
***Fisheries Dynamics of Modified Floodplains in
Southern Asia***

***Sub-Project 5: Management of Indonesian River
Fisheries***

Project R5953

Fisheries Management Science Programme
managed by *MRAG*, under the ODA
Renewable Natural Resources Research Strategy

MRAG Ltd, March 1997

ODA FMSP Project R5953
Fisheries Dynamics of Modified Floodplains in Southern Asia
Sub-Project 5: Co-Management of Indonesian River Fisheries

Contents

1. Background
2. Sub-project objective
3. Personnel
4. Research activities and programme
5. Description of outputs
6. Acknowledgements

Paper: Spatial Co-Management of Indonesian Floodplain River Fisheries

1. Background

The ODA Fisheries Management Science Programme's project R5953: Fisheries Dynamics in Modified Floodplains in Southern Asia is a three year comparative investigation of a hydrologically modified river floodplain in Bangladesh and a more pristine one in Indonesia. The project was designed to address two key developmental needs:

1. *To understand the implications of migration, reproduction and dry-season survival strategies of river fish on the management of inland capture fisheries.*
2. *To understand the impacts of flood control measures on the fish production potential of modified floodplains, and make recommendations on the wider management of floodplain resources for fish production.*

The first problem is essentially a spatial one, since river fisheries are usually managed using some form of area-based controls on fishing activities. Data on catch/effort, length frequencies and mark/recapture are being sampled at each study site to demonstrate the migratory behaviour of different key fish species in relation to the range of habitat types seasonally available in floodplain rivers. Such patterns, in relation to the spatial units used to manage the fishery, will show the degree of interaction between fishermen in different parts of the floodplain. This in turn, will clarify the abilities and incentives of different players in the fishery - the fisheries department, local communities, leaseholders and fishermen - to sustainably manage the resources on which they depend.

The project's Indonesian study site, on the River Lempuing on South Sumatra is based on a large 'internal delta' floodplain/lake system. An annual, government administered auction is used to lease spatial fishing rights to defined, and valuable waterbodies. Due to Indonesia's wide physical and culturally diversity, it was recognised that the Lempuing study site could not be taken as representative of the country as a whole. Therefore, for the project to produce generally applicable recommendations on inland fisheries management, there was a need to investigate current management practices at a small number of other river systems. This sub-project was developed to address this need.

2. Sub-project objective

This sub-project investigated the variability in local management systems used for Indonesian river fisheries, and its dependence on physical / hydrological and social / cultural features. The study was required to provide advice on the formulation of a generalised, nationwide policy for Indonesia's highly diverse inland fisheries.

3. Personnel

The sub-project was undertaken by the following collaborating staff of the Marine Resources Assessment Group Ltd (MRAG), 8 Prince's Gardens, London, SW7 1NA, UK:

Dr Daniel D. Hoggarth, Fisheries Biologist, Project Leader,
Mr Mark Aeron-Thomas, Economist

and of the Central Research Institute for Fisheries (CRIFI), Jl. K.S. Tubun, Petamburan VI, Slipi, Jakarta 11410A, Indonesia:

Dr Achmad S. Sarnita, Fisheries Biologist, Open Water Capture Fisheries Policy
Ondara, Fisheries Biologist, Project R5953 Indonesian Team Leader
Zahri Nasution, Socioeconomist, Director CRIFI Centre for Riverine Capture Fisheries

4. Research activities and programme

This investigation was undertaken during two separate field trips. The first field trip, between 15 May and 1 June, visited Sumatran river fisheries in the Ogan Komering Ilir (OKI) and Musi Banyuasin (Muba) *kabupaten*¹ of South Sumatra province, and the *kabupaten* Batanghari, of Jambi province. The second field trip was undertaken by two of the CRIFI researchers alone during the period 22-30 July to the Danau Sentarum Wildlife Reserve (DSWR), in the *kabupaten* Kapuas Ulu of Kalimantan's western province.

