintain daily or weekly records of species-wise catch, local demand, selling price, transport cost and unsold quantity. AI-assisted analysis can identify seasonal price patterns and help estimate the most suitable time and channel for marketing. It can also generate simple summaries for cooperative members, reducing dependence on manually prepared records.

Automated Reporting and Decision Dashboard

A digital dashboard can combine reservoir status, water-quality alerts, catch trends, stocking records, fishing effort and market information. AI can prepare draft weekly or monthly summaries in simple English or Marathi for review by the cooperative and fisheries department. Automated reports can reduce repetitive clerical work and improve transparency. The final report should be approved by an authorized person before official use.

Proposed AI-Based Cooperative Management Workflow

Table 1. Proposed applications of AI and digital tools in cooperative-based reservoir fisheries management.

Management Activity	Data Input	AI / Digital Function	Management Output
Water-quality monitoring	Temperature, dissolved oxygen, pH, transparency	Trend and anomaly detection	Early-warning alert
Fish observation	Photographs and field observations	Image classification / documentation	Species or mortality screening
Fishing operations	Catch, effort, gear, location	Catch and CPUE analysis	Fishing-effort planning
Stocking	Reservoir area, history, seed details	Data comparison and decision support	Stocking assessment
Reservoir surveillance	GPS points, photographs, incidents	GIS mapping and pattern analysis	Priority areas for inspection
Marketing	Species, quantity, price, demand	Trend analysis and forecasting	Marketing plan
Reporting	All cooperative records	Automated summary generation	Draft periodic report

Expected Results

The proposed framework is expected to produce measurable improvements in reservoir management. First, digital records can increase the frequency and consistency of field observations. Second, AI-assisted anomaly detection can shorten the time between detection of an abnormal condition and field verification. Third, systematic catch and effort records can improve understanding of fishing pressure and seasonal productivity. Fourth, digital stocking records can support better comparison of stocking inputs with subsequent fishery performance.

Fifth, GIS-based information can help cooperatives and fisheries authorities identify priority areas for sampling, surveillance and management intervention. Sixth, market analysis can support better harvest scheduling and reduce avoidable post-harvest losses. Seventh, automated report generation can reduce clerical workload and provide a common information base for cooperative meetings and departmental review. Finally, transparent digital records can strengthen accountability by documenting stocking, fishing operations, catch, sales and management decisions.

Suggested Performance Indicators

Implementation should be evaluated using practical indicators rather than only the number of AI tools installed. Suggested indicators include: percentage of scheduled observations completed; percentage of observations with valid GPS and date information; response time to water-quality alerts; number of verified fish mortality incidents; completeness of stocking and catch records; change in CPUE over time; reduction in reporting time; percentage of cooperative members trained; proportion of AI alerts verified correctly; and change in post-harvest or marketing losses. Baseline values should be established before implementation and compared with results after six and twelve months.

Challenges and Safeguards

AI implementation in cooperative fisheries may face challenges such as poor internet connectivity, limited digital literacy, incomplete historical data,

inconsistent species identification, sensor maintenance and the cost of digital infrastructure. These challenges can be addressed through offline-capable mobile forms, simple user interfaces, periodic data validation, local language training and phased implementation.

AI outputs should not be treated as final scientific or administrative decisions. False alerts and incorrect classifications are possible, particularly when training data are limited. Human verification by trained fisheries personnel is therefore essential. Data ownership, access control, privacy, cybersecurity and responsible sharing must be defined before deployment. Personal information of fishers should not be collected unless necessary, and only authorized users should access sensitive operational information.

Implementation Strategy for Fishing Cooperative Societies

A phased approach is recommended. Phase I should establish digital records and train selected cooperative members. Phase II should introduce water-quality dashboards, GIS mapping and catch-effort analytics. Phase III should add image-based identification, predictive models and market intelligence after sufficient local data have accumulated. Phase IV should integrate cooperative dashboards with departmental monitoring and reporting systems, subject to government policy and technical feasibility.

For each reservoir, a small trained team may be designated as a Digital Fisheries Management Team. The team can conduct routine observations, verify AI alerts, maintain equipment and present monthly findings to the cooperative. Fisheries officers can provide technical supervision, periodic validation and capacity building. This cooperative-government partnership is important because AI performs best when the underlying field data are accurate and locally relevant.

Conclusion

Artificial Intelligence offers an important opportunity to improve reservoir fisheries management through timely analysis of water quality, catch, fishing effort, spatial information, images and market data. For fishing cooperative societies, the most useful application is not highly complex automation but simple decision-support systems that improve routine monitoring, early warning, planning, record keeping and communication. A phased model based on mobile data collection, GIS, AI-assisted analytics and human verification can be implemented even in resource-constrained settings. The success of such systems will depend on reliable field data, training of cooperative members, technical support from fisheries authorities and responsible use of AI. Properly implemented, AI can help fishing cooperative societies move toward more transparent, efficient, participatory and sustainable management of reservoir fisheries.

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