

DIVERSITY OF SMALL-SCALE FISHERIES: RESEARCH PERSPECTIVES AND GOVERNANCE CHALLENGES

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Introduction

A high diversity is observed in the interactions between natural, economic, social, and institutional components of small-scale fisheries (SSF) and their sustainability depend on the ways these interactions work. To date research has been confronted to inherent characteristics of SSF compared to industrial fisheries, e.g. the high diversity and flexibility of forms of exploitation and their wide and diffuse geographical distribution. In 1989 one of the first international symposiums devoted to SSF (Durand et al., 1991) concluded (i) that research should promote multidisciplinary and integrated approaches to local SSF, (ii) that fisher awareness of research outputs should be improved, (iii) that research should provide managers with sound data and analysis to improve their understanding of SSF dynamics, and (iv) that commonly accepted ideas on SSF dynamics should be revisited, e.g. their supposed low economic contribution compared to industrial fisheries and the inefficiency of access regimes.

This communication illustrates how such perspectives have been incorporated in SSF research programmes led by the French Research Institute for Development (IRD, ex-ORSTOM) and its scientific partners in different SSF systems in developing countries. How management systems, exploitation patterns, information needs, and governance challenges in SSF have been addressed by these research initiatives since the 1990s?

Our review of IRD collaborative research dedicated to SSF during the last twenty years is based on six representative case studies located in Africa (Senegal, Mali), South-West Indian ocean (Madagascar),

South America (Peru), and the South Pacific (New Caledonia). They encompass very different geographical scales (from local to national studies), human patterns, resources, and ecosystems. For each case study an overview of historical and current SSF research programmes is described through their specific objectives, instigator, partnership, scientific fields, and data collection and analysis methods.

These research trajectories are used to exemplify the evolution of research frameworks to cope with SSF sustainability challenge.

Case studies

1. The small-scale shrimp fishery in Madagascar (South West Indian Ocean)

Historically shrimp fisheries in Madagascar have been dominated by the industrial sector and research did not specifically address the SSF component until the last decade. Studies were conducted within the Shrimp Fishery National Program (PNRC) with the support of Ifremer (France), local universities, and the Ministry of research and higher education. The initial demand for research in SSF was expressed jointly by Malagasy Fishery Ministry, the French Agency for Development, and a group of private industrial operators to assess the impacts of SSF in industrial activities.

At first research addressed knowledge supply: estimation of SSF capacity (number and characteristics of fishing units, effort and catches), catch biological characteristics (length spectra, sex ratio and fecundity), costs and incomes, social dynamics of the sector, and the role of traditional institutions. Data collection included daily catch/effort, biological surveys and landing prices using common sampling techniques, and two yearly census were conducted to extrapolate fishing data at the national level. Socio-economic and anthropological data were gathered independently with in-depth approaches during restricted periods of the program (Goedefroit et al., 2002). Management issues have been specifically addressed since 2001: 1) improving knowledge on effort and catches in areas concerned by co-management initiatives, and 2) including SSF in bio-economic modeling to produce integrated management scenarios. Catch/effort survey methods were adapted to help cooperation with fishers organizations involved in co-management projects (Caverivière et al., 2008).

2. Reef fisheries in Madagascar (South-West Indian Ocean)

Studies on poverty and biodiversity erosion issues related to forestry and marine resources were undertaken by human and social scientists in collaboration with the University of Antananarivo (C3EDM Program) in the early 2000s. Results highlighted the dilemma between the conservation of coral reef ecosystems and poverty alleviation in south Madagascar. A new multidisciplinary research program (economy, anthropology, ecology, geography, law) has followed up this work in Toliara area since 2005 in partnership with the national Fishery Institute of Marine Sciences (IHSM). The science-based initiative supports the Malagasy national policy on biodiversity conservation and the international commitment to increase marine protected areas (MPA) from 1.7 to 6 million ha in the country.

SSF research focused on the relevance of participatory approaches in ecosystem-based reef fishery monitoring (Brenier, 2009), and the acceptability and adaptability of fisher communities to MPA (Mahafina et al., this issue). Data analysis focuses on the definition of indicator sets and typologies of resource users to produce simple outputs on MPA effects for decision making at a local level. Collection methods mainly consist of (i) interview surveys of fishers and households about their perceptions of management measures and ecosystem health (habitat, resource), and (ii) catch, effort and consumption monitoring. Local communities including scholars were greatly involved in data collection.

