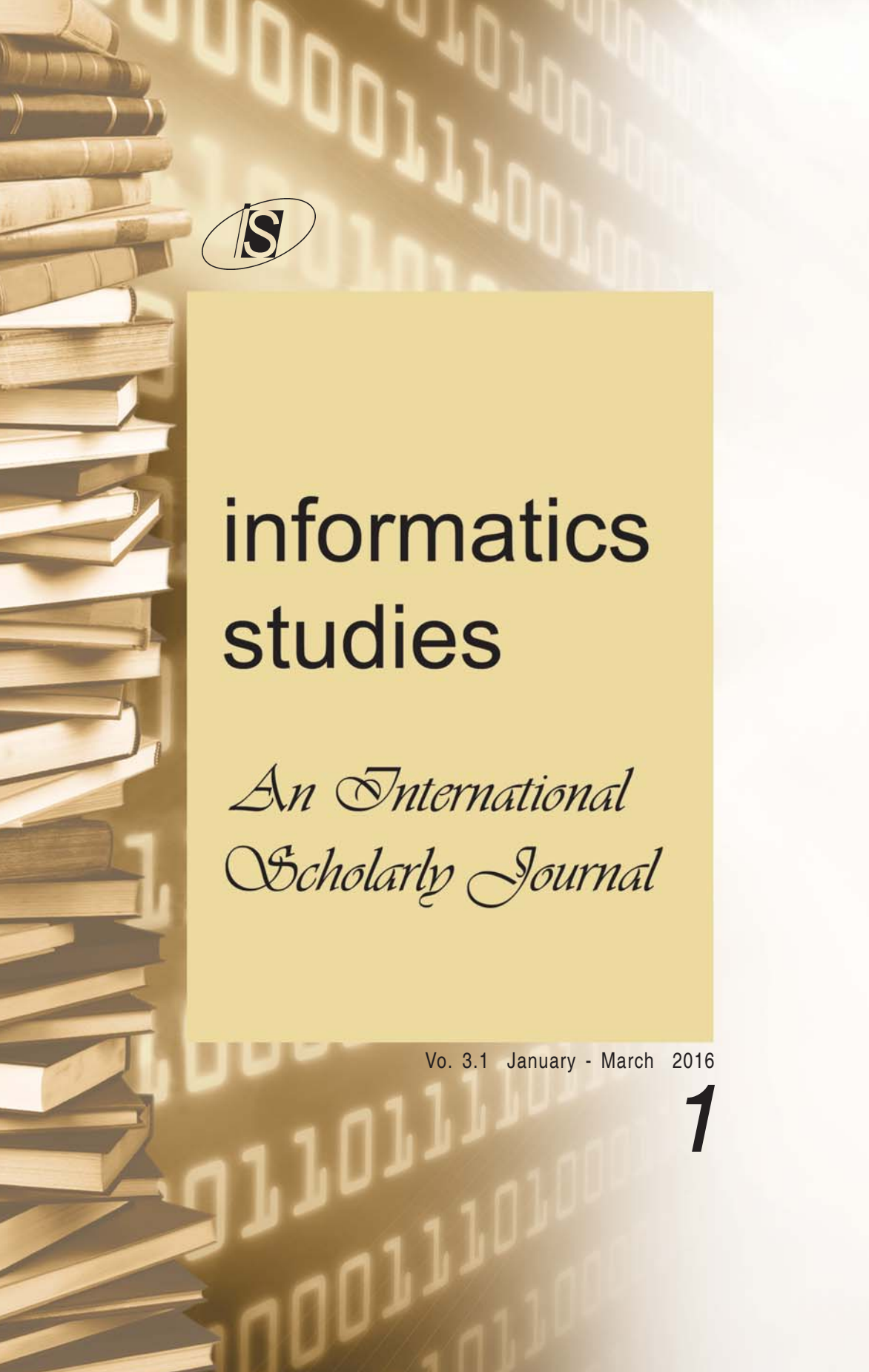

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Dynamics of Fisheries Information Transfer in India

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Abstract

Though India is rich in knowledge resources on fisheries, there are various constraints in its management and use. For sustainable development of fisheries sector there is an urgency to ensure flow of information to all in the sector especially to the grass root stakeholders - the rural communities. The available knowledge resources remain in different languages and formats under different authorities scattered over a wide geographical area uncoordinated. A resource sharing system, which can address the information requirements and problems for access prevailing in the sector, is an urgent necessity. The study suggests establishment of a Fisheries Information System Network (FISNet), with a Central Institute of Fisheries Informatics as its central Hub. It discusses in detail the network model, architecture, components, standards, procedures, formats, network backbone, use of cloud computing, partners, pre-requisites, execution, etc which can serve as guidelines for those involved

Keywords

Fisheries, Information, Informatics, India, FISI, CIFI, Network, FISNet, Web Portal.