These case study locations were selected for variations in both the hydro-morphology and sizes of their river systems, and their socio-cultural conditions. In hydrological terms, the OKI and Danau Sentarum sites have two of the largest floodplain lake complexes in Indonesia, while the Muba and Jambi sites have smaller fringing floodplains (Welcomme, 1985), but more closely adjacent to larger main river channels. Social conditions vary most between the remote and community-oriented Sentarum site and the more government-structured administrations in the three Sumatran sites (see appendix 1 for further details).

During each field trip, a mixture of informal interviews, semi-structured interviews, and formal meetings were arranged with a wide range of people connected with each fishery. The following itinerary lists the respondents interviewed at each of the Sumatran study sites.

Case Study 1. *Kabupaten* Ogan Komering Ilir (OKI), South Sumatra province

19 May	Interviews with individual/group fishermen in four R. Lempuing waterbodies Boat visit to R. Lempuing project study site waterbodies (also 20 May)
20 May	Interviews with leaseholders and fishermen in four R. Lempuing waterbodies
21 May	Formal group meeting with Fisheries Department & administrative leaders Ir M. Nasyiruddin, Programme Director, South Sumatra province Department of

¹ The Indonesian Government introduced a hierarchical system of administration during the early 1980s with the following four upper levels in decreasing size: 1 *propinsi* (province), 2 *kabupaten* (regency), 3 *kecamatan* (district), 4 *desa* (village).

- Fisheries / Dinas Perikanan (DOF)
 Ir Lukman Nulhakim, Director of Economics, South Sumatra province DOF
 Drs Syafei Ramli, Director, *kabupaten* OKI DOF
 Drs Muchlis Bakar, Director, *kabupaten* Muba DOF
 Mr H.M. Saleh Cekmat, Director, *kecamatan* Sunsang *kabupaten* Muba DOF
 Mr Mat Asim Mahidin, ex-Director, *kabupaten* OKU DOF
 Depati H. Muh. Rawas, 1949-83 Chief of *kabupaten* OKI administration
- 29 May Solo interview with Ir Lukman Nulhakim, South Sumatra province DOF
 Solo interview with Ir M. Nasiruddin, South Sumatra province DOF
 Solo interview with Drs Syafei Ramli, *kabupaten* OKI DOF
- 30 May Solo interview with Depati H.M. Rawas, 1949-83 Chief of *kabupaten* OKI

Case Study 2. *Kabupaten* Musi Banyuasin (MUBA), South Sumatra province

- 28 May Meeting with Mr Muchlis Bakar, Director, *kabupaten* Muba DOF
 Visit to *desa* Lupatin barrier fishing locations

Case Studies 3-5. *Kabupaten* Batanghari, Jambi province

- 22 May Meeting with Drs Herman Suherman, Dep. Director, Jambi province DOF
 23 May Meeting with Akhyar A. Pi, Director, *kabupaten* Batanghari DOF
 Interview with village leaders of *desa* Arang Arang, A.A. Ibrahim & Enwar
 Boat visit to *Danau* Arang Arang reserve waterbody & fishing areas
- 24 May Interview with *kecamatan* Marosebo assembled village leaders
 Interview with village leaders of *desa* Jambi Kecil, Haji Mahir & M.S. Hasan
- 25 May 2nd interview with village leaders of *desa* Arang Arang
 26 May Interview with village leader of *desa* Muara Jambi, Ibrahim Ar
 Interview with leaseholder / fish trader in *desa* Muara Jambi, Abu Zar
- 27 May Round-up meeting with Jambi province DOF staff

5. Description of outputs

The results from the Sumatran field visit of this sub-project have been written up as a descriptive paper on the 'Spatial Co-Management of Indonesian Floodplain River Fisheries', as attached to this report. The second field visit by the CRIFI staff to the *Danau* Sentarum reserve in Kalimantan is presently being written up by CRIFI staff.

6. Acknowledgements

For their assistance with the planning and development stages of this sub-project, grateful thanks are extended to CRIFI's Director Dr Fuad Cholikh, and to Dr Richard Dudley and Mr Kevin Jeanes of the *Danau* Sentarum Wildlife Reserve of the ODA/AWB/WWF UK-Indonesia Tropical Forestry Management Project.

