eMatsya – An Innovative Data Acquisition System To Collect Fish Catch Data From Reservoirs And Other Inland Water Bodies

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Abstract: Collection of real-time fish catch data from inland water bodies of India has been a huge challenge for a multiplicity of factors – a large number of inland water resources and their scatter being the most important among other things. To overcome this problem, making use of mobile communication technology, an Electronic Data Acquisition System (eDAS) was developed along with an Android Application - eMatsya that was implemented on smart mobile phones of fishery friends (knowledgeable fishers who could send data using eMatsya) to collect fish catch data from inland water bodies. The data sent by fishery friends using eMatsya would get populated in the database MySQL in the webserver. Trial-implementation of eMatsya in selected reservoirs of Karnataka and Jharkhand (Indian states) not only yielded promising results but also proved that the scaling-up of this eDAS implementation is easy and when done at the national level would result in a continuous flow of authentic information on inland fish catch data. The eMatsya would significantly reduce the time, cost of collection of data and would facilitate in developing a database of the inland fish catch of the Indian reservoirs.

Index Terms: Fish catch data, mobile communication, smartphones, Android application, eMatsya, reservoirs, inland fisheries

1. INTRODUCTION

India is bestowed with bountiful of inland water resources. The main inland fishery resources are shown in Table 1.

Table 1. *Inland Fisheries Resources of India*

Inland Resources	
Rivers & Canals (km)	*195210*
Reservoirs (million ha)	*3.510*
Tanks & Ponds (million ha)	*2.414*
Floodplain & Derelict Water Bodies (million ha)	*1.200*
Brackishwater (million ha)	*1.240*
Saline / Alkaline Affected Area (million ha)	*1.200*

Source: (Anon, 2012; CWC, 2016; Sarkar and Mishal, 2017)

The estimated total fish production in India during 2017-18 was 12.6 million tonnes and the contribution of the inland sector in this was nearly 65% (NFDB 2019). It clearly proves the importance of the inland sector in the overall fishery of the country. Further, within the inland fishery sector, the reservoir fishery holds a lot of promise in future vis-a-vis riverine fishery because of the rapid environmental degradation of rivers due to burgeoning industrialisation and developmental activities all along the rivers.

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Incidentally, multi-purpose reservoirs are construed to be very important for hydro-electric power generation, irrigation and flood control, but fisheries in such reservoirs are not fully appreciated - especially their economic use (De Silva and Amarasinghe 1996; P. Dugan et al. 2007; P. J. Dugan et al. 2010; Lymer and Funge-Smith 2009). Nevertheless, reservoir fisheries and aquaculture activities taken up in such impoundments give alternative employment opportunities for the people who get displaced after reservoir construction projects are over (Costa-Pierce, B. Soemarwoto 1990; Abery et al. 2005; Gurung et al. 2010). So, more focus should be given to reservoir fisheries for achieving fish yield optimisation by adopting suitable management measures and community participation. Lack of proper fisheries management in any water body leads to overfishing, results in depletion of fish stocks and also damages the ecosystem (Jackson et al. 2001). For effective reservoir fisheries management, several technical/extension bulletins have been published by ICAR-CIFRI (http://www.cifri.ernet.in). However, for sustainable exploitation of the fish production potential from reservoirs, development and deployment of innovative technologies were developed for assessing fish yield, production potentials, habitat and biodiversity assessment of the reservoirs (Jhingran et al. 1988; Cowx 1994; Tyagi and Mandal 2008; DeSilva 2015; NFDB 2016), no such attempt has so far been made on use of electronic devices/mobile apps to estimate inland fish catch from the reservoirs. To achieve sustainable fish production and conservation of resources, the data on fish yields, fish assemblages and diversity of the reservoirs need to be collected and assessed periodically for developing guidelines (Sarkar et al. 2018). The task of estimating the fish catch from these inland water bodies lies with the respective state governments of India and they are mandated to follow the sampling methodology developed by ICAR-CIFRI for the collection of data and for the estimation of fish catch. In