1. Introduction

Fisheries sector occupies an important place in the socio-economic development of the country. It is a source of livelihood for about 15 million people engaged fully, partially or in subsidiary activities, with an equally impressive segment of the population engaged in ancillary activities associated with fisheries and aquaculture. Indian fisheries industry includes culture, capture, post-harvest handling, marketing and processing of fish and fisheries products.

India is rich in knowledge resources on fisheries that can effectively utilized for implementation of various plans and programs in the sector. Integrated functioning of research, education, information and extension has been the cardinal principle of development agriculture, fisheries and related areas in developed countries. (Raman 2004). But, in India there are numerous constraints in managing the knowledge resources from its production, management, dissemination and access to its effective use. Notwithstanding these constraints, the information requirements are not easy to fulfill. The suggestions put forth in the article aim for concerted efforts towards making information support relevant and timely to all the stakeholders of the sector by proposing a Fisheries Information System of India (FISI).

Information domains under fisheries as per

Food and Agriculture Organization (FAO) of the United Nations (FAO 2005) are Fishery and Operations, Biology and Environmen, Economic and Financial and Socio-cultural. Effective information management needs to consider these domains in order to populate a knowledge system in fisheries sector. India being a signatory to the international agreements for sustainable fisheries development, it is also important to strengthen the information system with physical, economical, technical and human resources under the new regime.

1.1. **Need for the Present Study**

Technological transformation that can boost fisheries production consists of improvements in material inputs, farming techniques, storage technology, research, education and extension. Effective integration of these factors relates to the adequate information flow. Fisheries research conducted at various research institutions under Union and State Governments at huge public expense generate new technologies. The feed companies, seed companies, certification agencies, water resource development agencies, planning and administration agencies, market and price commissions, export agencies, development boards, NGOs and many other agencies are also engaged in production and dissemination of information relevant to fisheries sector. However, availability of fisheries information from any system is not easy, be it *Matsya Bhavans* in the villages or specialized institutions or Indian Council of Agricultural Research (ICAR) system.

The information scenario at present is far from satisfactory in spite of resources and Information and Communication Technology (ICT) infrastructure invested in the sector by using enormous public funds. A well-structured National Information System for fisheries is yet to be instituted in India. Also, a comprehensive information base is not formed and operated in the sector. Fisheries information systems and services are dispersed over numerous institutions and organizations spread throughout the country, are uncoordinated and proper access to information and its utilization is a problem. National policies and frameworks for information in India, limit systems within different departmetns and remain fragmented. This lacuna leads to limited coordination and ineffectual strategies in fisheries sector also.

A survey of published literature revealed that no study on information needs and perceptions of fishers, fish farmers and their community, entrepreneurs, hobbyists, marketers, financiers, businessmen, grass root level workers, workers, and other stakeholders such as scientists, students, administrators, planners, etc. of India was done with an integrated approach.

1.2. Methodology and Objectives

The objective of the study was to assess the present status of fisheries information resources, services and system in India as a whole, quantitatively and qualitatively, and to make suggestions for integration, flow, exchange and deliverance of information to the stakeholders in fisheries sector effectively and efficiently. Study was done using questionnaire, interview, and field visits. Sample population constitutes various stakeholders of fisheries sector. The study felt the need for a national level integrated Information Management System and network on fisheries that can support and restructure education, redefine scientific research and reorganize the media of communication to an inter-active and decentralized mode in fisheries sector.

2. Fisheries Information System

System is defined it as a regularly interacting or interdependent group of items forming a unified whole, an integrated assembly of interacting elements, to carry out co-operatively a predetermined function (Cleland and King 1969 and 1972) and as a set of parts coordinated to accomplish a set

of goals (Churchman 1968). 'Information system' is the effective design, delivery, use and impact of information technology in organizations and society (Mingers and Stowell 1997). From the functional point of view, it is an unique integration of men, methods, organizational patterns and software elements whose coordinated operations provide manifold dispersed communities of users with all the input data relevant to them at any time, irrespective of origin or physical location, in a variety of possible output formats selected by them as best suited to their information gathering habits, abilities and requirements (Atherton 1977).

Fisheries Information System for India proposed in this study, is composed of a hierarchy of sub-systems, interdisciplinary in nature and it seeks to integrate technological disciplines with management and other disciplines such as Library and Information Science, Computer Science, Electronics, Communication and Fisheries Science.

2.1. Indian Scenario

Institutions are fundamental to the economic change. Fisheries development depends on an efficient flow of information among all the actors in the system. There is also the need to mould the vast resources of fisheries sector including scientists, extension system and research information into a more coherent whole. Presently, information services by fisheries institutions in India do not satisfy the information needs of the stakeholders, especially farmers and the fishermen community at the grass root level though there are research and extension systems operative in the agricultural systems of Union and State governments. It is pertinent that an institution is necessary to implement an information system, based on current technologies, to accelerate the productivity and efficiency of research, education, extension and the development in fisheries sector of the country.

