Chapter 20

Data and computational needs in fisheries research and management
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INTRODUCTION

Statistics is extensively employed in many real-world measuring processes. It has wide applications in any branch of science or research viz., agriculture, meteorology, oceanography, forestry, fisheries, animal husbandry, geology, epidemiology, medicine, communication, visualization, education, politics, psychology, atomic physics, space research, climate change studies, economics and governance. Statistics also gets applied in many unconventional fields like mining and law. . A method called "kriging" enables scientists to interpolate a smooth distribution of some quantity of interest from sparse measurements. This method actually evolved out of data from gold mines when in 1950, a South-African mining engineer named DanieKrige used statistical techniques and assumptions to locate optimum places where boreholes can be drilled to extract gold ores.Genomics is another such field where the discovery through statistical methods of "biomarkers"—genes that confer an increased or decreased risk of certain kinds of cancer

Contribution of fisheries sector to GDP 1.1% and 5.0% to the agricultural GDP.Fisheries is one of the largest employer in the rural sector, providing direct and indirect employment to millions of rural poor, especially the weaker sections of the society. Fisheries sector also undergoes continuouschanges with introduction of newer technologies evolved through R& D institutions. Validation of these technologies and providing inputs for needs of the sector is one of the important mandate of Statisticians. Statistics per se deals with generation of data, data management, data analysis and information generation from data.

Statistics and the advanced methods are key to fisheries research and management. Fisheries with its varied disciplines viz., Aquaculture, Fisheries Resource Management, Fish Genetics, Fish Biotechnology, Aquatic Health, Nutrition, Environment, Fish Physiology and Post-Harvest Technology is a vibrant field with research taking place in practical aspects which affect production and sustainability. Statistics can play a crucial role in formulating advisories and policies for stakeholders at all levels.

Statistical system can play more dominant role

- in providing tools for policy making and implementation
- in directing the impact of technology
- in sustaining the nutritional safety
- in socio-economic upliftment of people below poverty   line
- to identify emerging opportunities through effective coordination
- speedy dissemination of information by networking and appropriate human resource development
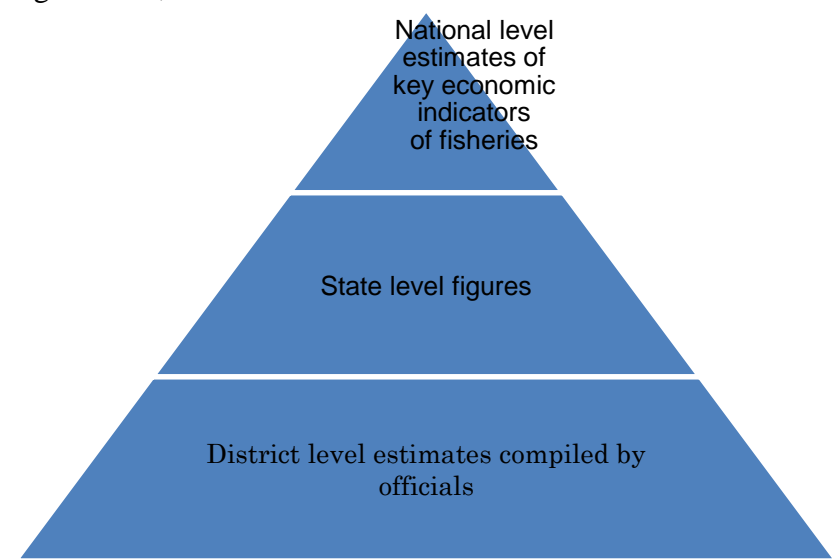
DATA NEEDS IN FISHERIES

The data needs in fisheries will vary according to type of research conducted by the researcher. A biologist who works on species behavior, growth, abundance, etc.will require information on the spatial distribution and catch. Likewise, an economist who wishes to predict next year's profits should understand the effect of population size on producer's costs. Policy makers may need macro level data on infrastructure, employment, earnings, investment etc. to formulate management measures.

Data on marine fisheries gets generated from the operation of commercial fishing vessels and research vessels.In 'Fishery technology' large volumes of data generated in a wide range of applied scientific areas of fishing technology, fish processing, quality control, fishery economics, marketing and management. Apart from statistical data collected in technological research, data also collected on production, export, socio-economics etc. for administrative and management decision making.

Major areas of data generation:
- ❖ fishing vessel and gear designs
- ❖ fishing methods
- ❖ craft and gear materials
- ❖ craft and gear preservation methods
- ❖ fishing efficiency studies
- ❖ fishing accessories
- ❖ emerging areas include use of GIS and remote sensing

Data on various aspects of fishing gets collected for administrative purposes and policy making. For administrative purposes, voluminous data gets generated through fisheries departments of states. Each district has officials entrusted with the work of collection of data which are coordinated at the state level. State level figures are compiled at the National level by Department of Animal Husbandry and Dairying, Ministry of Agriculture, New Delhi.