3. SSF in Senegal (West Africa)

Research on the Senegalese SSF was initially defined in the 1970's by the Senegalese Research Institute in Agriculture (ISRA) with an historical and significant partnership with IRD. It was devoted to monospecies approach to stock assessment for about 30 years including surveys of the fish biology and exploitation patterns of the most important commercial species to provide information for management in an equilibrium context (MSY, etc.). Due to the importance of SSF, which represent about 65 % of total catches, two major SSF characteristics were recently incorporated in fishery assessments: the multispecies nature of catches and the flexibility of fishing units, which generate variable fishing mortalities.

Social sciences (Stilwell, 2008) and statistical modelling (Pech, 1998) constitute emerging research fields on Senegalese SSF. One of the addressed questions remains the assessment of multispecies stocks with an increasing importance of environmental issues (e.g., pollution, habitat quality). This widening information has led to define comprehensive data collection and indicator systems to understand the socio-economic and ecological interactions and manage fishery sustainability (Thiao and Laloë, 2010).

4. SSF in continental waters in Mali (Continental West Africa)

Social and fishery research undertaken since 1986 showed (i) the strong dependence of the Inner Niger Delta fisheries on annual floods, (ii) the importance of livelihoods strategies of fisher communities, (iii) the effect of seasonal fishing reduction to increase the resilience of fish resources, (iv) the inefficiency of centralized management using uniform rules at national level. At the end of the 1990s, the fishing law was completely reformed by the Malian government taking some of the above research findings into account.

Two programs were initiated in 2008 by scientists to identify the factors of vulnerability of fisher communities at local scale (Mills et al., 2010). The challenge is to define and carry out concrete actions to strengthen communities facing growing environmental changes, e.g. the building of new dams in the Niger river upper basin (Marie et al., 2007). Scientists of this social science-oriented programs (socio-economy, economy of development, fishery biology, ecology, biostatistics, geography) belong to the Malian Institute of Rural Economy (IER), IRD and World Fish Center. They entered into collaboration with sedentary and migrant communities of the Mopti region. The approach consisted in household surveys conducted before and after the refitting of a large pond favorable to fishing activities and rice farming, linked with change in access rules. Landing surveys were also carried out in the vicinity of this development action in order to assess trend in fish resources.

5. SSF in Peru (South America)

Following preliminary surveys since the 1970s, the Peruvian Marine Research Institute (IMARPE) conducted an intensive national census of SSF in 1995 to complement available knowledge on industrial fisheries. Since then, main landing sites of SSF have been monitored at the national scale including direct census of fishing units (every five years) and the sampling of fishing trips at a very high rate (about 80%) to record data on species catch, geo-referenced fishing area, gear type, fishing effort, etc. The first objective of this data collection network was to produce accurate estimates of catches per species (Estrella and Swartzman, 2010). Micro-economics studies have also been undertaken since 2000. IRD (biology, biostatistics, economy, geographical information systems) collaborate with IMARPE (biology, biostatistics) since 2008 to process available information on SSF to improve management (e.g., typologies of exploitation, spatial distribution of catches, dynamics of exploitation in time and space). Computer tools are also under development (i) to facilitate the extrapolation of sample data at the national level, (ii) to generate an online atlas of SSF through a

generic mapping tool (with the assistance of the University of Caen), and (iii) to investigate environmental impacts of SSF through Life Cycle Analyses (Fréon et al., 2010).

6. Reef fisheries in New Caledonia (South Pacific)

Research initiatives on New Caledonian SSF started in the early 1990s using ecology-driven approaches. Direct fish stock estimations relied on *in situ* biomass observations and the use of conventional biological parameters to estimate MSY. Reef fishing activities *per se* have been described since 1996 using fisher interviews and household consumption data from local and national census (e.g., Guillemot et al., 2009; Labrosse et al., 2000). Research efforts on commercial, subsistence and recreational SSF concentrate in the main urban and developing areas, combining different fields (ecology, fishery science, geography, anthropology, socio-economy, law).