The results of this sub-project are based on the knowledge and experience of the various respondents listed under section 4, in addition to that of several CRIFI staff including Agus Djoko Utomo.

Spatial Co-Management of Indonesian Floodplain River Fisheries

By:

Daniel D. Hoggarth¹, Mark Aeron-Thomas²,
Achmad S. Sarnita³, and Ondara³

A manuscript for submission to the Indonesian Fisheries Research Journal

from Overseas Development Administration FMSP Project R5953
'Fisheries Dynamics of Modified Floodplains in S. Asia'

¹ Fisheries Ecologist, Marine Resources Assessment Group Ltd (MRAG), 8 Prince's Gardens, London, SW7 1NA, UK.

² Fisheries Economist, MRAG.

³ Fisheries Ecologists, Central Research Institute for Fisheries (CRIFI), Jl. K.S. Tubun, Petamburan VI, Slipi, Jakarta 11410A, Indonesia.

Spatial Co-Management of Indonesian Floodplain River Fisheries

Summary

An interdisciplinary investigation was made on the mechanisms underlying the development of local management systems for floodplain river fisheries at five case study locations in Sumatra. The study sites varied in the hydro-morphology and sizes of their river systems and in the spatial relationships between waterbodies and villages. Interviews and formal meetings with Fisheries Department staff, fishermen, traders and village leaders clarified the relative objectives of the different players in the fisheries towards profit maximisation, resource sustainability or social benefits; and their ability to achieve their aims in different hydrological and social situations. Strong local management regimes were found at all five sites, clearly adapted to local conditions. The site with the largest and most remote floodplains was managed for profit through an auction system. This contrasted with the other sites, where smaller, more locally accessible waterbodies were managed with more social objectives by the adjacent villages. Where permanent dry-season floodplain waterbodies were associated with villages, it was found that these were managed for the long term sustainability of local resources, especially using reserves. In contrast, main river habitats with migratory fish stocks more widely shared between communities were not managed in any way. Due to the complexity of factors affecting floodplain fisheries, and their variability between different locations, it is recommended that further consideration be given to a unified co-management strategy including elements of both local spatial control by communities for the resident floodplain 'blackfish' species, and a wider contribution by fisheries departments for the migratory riverine 'whitefish'.

Introduction

The case for spatial co-management of floodplain fisheries

Floodplain fisheries present unusual management problems. They are highly complex due to temporal and spatial variability; the number of species that make up the stock and the differences in their behaviour; the number of interacting gears; and the diverse forms of involvement of different social groups. To add to the complexity, management agencies are often set multiple, conflicting objectives.

These management issues can, nevertheless, be reduced to two main components: intra-seasonal management, which relates to the trade-offs between the catch of different gears (and the social groups that operate them); and inter-seasonal management, that relates to the survival and reproduction of different components of the stock - the issue of sustainability. These two components are linked in that the pattern of exploitation that emerges from the intra-seasonal management regime directly affects the survival of the breeding stock.

■ *Intra-seasonal management*

Intra-seasonal management issues are of particular importance on floodplain fisheries because the expansion and contraction of the flooded area, the sharp seasonal increase in fish biomass and the migratory behaviour of many species mean that the economic surplus extracted from the fishery is highly sensitive to the type and timing of gear effort. As in any fishery, the capture of young fish early in the season prevents them from achieving their growth potential and so can reduce the total catch value. In floodplain fisheries, delayed capture also results in reduced average costs as catchability increases significantly through the drawdown and/or into the low water period. This is particularly true of those gears with high capital costs, such as barriers, fish drives or dewatering, whose profitability is highly sensitive to the size of the stock remaining.

The impact of gear interactions on potential incomes is recognised by fishermen, who are

frequently found in conflict in an unregulated environment. These conflicts, and the dissipation of potential economic surplus of which they are both an expression and a cause, are best avoided through some form of spatial control. This can be achieved by leasing of discrete areas within the fishery or by any other socially accepted mechanism, such as the allocation of fishing spots according to historical precedent or through lotteries.