3. Fisheries Information System of India (FISI)

The establishment of a Fisheries Information System of India (FISI) can overcome the serious constraints prevailing in the sector that prevent systematic access to information. The problem is mainly with access to information rather than resources. The resources in the present form are also difficult for use by the stakeholders that constitute managers at the top and fish farmers at the grass root level. There is no integration, resource sharing, standards and protocols for dissemination of information in spite of huge ICT infrastructures, information and knowledge disssemination programmes launched by Indian Council of Agricultural Research (ICAR) and other agencies.

The proposed system, the FISI, consists of a network named Fisheries Information System Network (FISNet), a central institution named Central Institute of Fisheries Informatics (CIFI) and other institutions as different tiers and nodes of the system.

3.1. Objectives of the FISI

'An information system is a system for collecting, processing, storing, retrieving, customising and distributing information within the enterprise and between the enterprise and its environment. The information system is a functionally defined subsystem of the enterprise, i.e. it is defined through the services it renders' (Bernus, Mertins and Schmidt 2006). Thus, the FISI is envisioned to provide and maintain an integrated information flow throughout the sector, so that right information is served whenever and wherever needed, in the quality and quantity needed and in the format that is familiar to the user. The objectives of the FISI are:-

- To build an efficient information management and dissemination system that could reach fish farmers, fishers, public

research institutions, administrators and entrepreneurs, which will be accessible anywhere at any time by all concerned, which constantly updates content and technology, introduces new technology and services where in rural community can have more access.

- To function as a network to aggregate, share and disseminate information of importance and interest to the fish farmers, fishers, entrepreneurs and officials in ways that enhance development of the sector.
- To provide a fisheries information system platform that integrate the core competencies of partner institutions, enabling joint design, development, cost effective products and marketing of the knowledge products.
- To develop uniform hardware and software for use of participating organization and the professionals and executives in the sector.
- To provide a model and assist in developing fisheries information system in the States of India suiting to the local requirements.
- To formulate and implement standards for processing and sharing of information online and offline that goes hand in hand with international standards adopted by FAO and other agencies for information sharing.
- To assist and cooperate in the works of national agencies towards creation of Common National Information Infrastructure and 'Clouds' over a period of time that provide ready-to-use and secure environments for computing operations as well as users.
- To build common service delivery platforms in association with the agencies of Common National Information Infrastructure.
- To support directly or through participation the regional fisheries organizations and similar international information systems to benefit mutually in national, regional and international programmes for information exchange and dissemination.

3.2. Implementation Strategy

Dissemination of knowledge and information are essential for empowering fisheries sector wherein the grass root stakeholders are rural communities. Communication is central to this process. The current technologies enables efficient response to the information needs of rural communities, such as information related to fish farming, health, micro credit, government services, employment opportunities, training, education, support in production, storage and marketing of farm products etc. Hence the FISI shall have Web based information services, mainly portals at the national and state levels catering to general and region specific requirements.

The FISI can be implemented on mission mode with Central Government funds. The programme should be executable as per specific proposals submitted by a Working Group comprising of experts from concerned fields. Fisheries libraries of National/State levels for Research/ Education/Extension shall be the nodal centres of the system network. The initial cost for the physical (civil) infrastructure at central and nodal centres such as premises, site preparation, furniture, etc. should be met from central funds.

4. Central Institute of Fisheries Informatics (CIFI)

The FISI will be a decentralized system with centralized coordination and control by the Central Institute of Fisheries Informatics (CIFI). The CIFI with clear mandates has to assign responsibility for the implementation, functioning and development of the FISI.

4.1 Objectives of the CIFI

- To establish systems and facilities in the

country to provide services, appropriation of information and to meet user needs for sound and effective fishery science/ management decisions.

- To create awareness among all stakeholders, developing specific knowledge, market and trade information, advisory and decision support, offering short term training programmes, etc. through its wide range of consortium partners for data generation, data sharing, database management, trainings, courses, system management and coordination.
- To function as a platform for dissemination of fisheries information by building portals and digital information repositories which function as gateway of fisheries information.
- To establish and coordinate resource sharing mechanisms in order to avoid duplication of efforts, resources and services already available in the sector.
- To update technologies, introduce services, invent vehicles for information exchange, innovative information products on a constant basis by duly considering the expertise and experience of other agencies functioning on similar objectives/subjects/fields.
- To promote research, development and innovation in fisheries information technology for providing services relevant to the needs of the stakeholders.
- To build and integrate State and Central systems to improve data management/ data access facilities to become capable of supporting timely delivery of information to users in fisheries sector.
- To promote national, regional and international cooperation and liaison for exchange of fisheries and aquatic science related information.
- To establish national standards, policies, and best practices for data collection, management and dissemination by ensuring quality.
- To provide training in all aspects of information and knowledge management to the information service professionals in FISNet.
- To leverage investments and to promote efficient use of resources across the country to create and sustain governance structures that result in effective information management.
- To maintain and publish a comprehensive inventory of information assets in authoritative databases.
- To build and sustain effective partnerships to support collaboration among stakeholders.