inland fisheries, the collection of fish catch data is fraught with difficulties because of a multiplicity of factors: inland water bodies are innumerable, geographically wide-spread and the fish landing centres are mostly inaccessible. Further, there is an acute shortage of manpower, funds and logistics with the state governments to collect data on a regular basis (Stobberup 2012). Hence, there is an immense need for innovative data acquisition methods as conservative methods of data collection have become almost untenable primarily because of cost and time constraints. The present paper explains how mobile communication technology could be harnessed in developing an Electronic Data Acquisition System (eDAS) along with an Android Application – eMatsya (Here 'e' stands for electronic and Matsya means fish in Sanskrit language) - through which fish catch data could be collected seamlessly from reservoirs and other inland water bodies.

2. METHODS

The mobile communication technology has enormously benefitted every business domain and the fishery sector is not an exception to it. Mobile phones are found to influence social behaviour (Srivastava, 2005) and the cultural ecology of fishing in Kerala, India (Sreekumar, 2011). The use of mobile phones by fishermen is found to benefit them in marketing their produce at a better price (Srinivasan and Burrell, 2015) and to know about the weather conditions (Chhachhar and Omar, 2012). The mobile phones and their usage by fishermen have made the fish market more efficient by way of sharing the market price information (Jensen, 2007). There are reports of shark fisheries data being collected using the mobile phone in Madagascar (Humber, 2014). Smartphones and Digital Tablets are being used by fisheries professionals not only for data collection but also for public outreach and awareness (Gutowsky et al. 2013). There are reports of potential usage of mobile phones in data collection across different disciplines (Kwok 2009). Application of emerging technologies and advanced data systems are also being recommended for improving fisheries management (Bradley et al. 2019). Over the years, the objective of fish data collection has changed gradually from publishing "Annual Statistical Yearbooks" to "Electronic Fish Information Systems (FISs)" (Graaf et al. 2011). The estimated internet users in India (by the end of 2019) would be 627 million (Kantar, 2019). During 2018, the growth of internet users in rural India (35%) was much higher as compared to a mere 7% growth recorded in urban areas. According to this report, nearly 97% of the users use a mobile phone as one of the devices for accessing the internet. Also as the cost of mobile phones, as well as their tariff, is in the realm of affordability, the mobile phone penetration is profound - especially in rural India that includes the fishers operating in reservoirs and other water bodies of India. Being used by a large section of the society, mobile phones hasten the access to sources of data that are otherwise inaccessible (because of the remoteness of the data source) in a cost-effective way (Raento, Oulasvirta, and Eagle 2009).

3. ELECTRONIC DATA ACQUISITION SYSTEM (eDAS)

This has paved the way to harness this mobile communication technology to address the data acquisition problems in inland fisheries. Thus, an Electronic Data Acquisition System (eDAS) was developed (Karthikeyan and Rao, 2017). In a nutshell, eDAS can be described as follows:

> *"A method of capturing and sending the data on fish catch / effort directly from the fish landing centres through Short Messaging Service (SMS) using mobile phone / technology to the data centre".*

The feasibility and advantages of involving the local fishermen in scientific fisheries data collection have been discussed in detail by (Ticheler, Kolding, and Chanda 1998; Mangi et al. 2018; Kraan et al. 2013). Similarly, this eDAS was designed to collect fish catch data by deploying fishery friends (knowledgeable fishers at the fish landing centres who could be trained to send fish catch data using eDAS). Involvement of fishery friends facilitates the collection of large quantities of reliable data on the fish catch at less cost. The trial-implementation of eDAS was done in Tunga reservoir in Karnataka and Patratu reservoir in Jharkhand. Species-wise catch was collected from these two reservoirs on a daily basis. This trial-implementation not only yielded very good results but also showed that the scaling-up of this eDAS implementation is easy and when done at the national level would result in a continuous flow of authentic information on inland fish catch data.