The pattern of exploitation that results from the adopted system (or from open access, if no spatial management system is adopted) will have a direct impact on the size and social distribution of fisheries benefits, as those unable to fish or use certain gears will lose income. The nature of tradeoffs involved (economic surplus vs. total employment, leaseholders vs. fishermen etc.) will vary locally, according to the comparative advantage of different gear combinations. The pattern of exploitation will also affect the sustainability of the fishery.

■ *Inter-seasonal management*

Inter-seasonal management (sustainability) issues vary considerably in their local significance, the problems that they pose and, ultimately, the solutions that may be appropriate.

The proportion of a fish stock that survives to breed in the next year depends on the chances of its capture in each of the habitats that it occupies over the year. The habitats adopted by a species are determined by its behavioural ecology; the chance of capture in each is determined by local hydrological conditions and the pattern and level of fishing effort.

Floodplain fish species, then, have adapted their behaviour to the hostile conditions in residual, dry-season waterbodies in different ways. Some species, referred to as 'whitefish', return to the main river channels as the floods recede; others, 'blackfish', have developed anatomically to deal with deoxygenated water and remain on the floodplain. Whitefish species tend to be most vulnerable to capture during their migration through the connecting channels and minor rivers; blackfish are most vulnerable in the residual waterbodies during the dry season.

Local hydrology also affects fish survival as it determines which gears might be used and how successful they are likely to be. Most gears can only be used within certain ranges of depth, river width and current speed². In some areas shallower rivers and floodplain depressions can be fished out almost completely every year, increasing the chances of overfishing. Elsewhere they can only be fished out occasionally, when water levels fall low enough, or not at all; here stocks are more likely to survive.

The pattern of effort is also affected by the management regime. This can be either direct - when specific controls are placed on the type and timing of effort, or indirect - when spatial control is devolved through leasing, which can result in a lower level of effort for some gears but a higher level for others. A leaseholder operating a barrier gear may thus not allow the use of competing gears that select for similar species or age-classes of fish. He may also restrict the effort of other gears to avoid the dissipation of fishermen's economic surplus (the standard open-access outcome), which would reduce their fee paying ability. In most cases, the presence of indirect controls encourages greater use of capital intensive gears.

The spatial variability of floodplain fisheries, particularly in terms of species composition and their vulnerability due to local hydrology, mean that it is very difficult to devise a generally applicable inter-seasonal management regime: a system that works in one place could be disastrously destructive or unnecessarily restrictive in another.

■ *Finding the right balance*

As a fishery develops both intra- and inter-seasonal management usually become necessary.

² Non-hydrological factors can also play a role, such as the use of the river for boat traffic or the presence of a large mass of aquatic vegetation.

The priority given to the two management needs varies, however, among the different interest groups. Fishermen will thus agree to the restrictions on access arising from spatial control of their fishery, sometimes because they have little choice but also because they often recognise the costs to themselves of continual disputes. They are, however, less likely to moderate their catch of overexploited species unless they believe that their actions will encourage others to behave similarly. Leaseholders, whose individual behaviour influences only a fraction of the stock and whose uncertain tenure further undermines their incentive to take a long term view are more concerned with intra-seasonal management issues, even though they may be aware that collectively their actions are unsustainable. Fisheries departments or policy makers, whose mandate extends to the entire stock, are more concerned with sustainability but frequently lack both the knowledge of local conditions and the resources necessary to manage the fishery effectively.

Local communities, on the other hand, tend to be concerned with both sets of management issues. Intra-seasonal management avoids both the dissipation of fishermen's incomes through excessive levels of effort, and conflict. Inter-seasonal management can ensure that the flow of incomes to members of the community is sustained. Moreover, strong local participation in fisheries management decisions has a number of distinct advantages. The distributional trade-offs implicit in alternative management regimes can be set against local socio-economic priorities - communities with significant underemployment might thus prefer to widen the fishing opportunities available even if this reduced the potential economic surplus generated. Also, local communities often have the means to deal with the practical problems of management, as local organisations in which fishermen participate are well placed to encourage collective modifications in behaviour appropriate to the condition of the fishery, impose social sanctions on rule breakers and act as arbitrators in disputes.