The CIFI shall be the apex body of the FISI. It shall be established by the Central Government and shall be formed under the Ministry of Agriculture with clear mandates. The CIFI shall be a high-level central focal agency for developing fisheries information system in the country, headed by a top-ranking official. The CIFI should be provided with inputs relating to information, man-power and expertise, facilities, buildings and equipments. The CIFI shall be organized with executive authority for administration, functional organization, costing, budgeting, operational capability, and infrastructure. The CIFI shall rely on a multidisciplinary management team, including scientists from fisheries, library and information, computer science, information and communication specialists, language technology experts and statisticians.

The CIFI will have a Governing Council. Director, National Informatics Centre (NIC); Programme Director, Directorate of Knowledge Management in Agriculture (DKMA), ICAR; Head, Department of Computer Science and Engineering, Indian Institute of Technology (IIT) Kanpur; Librarian, National Information Centre for

Marine Sciences, (NICMAS), National Institute of Oceanography (NIO); Programme Director, Information Education and Communication, M S Swaminathan Research Foundation (MSSRF); Joint Secretary (Fisheries), Department of Animal Husbandry, Dairying & Fisheries (DAHDF), Ministry of Agriculture and Director, Indian Institute of Information Technology and Management, Kerala (IITM-K) should be the members of the Governing Council. The Chairman shall be appointed by the Government of India on the grounds of the expertise, contributions and services in the field of information technology, networking, and library and information science. The CIFI will have a Director for programme planning and execution as executive head. The Director should be appointed from among the experts in the fields of communication, networking, library and information systems, by the Government of India on the recommendations of a select committee constituted by the Union Public Service Commission (UPSC). Expert groups will be responsible for the span of activities concerned. Two committees of review and evaluation shall advice the Director on the activities of the CIFI from time to time. Chairpersons of these two committees shall be the subject experts in the Governing Council, nominated by the Chairman.

4.2 Fisheries Information Centres

Fisheries Information Network will consist of a set of inter-related Information Centres and systems associated with communication facilities, which cooperate under more or less formal and institutional agreements, in order to jointly implement information handling operations with a view to pooling their resources for serving the users in an effective manner (Anderson with Minasi 1999). The functional basis of the FISI shall be the Information Centres of the specialized institutions in the sector. They shall constitute the second tier in the network for functional responsibilities. Functional responsibilities of the Nodal centres are to: select, acquire, store and retrieve information in response to requests; announce, abstract, extract, index information and disseminate information in anticipation and in response to requests.

4.3. National Fisheries Portal

Creation and management of Indian Fisheries Portal is one of the main objectives of the CIFI. Thus, CIFI will have a National Fisheries Portal Content Management Team which shall examine all aspects of content contribution, approval, review and archiving. The portal shall have static and dynamic information content, multi language interfaces with an endeavor to continue the enhancement and enrichment of the Portal in terms of content coverage, design and technology on a regular basis. National Portal of India at http://india.gov.in shall be the model for the execution, operations and content contribution. The mother portal of the CIFI shall be the platform for inter nodal interaction. The portal designed and organized to provide easy access to the multitude of fisheries related information available within the FISI shall be the one-stop option for fisheries information and gateway.

4.4. Components of Information Services

The information service components proposed for the portal to be maintained in different locations under the FISI are given below. The list is not intended to stuff the portal with information but to enlist vivid resources, needs, demands and services to be considered for inclusion.

Bibliographic Database: Record of bibliographic reference to fisheries research and management.

Document Database: Digital repository of documents on fisheries studies, laws and policies.

Fisheries Statistics: Catch and effort

information, time series data on landed and on-board catches and their corresponding effort units.

Fisherfolk Database: Census data of fisherfolk.

Expert's Database: Fisheries experts' information, contact details, etc.

Fish Information: Production, sources, culture methods, catch methods, technology, market price, etc.

Fish Health and Disaster Management: Fish diseases, prevention, cure, management of disasters/diseases.

Communication and Extension: Extension activities and related resources, audio, video, etc.

Education Information: Information on fisheries education institutions and their information resources.

Management Information: Policies, regulations, conventions, treaties and legislations.

Export and Quality Control: Fish inspection, quality control, food safety and other related information.

Geographic Information: Maps, observation systems and tools for analysis.

Fisheries Licensing: Rules and procedures of licensing process.

Decision Support: Interactive system for managers.

Resource and Ecological Assessment: Resource protection, conservation and associated ecological elements.

Socio-Economic Assessment: Demographic profiles, fishing activities, income and livelihood.

E-services: e-mail, chat, search, FAQs, archival, knowledge base, form processing, feed backs, etc.

Virtual Krishi Vigyan Kendra: E-Learning/ extension/open/distance learning.

Advisory Services: Meteorological, market intelligence, etc.

News: Local, meetings, conferences and workshops calendar, regional initiatives and projects.