3.1 Development of Android Application eMatsya

For the easy usage of eDAS by fishery friends to send data, a user-friendly-menu-driven Android Application - eMatsya was developed and interfaced with eDAS. In eMatsya, the fish catch data is captured in the mobile phone and the data is sent directly to the server (unlike in the earlier version where the data was sent through SMS). Using eMatsya, data can be collected on any number of species but for the data collection to be sustainable in the long-run, especially in small-scale fisheries, priority should be given only for important species (Graaf et al. 2011). Further, this application has multi-lingual features (i.e. Display of fish species local names in the desired language such as Hindi / Kannada / Tamil / Telugu, etc. along with English) to facilitate easy inputting of data by the Fishery Friends (Fig. 1). Only registered fishery friends (i.e. User id and password are created by System Administrator and given to fishery friends) would be able to send the fish catch data through eMatsya.

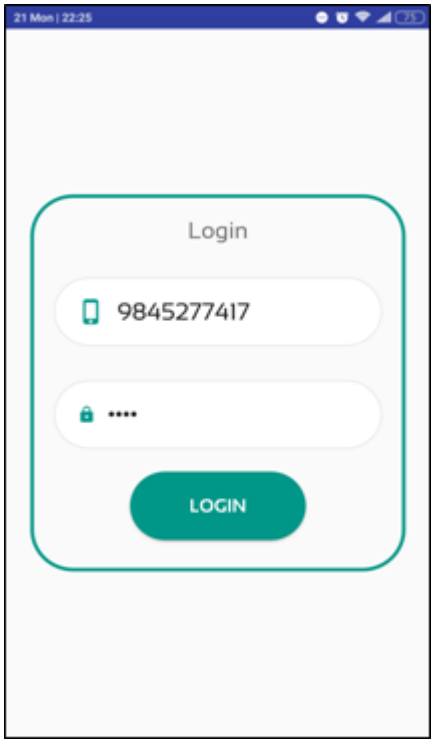

Fig. 1. *Sample screen-shots from eMatsya*

The data sent by fishery friends using eMatsya would get populated in the database MySQL in the webserver. Customised web-application software is used for the management of database and report generation. The data acquisition process in eMatsya has been depicted in Fig. 2.

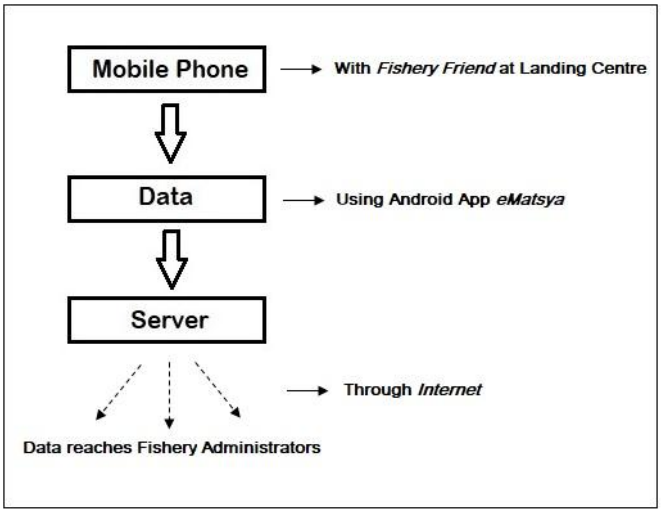

Fig. 2*. Data Acquisition Process in eMatsya*

Modern technologies/tools (viz. mobile phone, internet, email, WhatsApp, SMS, etc.) are being used in both agriculture and fisheries predominantly for the dissemination of information (MANAGE 2017). However, in eMatsya, mobile communication technology is harnessed for the collection of fish catch data. This is new and innovative, especially in inland fisheries.