Local community management, however, can not be the solution to all problems. The incentives of communities to avoid excessive catches of local blackfish stocks are strong, but they may rightly see the sustainability of the more wide-ranging, whitefish species as a problem beyond their individual control. Accordingly, there remains an important role for government authorities in monitoring the catches of whitefish species, and then co-ordinating communities to reduce their overfishing should this become necessary.

Background

This study was undertaken as part of a project comparing Indonesian and Bangladeshi floodplain fisheries². In Indonesia, the project investigated the River Lempuing '*lebak-lebung*' floodplain lake system, one of the country's most important inland fisheries, with a highly organised auction leasing system. The project's field sampling activities and a fish mark-recapture programme have given a good understanding of the fish and fisheries ecology at that site (to be published separately). However, since the project aimed to provide management advice for Indonesian inland fisheries as a whole, and since conditions vary widely across Indonesia's many islands, it was recognised that a broader approach was needed. This study therefore investigated the variability in local management systems used for Indonesian river fisheries, and their dependence on physical / hydrological and social / cultural features. As will be shown by the following case studies, the apparently complex management issues become much clearer when viewed from such an interdisciplinary position.

¹ Fisheries Dynamics in Modified Floodplains in Southern Asia, UK Overseas Development Administration, Fisheries Management Science Programme, Project R5953.

Methodology

Information requirements

As outlined in the introduction, understanding the management issues of floodplain river fisheries requires a knowledge of a wide range of physical, ecological and socio-economic factors. On the physical side, the scale of the fished waters broadly determines the size of the potential catch, and hence the likely competition for access to resources. The morphology of the waterbodies - the width of the rivers, the depths of any adjacent lakes etc - affects the types of gears which may be effective, and the potential for large individual profits. Permanent waterbodies, either main river channels or lakes, which are too deep to be fished by efficient methods such as dewatering or fish drives, are also likely to be important areas for the survival of fish over the critical dry-season period. Physical factors thus determine the potential value of local resources, and their inherent sustainability.

On the ecological side, different fish species use different habitats within the floodplain, reflecting their tolerance of low oxygen conditions and the spatial details of their migratory life history behaviours. Such behaviours determine their vulnerability to different gears, and their relative sustainability in different habitats. The relative mobility of fish, from the more resident floodplain blackfish to the migratory, riverine whitefish determines the extent to which fish move between the spatial units of different fishermen, and hence the degree of ownership of fish stocks. The sense of ownership, and the desire for a sustainable future, is also likely to be greater where human settlements are located among the waterbodies, and associated with them, and where fishing is a major local employer.

In this study then, qualitative information has been collected on the above physical factors, and on the fishery management mechanisms which have evolved in each locality, and the resulting fishing activities. Particular consideration has been given to the spatial aspects of allocating use rights, eg by licensing, and of preventing overfishing, eg by the use of reserves, or localised gear restrictions.

Study locations

Information was collected at five case study locations, in two provinces of the island of Sumatra (Figure 1):

1. River Lempuing, Ogan Komering Ilir (OKI) *Kabupaten*³, South Sumatra Province
2. River Musi, Musi Banyuasin (Muba) *Kabupaten*, South Sumatra Province
3. Arang Arang village, Batanghari *Kabupaten*, Jambi Province, Sumatra
4. Jambi Kecil village, Batanghari *Kabupaten*, Jambi Province, Sumatra
5. Muara Jambi village, Batanghari *Kabupaten*, Jambi Province, Sumatra

In both physical and social terms, the River Lempuing study site proved to be the most unusual of the five selected. It includes one of the largest floodplain river and lake complexes in Indonesia, with fishing villages which are occupied on a temporary basis following the annual licensing of waterbody units. In contrast, the other four sites have smaller fringing floodplains (Welcomme, 1985), more closely adjacent to larger main river channels, and relatively permanent settlements scattered among the waterbodies.

