ICLARM Software Projects: Back to the Future

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The notion that microcomputers have altered the course of fisheries science may be disputed - but not the fact that microcomputers have helped shape fisheries science as it is now. The late John Gulland once referred to traditional procedures in fisheries research as seemingly inappropriate on two counts; (i) fisheries have the capacity to develop and reach a critical level in a much shorter time than that required for their scientific assessment by classical methods, which render *post mortem* results rather than useful advice; and (ii) a much greater degree of accuracy is often expected as computational difficulties were circumvented through approximation.

Developments in computer science have brought powerful computing facilities, once only available to those who had access to large and sophisticated computers, to the desks of most researchers in the world. This has, in some ways, diminished the 'inappropriateness' of what was termed traditional procedures. Complex, yet more accurate, algorithms have emerged; procedures once performed tediously can now be accomplished with the press of a button and results are provided instantly; fascinating tables and/or graphs of once meaningless hieroglyphics have been reconstructed to be more friendly and useful.

The turning point in these developments can be traced back to milestones in the computer industry of the early 1980s. This was the time when relatively cheap microcomputers were first made available to the general public. Anticipation of what will be expected from the microcomputer industry was in the mind of every scientist involved in software development, following the trend set by electronic calculators - bigger memory, faster processors and decreasing hardware sizes, weight and more importantly, acquisition costs. These factors set the tone of what is to be the future direction of software development in ICLARM.

Where there are microcomputers there must be software. ICLARM started translating methodologies as early as 1978 (see Fig. 1). The ELEFAN suite of routines was the first system developed by ICLARM implemented on a low-cost microcomputer. Its original version was, however, developed and designed to run on a slow (but in those days, fast) 16 Kbyte(!) microcomputer fed via cassette tapes. In spite of its limitations, the software was a success, measured by the number of requests for a copy. This is attributed to the following reasons:

- it was better than the traditional methods of analyzing data;
- program messages were easy to understand making the procedure straightforward and the methodology better appreciated; and
- it required data which are readily available in most marine laboratories of the world and cheaply obtained.

The Compleat ELEFAN software project followed in the late 1980s, translating and improving routines for use with IBM PCs which at that time were setting the pace in the microcomputer industry. Comments and suggestions were

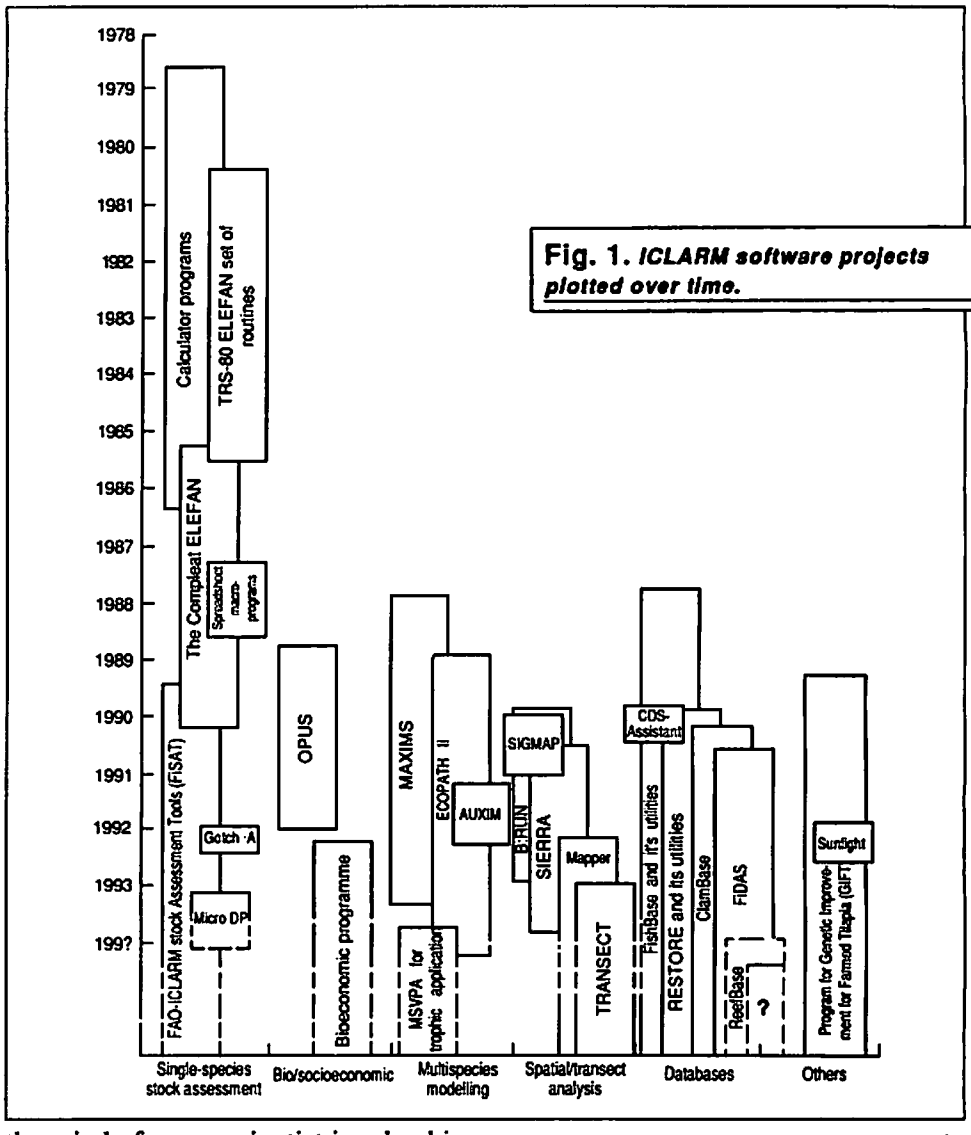

Fig. 1. ***ICLARM software projects plotted over time.***

compiled and used as guidelines for the further development of this software. To date, there are over 500 copies of the Compleat ELEFAN package in circulation.