Links to Virtual Libraries, online journals, e-Repositories, global databases, resource centres, organizations, institutions, training and educational resources.

5. Fisheries Information System Network (FISNet) Model

The FISNet shall be the framework of the FISI. The FISI shall consist of components and processes, resources and system that deliver information products. The resources consist of network, software, hardware, data and human resources. The model of Information System Resources and Processes of FISI is given in Figure 1. The model of Network Schema of FISNet is given in Figure 2.

Internet shall be the connecting medium for communication between member institutions. The component networks can exploit numerous telecommunication

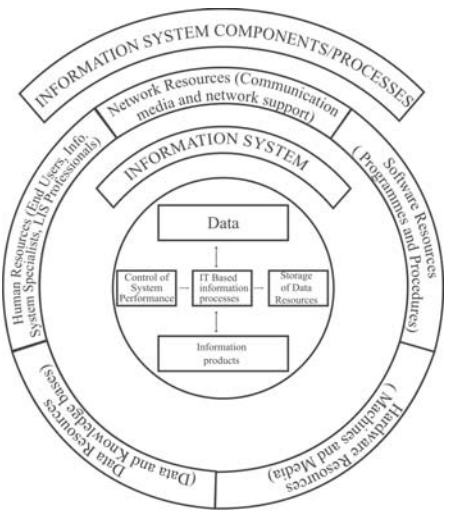

Figure 1: Information System Resources and Processes in FISI

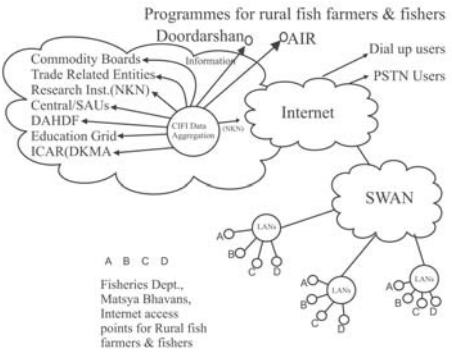

Figure 2: Network Schema of FISNet

technologies, ranging from the dial-up telephone network to state-of-the-art broadband switching technologies. The FISNet model that ensures multi-directional, participatory, speedy and dynamic flow of Information and Knowledge is given in Figure 3.

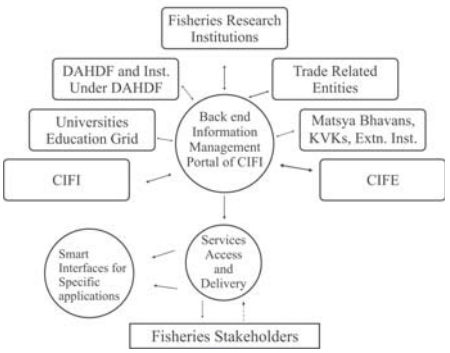

Figure 3: Information Flow Model of FISNet

State Wide Area Network (SWAN), the main connecting channel between the different Departments, will provide a dedicated speedy channel for the efficient functioning of the e-governance applications. SWAN infrastructure that reaches even remote regions of the State shall be used by the FISI to implement network services and e-governance applications to the bottom line users. SWANs are integrated using National Knowledge Network (NKN) and envisaged as the converged backbone network for data, voice and video communications throughout a State (Jayakrishnan 2013).

The CIFI will have a server system with appropriate configuration to aggregate and manage all data coming from member institutions, for accessing from any part of the world and for content creation initiatives like Digital Libraries, Internet accessible Institutional Repositories acceesible online world wide, etc. Web server shall host the website of the CIFI. The CIFI shall facilitate information sharing over the FISNet. Various kinds of documents can be converted into HTML and made web-accessible. Policies, procedures, forms, annual reports, manuals, schedules, calendar of events and programs, and other print documents can be converted to digital format and made accessible over the network.

5.1. Framework of the FISNet

The system framework needs to be developed by analyzing the basic functional processes of the System. Accordingly, the FISNet framework is envisaged with a System Architecture that identifies the major modules of the systems network required to support the FISI, the type of information maintained by each system module and the information flow between various modules; and a Technology Architecture that identifies the appropriate technology choices for the hardware and software to set up various modules. The network shall consist of a core using Internet Protocol (IP) and Multi-Packet Labeled Services (MPLS) technology, an aggregation or distribution network, and an access or edge network linking the Local Area Network (LAN) of nodal centres to the core.

5.2 Model System Architecture

The model System Architecture of the FISNet is given in Figure 4. The hardware and software required are given in approximates in Table 1.