Data collection

³ The Indonesian Government introduced a hierarchical system of administration during the early 1980s with the following four upper levels in decreasing size: 1 *propinsi* (province), 2 *kabupaten* (regency), 3 *kecamatan* (district), 4 *desa* (village).

Knowledge of the River Lempuing study site has been built up over several years of study by both CRIFI and MRAG staff. Comparative data on this site, and the other four sites were collected during short field visits in May 1996. The four man team spent five research days at each of the OKI and Jambi sites, and one day at Muba. During the field trips, a mixture of informal interviews, semi-structured interviews, and formal meetings were arranged with various people connected with each fishery, in both field and office situations. The categories of respondents included Department of Fisheries (DOF, *Dinas Perikanan*) staff at both provincial and *kabupaten* levels; village leaders - administrative and traditional; fishing leaseholders; fish traders; and group and individual fishermen.

Results and Discussion

In the following case studies, brief information is given where available on the hydrology, fish ecology, socio-economics, fisheries management and exploitation of the sites. These sections are then followed by a summary of observations on the relationships between the management and exploitation patterns, and the underlying physical and social features of the sites. These various features are summarised for each site in Table 1.

Case Study 1. River Lempuing, Ogan Komering Ilir (OKI) Kabupaten, S. Sumatra Province

The OKI floodplain system is the main Indonesian study site of ODA project R5953, and has been the subject of a number of earlier studies (eg Vaas, Sachlan & Wirwatmadja, 1953; Giesen & Sokotjo, 1991; Hoggarth & Utomo, 1994).

■ *Hydrology*

The River Lempuing rises in the western Barisan mountain range of South Sumatra, and joins the Ogan and Komering rivers before meeting the larger Musi River at Palembang (Figure 1). In the Pedamaran and Tugo Mulyo *kecamatan* of *kabupaten* OKI, the Lempuing overflows into an approximately 10km by 20km area of '*lebak-lebung*' floodplain lakes, known as '*Marga Danau*' or Lake District.

At the study location, the R. Lempuing channel varies from approximately 15 to 40m in width. Nineteen *lebung* lakes are scattered around the river, ranging in size up to a substantial 390ha dry-season area (Figure 2). All the Lempuing river channel and most of the larger lakes retain some water in the dry season, and become interconnected in the wet season. Due to the relatively small size of the Lempuing, though, all locations are fishable by the highly exploitive *ngesar / ngesek* fish drives and *penetak* barrier traps, used in the drawdown and dry seasons respectively (see later, and also Hoggarth & Utomo, 1994). The Lempuing joins the Ogan River, which is too large for fish drives or *penetak*, some 10km downstream of the study location (Figure 1).

■ *Fish ecology*

The Lempuing fishery is based on over 30 common fish species, including migratory 'whitefish' such as *baung* catfish (Bagridae, *Mystus nemurus*) and *udang galah* prawns (Palaemonidae, *Macrobrachium rosenbergii*), and more resident 'blackfish' such as *tembakan* (Helostomatidae, *Helostoma temmincki*) and *palau* (Cyprinidae, *Osteochilus hasselti*). The whitefish species are 'shared stocks', as their extensive migrations take them between the different spatial fishing units over the whole study site (see later). The blackfish species are more confined within single waterbodies, while other species such as the *gabus* snakehead (Channidae, *Channa striatus*)

have intermediate mobilities (project mark-recapture migration data, to be published elsewhere).

■ *Socio-economics*

The fisheries of *kabupaten* OKI, including the Lempuing study site, are both productive and valuable. The total OKI catch has been around 16,000t in recent years, with a value of over Rp12,000m (£3.4m, South Sumatra DOF figures). By leasing the rights to fishing for the 1996 season (see later), the local government raised Rp890m (£0.25m), around half the total *kabupaten* income. The two R. Lempuing *kecamatan* produced an average 20% of total leasing revenues, and employed a total of 587 full time fishermen in 1995.