Other than the 'Herculean' effort to involve the clients themselves in the design of the software, the major factors which have contributed to the success of ELEFAN and other ICLARM software are:

- the software products include methods that can be used and for which data are available or readily collected;
- they are designed to run in low-cost computing environments;
- they are available free or at a very low price; and
- they are fully documented and maintained.

In the late 1980s and early 1990s, the microcomputer industry introduced more powerful low-cost systems which (i) allowed the plot of high resolution graphics, (ii) had bigger storage capacities, and (iii) had bigger and faster processing capabilities. Software products that followed at ICLARM took advantage of these advances.

Thus, in the late 1980s, software in other fields of interest to ICLARM staff began to emerge: OPUS, a socioeconomic software for solving linear programming models using simplex algorithm; MAXIMS, which estimates the food consumption of fishes from diel stomach contents data and population parameters; and FishBase, the electronic encyclopedia of fish, began their development in 1988.

The following year, ECOPATH II, a software for balancing steady-state ecosystem models and calculating network characteristics; B:RUN, a low-level GIS program which is utilized as a decision support system and teaching tool for managing the coastal resources of Brunei Darussalam, incorporating modules for fishing cost-return analyses, oilspill trajectories and color plots of table values, later similarly applied in Peru (SIGMAP) and Sierra Leone (SIERRA); CDS Assistant, a program to facilitate and expand the capabilities of CDS/ISIS bibliographic software released by UNESCO; and a program to analyze the vast amount of data in the Genetic Improvement of Farmed Tilapias (GIFT) project (see *Naga*, April 1991), all began.

There has been further proliferation in recent years with the development of FiDAS, a data acquisition system for marine fisheries research; Sunlight, a software to estimate the amount of sunlight that reaches the surface of the earth; Gotch.A, for the construction of catch curves (for estimation of total mortality) when growth is seasonal; AUXIM, auximetric grid analysis of population growth parameters; ClamBase, a database to genetically track, monitor and evaluate giant clams; RESTORE, a tool to monitor and evaluate natural resource systems; Mapper, a low-level GIS which allows the plot (in part or in full) of the earth with facilities to superimpose on the map other values; and TRANSECT, which graphically plots and analyzes the components of a transect.

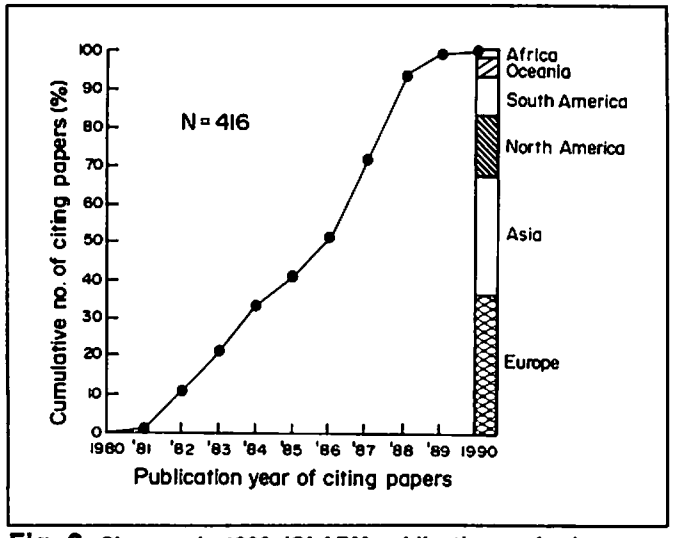

Fig. 2. ***Since early 1980, ICLARM publications referring to the ELEFAN programs have been cited at least 846 times in at least 416 citing papers, reports, theses, etc. This impact is illustrated here as a temporal trend, and by major regions.***

Developments in the pipeline include microDP, which incorporates the routines described in Pauly*; a multispecies virtual population analysis for tropical application; bioeconomic software utilizing yield-stock prediction models coupled with the routines applied in the OPUS software; and a database for information pertaining to reefs.

The major products to date, the Compleat ELEFAN and ECOPATH II, have found equal acceptance in developed and developing countries. For ELEFAN, we are aware of over 400 papers in the literature which cites the software (Fig. 2); European and Asian authors predominate.

The advances in computer science in the past were manageable and could be anticipated. However, computer science is moving exponentially with new trends that are increasingly difficult to anticipate. The introduction of multimedia technologies is begining to gain wide acceptance and will effectively shape current concepts of database development. New inputs to computer science like parallel distributed and neural network programming could prove extremely useful in modeling and data analysis. These new developments carry with them promises that are still beyond the reach of most fisheries scientists. Is scientific finality in fisheries science and management achievable through these advances? Fisheries science can only watch and wait.

Regardless of these uncertainties, ICLARM's software products will continue to flow and be used as tools to test hypotheses and more importantly, as tools for disseminating new findings. ICLARM's new Medium Term Plan (1994-1998), which includes a Computer Services Unit primarily to handle software development and database developments in anticipation of a much bigger demand, is an indication of ICLARM's long-term commitment to continue this endeavor.

Part of this article is based on a paper by S. Garcia, F.C. Gayanilo, Jr. and D. Die on software development at FAO and ICLARM to be presented at the annual meeting of the International Council for the Exploration of the Sea in Ireland, Sep.-Oct. 1993. Copies are available on request.

For further information about the programs mentioned in this article, please contact the author at ICLARM.

*Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev. 8, 325 p.

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