National level estimates of key economic indicators of fisheries

State level figures

District level estimates compiled by officials

Information is also compiled on macro economic variables like GSDP from fishing by the respective Directorates of Economics & Statistics.

Infrastructure

Indian fisheries is supported by a vast fishing fleet of 2,03,202 fishing crafts categorized into mechanized, motorized and non-motorised. The registration of these fishing crafts are done at various ports across India and license for fishing operations has to be obtained from the respective states. The fish processing sector largely managed by the private sector has per day processing capacity installed at 11000 tonnes per day. Data is also collected on the infrastructure facilities and inventories by agencies from time to timesuch as number of mechanized, motorized and non-motorized fishing crafts, fish landing centers, fisheries harbours, types of gears and accessories, fish markets, ice plants and cold storages, Socio-economic data like population of fishermen, welfare schemes, cooperative societies, financial assistance, subsidies, training programs, etc.

Fish Landings and fishing effort

Indian fisheries has seen tremendous development over the past six decades owing to technology changes in fishing like mechanization of propulsion, gear and handling, introduction of synthetic gear materials, development of acoustic fish finding devices, satellite based fish detection techniques, advances in electronic navigation and communication equipment. The increase in fish production can be said as exponential with a mere 75000 MT in 1950-51 to 11.42 million MT in the current year. Both marine fisheries and aquaculture have contributed to the present level of production with share from culture fisheries more than the capture fisheries. It is important task to collect macro level data from state and country on fish production and details of the species caught in the sea.

The data on fish catch and effort (a measure of fishing activity of vessels at sea), from all the coastal states, Union territories, Islands is being done by ICAR-Central Marine Fisheries Research institute and maintained as database. Based on standard sampling methodology developed by CMFRI, daily data on commercial landings from selected centres/zones all over the coast is collected, compiled and published.Detailed time series data has been generated on species wise, region wise, gear wise fish landings are collected and compiled for the use of researchers and policy makers. The beach price of fish (species wise) is also collected periodically.

Data on fish farms, production and area under aquaculture is maintained by the respective State Fisheries departments and compiled at the National level. Apart from capture fisheries (marine) and culture fisheries (aquaculture) the fish production from inland water bodies like lake, ponds, reservoirs, etc. is collected and compiled at State level. For developing the sector, various programmes and projects have to be formulated and implemented. To achieve the objectives of such developmental programmes, the current status of production of fish from various regions has to be made known. The need for fish production data maintained by these agencies from marine sources, aquaculture and inland water bodies arises while formulating various research studies and development projects at district, state and National level.

Data generation along the fish value chain

Fresh fish after harvest is iced and distributed through various channels into the domestic markets and overseas markets. Around 80% of the fish is marketed fresh, 12% of fish gets processed for the export sector, 5% is sent for drying/curing and the rest is utilized for other purposes.

Marine Products Export Development Authority (MPEDA) maintains the database on export of fish and fishery products from India to various country. The weekly prices realized by Indian seafood products in the various overseas markets are also collected and compiled by the agency.Marine Products Export Development Authority (MPEDA) established in 1972 under the Ministry of Commerce responsible for collecting data regarding production and exports, apart from formulating and implementing export promotion strategies. Prior to the establishment of MPEDA, Export Promotion Council of India was undertaking this task.

Fish processing factories established all over the country generate data on daily production, procurement of raw material and movement of price structure etc. which is generally kept confidential.Data on quality aspects maintained by Export Inspection Council of India through Export Inspection Agency (EIA) in each region, under Ministry of Commerce and Industry. The EIA is the agency approving the suitability of the products for export.

- bacteriological organisms present in the products
- rejections in terms of quantity
- reason for rejection etc.

Fish quality control

Other types of data generated by CIFT in fishing and fish processing technology are quality control data on fish and fishery products, ice, water, etc. Offshoot of processing technology is Quality Control of which Statistical Quality Control forms an integral part. Due to the stringent quality control measures imposed by importing countries, especially the EU and USFDA standards samples of fish and related productslike raw materials, ice and water samples and swabs from fish processing factories are tested at the quality control labs. Another area where statistics gets generated is in product development : consumer acceptability and preference studies mainly for value-added products. Using statistical sensory evaluation methods this data gets analysed.