Software and hardware choices proposed for

Table 1: Hardware/Network Components and Software Tools of FISNet

Central		Nodal	
Hardware/ Networking components	**Software tools**	**Hardware/ Networking components**	**Software tools**
High Availability Servers (lower end) +OS (3) (Data base Server, Application Server, Patch/Anti-virus Server)	Operating System for Server-(3)/ OS for client (3) media + Firewall	High Availability Servers (lower end) + OS (2) (Database server and application server)	Operating System for Server (2)/ OS for Client (2) media +Firewall
Multi-media Clients (P-V or above) System + OS (3)	Database Software and other access software tools including data security	Multi-media PC Client System + OS (2)	Database Software and other access software tools including data Security
Printers (3)	Office Productivity Tools with multi-lingual support	Printer (2)	Office Productivity Tools and Multilingual Support (2)
LAN infrastructure along with Networking interface	Development Kit	LAN infrastructure along with network interface	-
High End Scanners (3)	-	High End Scanners (2)	-
UPS (24 x 7 x 365)	-	UPS (24 x 7 x 365)	-

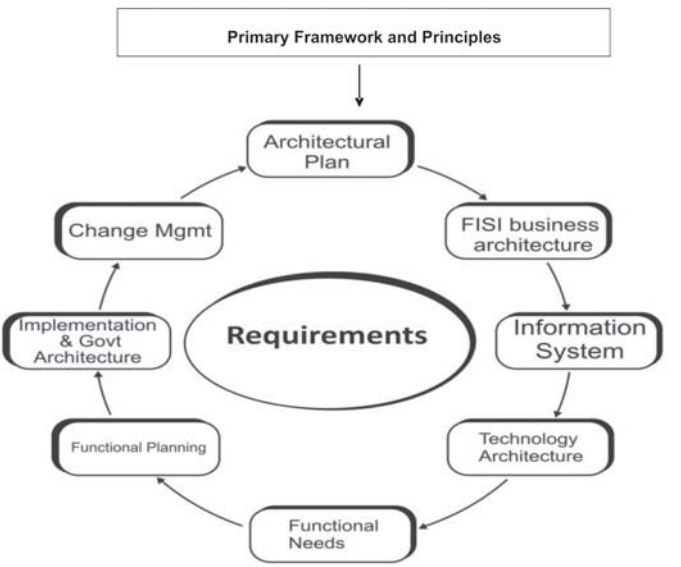

Figure 4: Model System Architecture of FISNet

the FISNet are not final as technology is always in a flux and they are to be continuously be improved to keep in pace with the state-of-the-art technology.

5.3 Components of the FISNet

- Apex Centre : One - CIFI
- Nodes : 10 - Fisheries Information Centres (in the first phase)

- Jurisdictions : 36 - 30 Indian States and 6 UTs
- Development Teams : Six (Project Committee and Divisions of CIFI)
- Support Centres : Two (NIC/NKN and ICAR (DKMA))
- Web Tools/Portals
  - National Portal- Public view of fishery data
  - Provincial Portals
  - Themed Portals viz., Fish Genetic resources, etc.

State Data Centre (SDC) facility of the Government can be used by the State Department of Fisheries to host its Web portal, digital library, union catalogue and databases required for its e-Governance for fisheries stakeholders. SDC, the core component of the e-Governance infrastructure, consolidates services, applications and infrastructure to provide efficient electronic delivery of G2G, G2C, G2B and G2F (denote electronic sharing of data and information systems between government agencies, departments or organizations (G2G), government to citizen (G2C), government to business (G2B), and government to farmers (G2F)) services. These services are rendered by the States through common delivery platform supported by core Connectivity Infrastructure such as SWAN and Common Service Centre (CSC) connectivity extended up to village level. State Data Centers provide functionalities like Central Repository of the State, Secure Data Storage, Online Delivery of Services, Citizen Information/Services Portal, State Intranet Portal, Disaster Recovery, Remote Management and Service Integration by providing better operation and management control and minimizing overall cost of Data Management, and IT Resource Management. SDC acts as a mediator and convergence point between open unsecured public domain and sensitive government environment and enables various State Departments to host their services/applications on a common infrastructure (Jayakrishnan 2013)

5.4. Network Topology

A computer network topology is the physical communication scheme used by the connected devices (Shaw and Garlan 1996). The common topologies include bus, ring, star and mesh. Network topology of the FISNet will be hybrid. The mesh topology of the NKN shall be the backbone network of the FISNet. Connectivity shall be provided by the NIC, the operating agency of the NKN.

5.5. National Knowledge Network (NKN)

NKN is a state-of-the-art pan-India network enabling to provide a unified backbone network for all the sectors. NKN will be a critical information infrastructure for India to evolve as a knowledge society. It also facilitates integration of different sectoral networks in the field of research, education, health, commerce and governance. Backbone network ranges from 2.5 Gbps onto 10 Gbps connectivity between seven Supercore fully meshed locations pan India. The network is further spread out through 26 Core locations with multiple of 2.5/10 Gbps partially meshed connectivity with Supercore locations. The distribution layer connects entire country to the core of the network using multiple links at speeds of 2.5/10 Gbps. The end users are connected up to a speed of 1 Gbps. NKN is fully owned by Central Government. Therefore, networking cost should not be considered for funding while implementing the FISNet, pending further elaboration on those aspects.