A project on co-management of reefs and lagoons was instigated in 2008 with the support of the Fisheries Division of the Northern Province, other research institutions, and private industrial operators (i) to provide public authorities with integrated knowledge and analysis on the dynamics of the fishery system in a multicultural context, and (ii) to strengthen stakeholders participation in SSF management in pilot sites. Data was collected through (i) interviews of fishers, households, Melanesian customary representatives, political leaders and administrative staff, and (ii) direct assessments and monitoring of main resources (sea-cucumber, mangrove crab, reef fish). It provided estimates of catch and effort of main SSF and described the sea tenure, commercial networks, household socioeconomic strategies, and the legal framework. A successful co-management system of the sea cucumber fishery was achieved between public authorities, local fisherfolks, and fishery scientists through participative and direct stock assessment, locally-based and locally-enforced rules (total admissible catch, individual quota, temporary closure), and strong relationships between stakeholders.

Discussion

Social and human science in SSF

In our case SSF studies, we observed for the last two decades a relative increase of the role of social and human science (SHS: geography, anthropology, law, fishery economics, development economics, socioeconomy) compared with the conventional fishery science fields historically involved in fisheries research (e.g. fishery biology, fish population dynamics, biostatistics). Indeed, almost all recent projects developed multidisciplinary research frameworks. Moreover, the role of SHS has greatly changed: twenty years ago, SHS were only used to answer specific questions expressed by fisheries scientists, providing uncommon and relevant insights to better understand SSF complexity (organization of fishing activities, local governance, etc.) whereas some of the current research projects are definitively SHS-driven. Nevertheless, blending SHS and conventional fisheries science required specific efforts from partners, because of the difference in time and spatial scales and data collection/processing methods.

Information on SSF

There was a marked change in the information collected by research programmes across our case studies :

(i) the nature of data has changed including: new research fields, new methodological development due to the widening scope of surveys from monospecies stocks to fishery systems, and the use of spatial fishing data with strong social influence which may lead to local co-management initiatives.

(ii) There is a trend to involve stakeholders in data supply with the use of interviews and participative assessments as new widespread approaches in fishery science to collect local knowledge on practices and perceptions or at the household scale.

(iii) Data is more and more used to define, assess and/or monitor indicators of the state and the performance of SSF and management, including conventional (e.g., catch, effort) or ecosystemic (e.g., habitat characteristics, household socioeconomics) indicators from model outputs or direct estimates.

Typology of research actions in SSF

Research programmes of our case studies may be classified in four categories :

- i) conventional resource management based on simple articulations between natural capital (i.e., resources) and fishing technology;
- ii) social capital-oriented management;
- iii) spatial integrated approaches (e.g., MPA, user conflicts, fishing territories and access)
- iv) co-management approaches (e.g., empowerment of local fisherfolks, information networks, decision process of management rules)

These categories are not exclusive and may overlap. We observed a progressive shift from type (i) to other research types due to emerging issues in SSF but former questions on resource management still remain relevant. Common tools such as stock assessment remain useful given their development and use have been adapted to fit SSF contexts.

Research and action in SSF

We observed that the objects of SSF research have changed: scientists continue to survey catch and exploitation patterns, but the fishers themselves (i.e., their social organization, their perceptions, etc.) and/or the entire management system (i.e., governance issues, etc.) have in many cases become new objects of research. In some cases, research did not involve public authorities while building direct relationships with local communities. This coincidence between objects and beneficiaries of fishery research then enhances the relationships between scientists, stakeholders and decision-makers and involves *de facto* the former in the governance of SSF systems. The role of research consisted in (i) supplying global analysis to decision-makers (e.g., bio-economic models, evolution scenario, functioning of SSF) or data on strategic indicator (e.g., observatories), (ii) strengthening management systems, and/or (iii) instigating collaborative management depending on local issues, study scale, and research fields.

Conclusion

The above trends result from the growing research efforts on SSF for the last twenty years. SSF have received methodological tools previously developed for industrial fisheries (e.g., models, indicators, observatories). Research outcomes in terms of natural resources and users management have also been food for thought to SSF. In our case studies SSF research tackles biological and ecological resource sustainability as well as the participation of local stakeholders (especially fishers) in fishery assessment and/or decision making. Fisher participation appears in a way or another at the heart of current SSF research (e.g., as simple contacts, representatives, decision-makers, beneficiaries). Perspectives may be to define integrated research frameworks to address this challenge to accompany or adapt current governance systems and meet SSF sustainability.

Following other authors (e.g., Berkes et al., 2001), this communication may push forward revisiting SSF research frameworks and creating an interdisciplinary research network to produce and mobilize a more comprehensive and integrated knowledge on SSF.

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