The extensive Lempuing floods, which provide the foundation for the value of the fishery, have discouraged permanent settlement within the leased areas. Most of the Lempuing fishermen live in the town of Pedamaran, located on the river below the main fishing areas (Figure 2). However, those fishermen who are able to obtain fishing rights for a given year usually build temporary houses, or *pondoks*, on their waterbodies.

■ *Fisheries management and exploitation*

The management system in OKI is based on an annual auction of spatial fishing units, originally established by the ancient Palembang Kingdom in 1822 to avoid conflicts among fishermen. Within the two Lempuing *kecamatan*, 35 distinct auction units are recognised and licensed. These may include areas of floodplain, lakes or river channels, or combinations of the three, but are clearly defined by hydrological features such as levees or high ground, at least during the dry season. All waters are leased for fishing, except for the 126ha Teluk Rasau lake (Figure 2), declared by the DOF as a reserve, and the stretch of river flowing through Palembang town, which is free for public use.

Separate auctions are held for each *kecamatan*, supervised by a committee including representatives from the *kabupaten* DOF and the *kecamatan* administration. The auction is open to all, except for the employees of the local administrations. Each year, the auction committee sets minimum 'standard' prices based on last year's sale price, sometimes plus 10% or more. Unsold auction units are subsequently made available in a closed bid auction, at less than the standard price. As noted earlier, the substantial revenue from the auction is mainly taken by the *kabupaten* administration (60%, see Table 1). An additional 15% '*retribusi*' tax has also been imposed since 1983.

Reserves are seen by the OKI DOF as the main mechanism for sustaining the fishery. The DOF's enforcement capacity is limited, though, and some fishermen are cynical about the effectiveness and value of such reserves, seeing them more as a lost fishing opportunity. Other DOF regulations banning the use of poisons, electric fishing and explosives are occasionally broken, and the few mesh size regulations are effectively unenforceable and ignored.

Leaseholders often change between years due to competition for access to fishing. The relationships between leaseholders and fishermen also vary widely. Most commonly, the leaseholder is a fish trader, who sub-leases the rights to fish agreed gears in defined sub-units of his waterbody to separate small groups of fishermen. The leader of each group may then also provide further sub-leases to individual fishermen for certain gears. Credit arrangements are variable and complex, but lease prices may either be paid in advance, or 'in fish' as the year progresses.

Seven main classes of fishing gears are used on the Lempuing (see Hoggarth & Utomo, 1994). In the ebb season, the better financed, group fishermen usually use the expensive *tuguk* trawls and *corong* flumes mounted in heavy *penetak* barriers, spanning the width of the river (see Hoggarth & Utomo, 1994). In the dry season, hydrology-permitting, they use active fish drives, known locally as *ngesar* when undertaken in the river, and as *ngesek* in the lakes. Barriers were

first observed in riverine positions on the Lempuing in 1982, and there are now 17 units. Both large *kilung* and smaller *empang* barriers have, however, been used where the floodplains drain into the rivers for many years. Individual fishermen use smaller, cheaper gears including various forms of small lift nets, gill nets, cast nets, portable traps and hooks. Such gears generally have a longer fishing season than the group gears, being also effective in the flood period. The different fishing gears interact with each other in various ways, depending on the fish species they catch, and the seasons and locations they are set. Many of the interactions are strong, and all fish species are taken by at least two fishing gears (Hoggarth & Kirkwood, 1996).

■ *Observations on the management pattern*

Due to the high potential value of the fishery, and the absence of permanent villages among the waterbodies, OKI's auction based spatial management system is organised by the *kabupaten* and *kecamatan* level administrations. The *kabupaten* now have a high stake in maintaining the auction system, due to their dependence on revenues obtained from it. Several key points about the structure of the auction system confirm the administrations dedication to raising revenues. Firstly, the auction is open, allowing the possibility of high bids from rich traders outside the local area. Secondly, the 'standard' prices are set by an administrative committee, with no fishermen's representative; this prevents the possibility of price rigging by collaborating fishermen. Thirdly, the 15% *retribusi* tax imposed in OKI alone since 1983 is usually applied for 'commodity flows', such as on toll roads, and is resented by some fishermen and questioned by some provincial administrators.