5.6. Standards, Formats and Procedures

The CIFI shall implement standards and uniform guidelines in techniques, methods, procedures, hardware and software for communication, exchange and inter-

operability of data, information and services. The library and information system standards shall be MAchine-Readable Cataloguing MARC 21, Anglo-American Cataloguing Rules (AACR)-II, Open Archives Initiative-Protocol for Metadata Harvesting (OAI-PMH), Search/Retrieve URL-Search/Retrieve Web (SRU-SRW) Service, *NISO Circulation Interchange Protocol (*NCIP) Z39. 83 Ver 2.0, International Organization for Standardization (ISO) 2709, Unicode 4.0 / 5.0, Z39.50, Code39 [barcode], Fedora Digital Object, Open Uniform Resource Locator (URL), etc.

5.7. Cloud Computing

Cloud Computing is services and storage space sold and delivered over the Internet which has become a feasible model for organizations and institutions (Nath 2014) Library/Information/content management systems can switch over to this facility to get networked storage facilities and various computer applications, to provide services which can relieve them from investing on huge infrastructures.

Cloud Computing can ensure adoption of standards for information sharing, uniform applications and low investment at end user. With Cloud Computing, information centres can work as a system on common platform, integrate resources for maximum utility such as e-resources, processing, Union Catalogue, Digital Library, repositories and other value added services.

The CIFI should have a Cloud strategy on how to make best use of this new facility. The CIFI should also function as a facilitating centre for Infrastructure-as-a-Service (IaaS) Cloud. Cloud Computing can be utilized in FISNet to amplify the power of cooperation among information and data centres and to maintain the quality of information and the standards for information sharing.

6. Partners for Information and Network Services

As no single organization would be able to meet the aims of the FISI, many organizations are to be involved in the FISNet to serve fisheries stakeholders. Some of the organizations have already been mentioned in this study. Examples of some organizations to be involved in the process are: National Informatics Centre, National Knowledge Network, National Fisheries Development Board, Department of Animal Husbandry and Dairying, Min. Of Agriculture, Directorate of Knowledge Management in Agriculture under Indian Council of Agricultural Research, Indian Institute of Information Technology and Management (of States with relevant contribution), Projects for ICT Application in different States like Information Kerala Mission, Indian Institutes of Technology, State/UT Fisheries Departments, M S Swaminathan Research Foundation/NGOs, Marine Products Export Development Authority, Doordarsan- India's National Broadcaster, and All India Radio.

CIFI and NIC can jointly form a Project Committee consisting of project executives from both the NIC (Technical) and the CIFI (Fisheries and Information Science) and also members from the partners. The Project Committee shall suggest patterns for improving the system.

7. Pre-requisites

The CIFI shall moot Agreements and Memorandum of Understanding (MoU) between the partners, agencies and providers of infrastructure and services. The CIFI shall also ensure the following:-

- Establishment of facilities and infrastructure for the network.
- Formulation of schemes for information services.

- Methods for delivery of resources to users.
- Ensuring compatibility and interoperability for resource sharing.
- Standardization of policies, procedures, formats and methods.

7.1 Execution

The FISI shall be structured along functional rather than organizational lines. The FISI shall be a three tier system consisting of Central Institute of Fisheries Informatics at the apex, Fisheries Information Centres as nodal points and Service Centres such as Village Knowledge Centres (VKCs), Village Information Centres (VICs), *Matsya Bhavans*, Fisheries Department Office, Extension Offices and NGOs at the grassroots, facilitating information access to the rural community stakeholders.

The FISI shall be implemented in a phased manner. The first phase shall cover all the National fisheries institution libraries/ information divisions that function as specialized divisions, traditionally collecting and disseminating records on fisheries science and of scientific thinking. At present, these divisions/libraries have not evolved in to Information Centres and lack innovative services, resource sharing and networking in fisheries sector. Therefore, a tough task is ahead for molding these divisions into Fisheries Information Centres to achieve the aims and objectives of the FISI. Libraries/ information divisions attached to the National fisheries institutions shall be designated as the Library and Information Centre in that specialized field of the parent institution and shall form the specialized centre in the information system (For example, Central Institute of Brackish water Aquaculture (CIBA) library /information division shall designated as Brackishwater Aquaculture Information Centre)

The CIFI shall outline the regional and sectoral nodal centres by formulating a model, the professionals and their qualifications, standards and protocol for information exchange and other information services common to the Fisheries sector. Nodal institutions shall implement these aspects based on signed agreements. Central funds for capacity building shall be utilized for ICT infrastructure development and network activities. The Information Centres shall be headed by Library and Information Science (LIS) professional of scientist level supported by sufficient computer and communication technicians, and LIS professionals as the services of the information system depends on the products of well-organized, professionally staffed Information Centres.