At Central Institute of Fisheries Technology (CIFT) we are periodically collecting data on the following aspects which is used for policy decisions

- Techno-economic data on various technologies developed
- Data on Economics of operation of mechanized, motorized and traditional crafts
- Data for the estimation of fuel utilization by the fishing industry
- Year wise data on Installed capacity utilization in the Indian seafood processing industry
- Demand – supply and forecast studies on the fishing webs
- Harvest and post-harvest losses in fisheries
- Transportation of fresh fish and utilization of trash fish
- Impact of major trade policies like impact of anti-dumping, trend analysis of price movement of marine products in the export markets
- Study on impact of technology and study on socio-economic aspects

Weaknesses of the fisheries statistical system

The major weakness of the fisheries statistical system is the lack of effective coordination between Central and state agencies in collecting data. Many a time, the credibility of data is in question as no common methodology and format is being adopted. There exists no coordinating centre to scrutinize quality and authenticity of data collected and for providing common statistical approach for various issues. Alsomany data gaps exists at the micro level, like lack of data on private capital investment and price movement in domestic as well overseas market. The data provided by many agencies are not updated over time and lack of interaction among officials and data exchange that is vital to the functioning of a dynamic system. There is no prioritization of the data requirement is attempted and non availability of trained manpower is observed to be a major problem in this area. A common data bank comprising of all major fisheries statistics must be evolved which should be accessible to all stakeholders, including government departments.

Future of Indian fisheries & role of statistics

In the background of WTO and other economic reforms, the fisheries technology will play a significant role in the economic development of the country. India is attempting to emerge as one of the top fish producing countries in the world. With a fish production projected at 13 million MT and getting equipped for export of marine products to a tune of 18.9 lakh metric tonnes,the sector is set to provide employment to about 20 million people. Fisheries sector is poised to make a significant impact on the economy of the nation particularly on the socio-economic conditions of the rural population.

In order to make Indian seafood exports competitive, effective strategies have to be developed. New areas of technological research are emerging to increase production and sustain the sector. Modern marketing strategies including market intelligence will play a key role in the future and techno-economic studies will become imperative. Large volume of statistical data expected to be generated in the scientific areas, fishing and fish processing industry, export market and fishery management.

Ensuring quality of data and management of data for generation of valuable information not going to be easy.Complete restructuring of fisheries statistical system in this background with common accessible database and a central coordinating agency for fisheries to monitor, guide and improve the existing system is the need of the hour.

Computational software

From data punching using cards, computation has come a long way over the past century. With the advent of personal computers, data management and analysis had become a lotmoreeasier. Prior to the development and use of statistical software data analysis was done using programming in languages like FORTRAN. A plethora of computing software is available for analysis of data suitable to the needs of researchers.

(i) Statistical Package for the Social Science. SPSS is one of the most popular statistical packages which can perform highly complex data manipulation and analysis with simple instructions and is widely used by researchers. The GUI software has data management features, wide range of analytical options, plotting and missing data options.

(ii)   The FishStatJ application developed and maintained by FAO provides users yearly timeseries data on variety of aspects of fisheries. Data on global capture fisheries and aquaculture fish production can be obtained from this application.

(iii) FiSAT is a program package containing methodologies for fish stock assessment and was developed by FAO-ICLARM. The ASSESS module of the package handles the growth parameter estimation, analysis of length frequency data, virtual population analysis and stock prediction.

(iv)   The LFDA (Length Frequency Data Analysis) software package is useful for estimation of growth parameters and mortality. The Catch Effort Data Analysis package (CEDA) is a PC-based software package for analysing catch, effort and abundance index data.

(v)   Plymouth Routines in Multivariate Ecological Research (PRIMER) is used for statistical analysis of multivariate data including species assemblages, physico-chemical variables, genetic, microbial data. Assessment of environmental impact of oilfields, discharges, mining, trawling, aquaculture can be done using the software. Another unique feature of PRIMER is the ability to calculate bio-diversity indices based on taxonomic distinctness or relatedness of the species.

(vi)   Data Envelopment Analysis Models are used for examining technical and economic efficiency of fishing fleets. DEAFrontier uses Excel Solver as the engine for solving the DEA models. In order to run the DEAFrontier software, Excel Solver must be installed in the Excel.

(vii) SAS (Statistical Analysis Systems) is a versatilesoftware aiding in advanced analytics, multivariate analyses, business intelligence, data management, and predictive analytics. The programming environment helps in customized analysis of data. The procedures which are components available in the software allows the user to perform analysis and data management as well as produce text-based and graph-based output.

(viii) R is a programming language and free software environment for statistical computing and graphics. The dplyr and ggplot2 packages for data manipulation and plotting are excellent features of the software. R is the best way to create reproducible, high-quality analysis and graphs. It has all the flexibility and power as it is a vector based language.It is freely downloadable from the CRAN (Comprehensive R Archive Network - The website which keeps the R job) repository.

(ix)   PAST (PAleontologicalSTatistics Software) is free software for scientific data analysis, with functions for data manipulation, plotting, univariate and multivariate statistics, ecological analysis, time series and spatial analysis, morphometrics and stratigraphy.