3.2 Framework of eMatsya

The eMatsya combines the power of electronics and computer technology along with human resource development in providing an effective solution to the data collection issues plaguing the inland fishery sector – including the difficulty of last-mile connectivity. The general framework of eMatsya is given in Fig. 3.

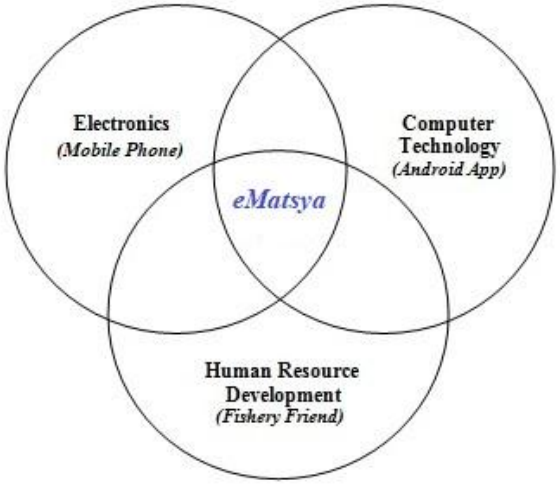

Fig. 3*. Framework of eMatsya*

Training fishers as fishery friends and deploying them in data collection activities (using eMatsya) instils a sense of inclusiveness in them in nation-building besides creating employment opportunities for them though in a limited way as fishery friends are paid an honorarium.

3.3 Advantages of eMatsya

The main advantage of eMatsya is that it addresses precisely all the data collection problems faced by the inland fisheries sector, especially the last-mile connectivity issues. Besides being easily implementable and scalable at the national level, the cost of fish catch data collection using eMatsya (through fishery friends who are stationed at the fish landing site itself) would be very less as compared to the conventional/traditional data collection methods (i.e. Regular data enumerators visiting the water bodies for a few sampling days in a month - one that involves travel cost and other related expenses). Again, in traditional data collection methods, enumerators collect data only on the selected sampling days in a month, whereas using eMatsya, fish catch data could be collected on all days of the month and the data collection is also instant. eMatsya is very simple to use and the fishery friends can be trained in its usage within minutes. Very importantly, in eMatsya, the fish catch data is getting digitised at the initial data collection stage itself. Android Application (the front-end of eMatsya) is fully user-friendly-menu-driven with multi-lingual prompts and this helps the fishery friends to use it seamlessly without any difficulty. Through eMatsya, data capture is immediate. Fisher-women (who constitute almost half of fishers' population) could be trained in the usage of eMatsya to send fish catch data from landing centres and they could be paid an honorarium for their services. This would indeed empower fisher-women financially and create employment opportunities.

4. Conclusion

Presently, a comprehensive and reliable database on inland fishery resources and production of India is almost non-existent. Because of the acute manpower shortage and financial crunch faced by the fishery departments of all states of India (who are actually responsible for the collection of fish catch data), conventional methods of data collection by the states have become untenable. Increase in inland fisheries productivity relies heavily on reservoir fisheries (Sugunan, 1995; Sarkar et al 2017) and so the collection data pertaining to reservoir fisheries on a continuous basis should be given precedence over the collection of information from other inland resources. Hence, effective implementation of eMatsya initially in selected major reservoirs of India and thereafter in other inland water bodies, in a phased manner, would help in building an authentic database for inland fishery resources and production of India. To ensure the quality of data collected, constant monitoring of fishery friends (through surprise checks) and educating them on the importance of collecting authentic data are essential. The future of fisheries management does not depend on any single innovative technology but on the whole ecosystem of technologies that are complementary to each other (Girard and Du Payrat 2017). With the burgeoning technological advancements, it would be only prudent to latch on to an emerging new one that would provide plausible solutions to issues concerning data collection from inland water bodies of India. Surely, adopting eMatsya would be one right step in that direction resulting in a continuous flow of data on inland fish catch and other related things. This, in turn, would immensely strengthen the Decision Support System in inland fishery research and management.

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