In the second phase, national fisheries institutions where library services are absent are up-graded with resources, services, professionals and these institutions hooked to the network. The CIFI shall implement State level information centres in consultation with respective State Government Departments. In the third phase, out stream institutions, universities and educational institutions engaged in aquatic, fisheries and fisheries related education and research are added to the FISI.

The third tier constitutes the 'last mile' (Moni 2004) nodes such as VKCs, VICs, Matsya Bhavans, NGOs and Extension Offices. Solutions on connectivity at 'last mile' are provided by the network agency of the FISI, i.e., NKN. Solutions on information service aspects shall be dealt by the State government by establishing VKCs/VICs in Matsya Bhavans, NGOs, Department Offices and by employing service/extension personnel to facilitate 'knowledge services' (Suri, Lokhande and Naveen 2012) to the rural community stakeholders.

8. Conclusion

It needs to be emphasized that the constraints faced by the primary stakeholders of the fisheries sector cannot be fully solved

using ICT and digital technologies. However, ICT can contribute for the development of the sector. An Information system has the potential for improving the efficiency and effectiveness of research, education and extension in the sector. It can also address the urgencies prevailing in the sector. The survey conducted by the author has revealed the urgent need for establishing a Fisheries Information System of India. Based on the study the concept, design network model, network schema, information flow model, components, standards, procedures, formats, network backbone, partners, pre-requisites, execution, and various factors involved in developing an integrated fisheries information system and network has been discussed here. An attempt was also made to evolve the objectives of the proposed system, aspects to be cared for in its organization and associations, possible phasing of implementation, etc. FISI can establish a National Fisheries Portal as its information service component. Considering the complexity of the subject, the proposals in this paper are to be considerd only preliminary and are not altogether indisputable.

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Appendix I

List of the main-stream and the out-stream institutions having capacity to be the part of the proposed Fisheries Information System

No.	Institute	Control	Implementation Phase
1	Central Agricultural Research Institute (CARI), Andaman Nicobar Island (ANI)	ICAR	I
2	Central Food Technological Research Institute (CFTRI), Mysore	CSIR	I
3	Central Inland Capture Fishery Research Institute (CIFRI), Barrackpore	ICAR	I
4	Central Institute of Brackishwater Aquaculture (CIBA), Chennai	ICAR	I
5	Central Institute of Coastal Engineering for Fishery (CICEF), Bangalore	DAHDF	II
6	Central Institute of Fisheries Education, (CIFE) Mumbai	ICAR	I
7	Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Kochi	DAHDF	II
8	Central Institute of Fisheries Technology (CIFT), Kochi	ICAR	I
9	Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar	ICAR	I
10	Central Marine Fisheries Research Institute (CMFRI), Kochi	ICAR	I
11	Centre for Marine Living Resources and Ecology (CMLRE), Kochi	Min. of Earth Sciences	II
12	Coastal Aquaculture Authority (CAA), Chennai	DAHDF	II
13	Directorate of Coldwater Fisheries Research (DCFR), Bhimtal	ICAR	I
14	Export Inspection Council of India, (EIC) New Delhi	Min. of Com & Industry	II
15	Fishery Survey of India (FSI), Mumbai	DAHDF	II
16	Indian National Centre for Ocean Information Services (INCOIS), Hyderabad	Min. of Earth Sciences	I
17	Krishi Vigyan Kendras (KVKs)	ICAR	I
18	M S Swaminathan Research Foundation, (MSSRF) Chennai	NGO	I
19	Marine Products Export Development Authority (MPEDA), Kochi	Min. of Com & Industry	I
20	National Academy of Agricultural Research Management (NAARM), Hyderabad	ICAR	I
21	National Bureau of Fish Genetic Resources, (NBFGR) Lucknow	ICAR	I
22	National Centre for Agricultural Economics and Policy Research, (NCAP) New Delhi	ICAR	I

23	National Federation of Fishermen Cooperatives Limited (FISHCOPFED), New Delhi	DAHDF	II
24	National Fisheries Development Board (NFDB), Hyderabad	DAHDF	II
25	National Institute of Agricultural Extension Management (MANAGE), Hyderabad	ICAR	I
26	National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT), Kochi	DAHDF	II
27	National Institute of Nutrition (NIN), Hyderabad	CSIR	II
28	National Institute of Ocean Technology (NIOT), Chennai	DAHDF	II
29	National Institute of Oceanography, (NIO) Goa	CSIR	I
30	National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad	Min of Rural Devtt	II
31	National Remote Sensing Centre, (NRSC) Hyderabad	Dept. of Space	I
32	The Bay of Bengal Programme (BOBP)	DAHDF	II
33	Zoological Survey of India (ZSI), Kolkata	Min. of Envt & Forest	II
34	Universities- Aquatic/ Fisheries Science Schools/ Departments of the Central/ State Universities/ Agricultural Universities	Universities	III
35	States' Main Stream/ major Fisheries Institutions	State Govt.	III
36	Regional Centres of National Institutions (of Phase I and II)	Respective Depts	III

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