The leasing system does have some clear intra-seasonal management benefits for the fishery itself. It delegates authority for the regulation of fishing effort on a local basis. This reduces the potential for conflict and encourages a greater level of economic efficiency in the choice and timing of gear use, raising the net economic benefit generated by the fishery.

The benefits for inter-seasonal management are less clear. As noted above, the patterns of fish migration and the uncertainty of tenure do not encourage leaseholders to restrict catches even when breeding stocks are known to be stressed. However, for economic reasons, the leasing system does encourage some control of effort (and hence catch) during part or all of the season to a level below that which would occur if access were open. In some leased areas, all fishing is effectively on an individual basis subject to fee payment. Here leaseholders restrict the number of fishermen to ensure that each can generate a sufficient economic surplus to pay their fees. This keeps catch at a lower level than under open access. Elsewhere, where environmental conditions encourage the use of large barrier gears or fish drives, the leaseholders restrict the level of effort of individuals using competing gears to ensure that their own return is maximised. The overall impact of lease holding on the catch then depends on the pattern of effort (and the associated gear efficiencies) that would have applied if access were open.

The effect of the system on fishermen's incomes may well be negative. This effect remains uncertain because the level and pattern of effort that would apply if access to the fishery were open is unknown. More fishermen would certainly come in - leaseholders report that they ration individual fishing opportunities even with current levels of fees - but fishermen do report that life was easier in the past, when licence fees were lower.

The impact on equity is also probably negative, due to the large shares taken by government and leaseholders, and because the pattern of effort is skewed toward the more capital intensive gears. If the system were open access, there would be more fishermen fishing on their own account with simpler gears (see Case Study 3).

The OKI system then has some economic and financial benefits, and prevents conflicts for both the administration and the fishing community. Apart from the Teluk Rasau reserve, though (of unknown benefit), the system does little to guarantee the sustainability of the fishery.

Given the lack of association of any of the Lempuing waterbodies with single villages, the methods for both inter- and intra-seasonal management described in the following case studies would probably not have been viable in this area. In consequence, the current arrangements here - which do have distinct benefits - make sense in the light of local circumstances.

Case Study 2. River Musi, Musi Banyuasin (Muba) Kabupaten, South Sumatra Province

The land bordering the lower stretches of the Musi River, around Palembang, is industrialised and heavily settled, giving some concerns about pollution and degradation (Pollnac & Malvestuto, 1992). In the middle reaches of the river, however, around the *Kabupaten* Muba capital of Sekayu, the river and its fringing floodplains flow through agricultural lands, with increasing proportions of indigenous forests as one moves upstream to the West. The study site around Sekayu (Figure 1) was selected due to its close proximity to the main OKI study site (in the same province), to investigate the operation of the regional auction system on a larger main-channel river system with comparatively smaller floodplains.

■ *Hydrology*

The main River Musi channel in the vicinity of Sekayu has a width of between around 200 and 400m, too wide to be fished by barriers or fish drives. Though ox-bow lakes and other floodplain depressions are reportedly common in Muba, the fishing site actually visited had only a relatively small secondary river, the 10-20m wide *Sungei* Lumpatin, flowing from minor floodplains without permanent dry-season habitats, directly into the Musi.

■ *Fish ecology*

The main catches of fish at the Lumpatin site are of migratory riverine whitefish, particularly the silurid catfish *M. nemurus*, *Cryptopterus* spp., and *Wallago leeri*, the giant freshwater prawn *M. rosenbergii*, and the small cyprinid *Rasbora* spp. The greatest catches were reported to be taken at the beginning of the flood season when fish were migrating up the Lumpatin from the larger Musi. Blackfish species are not locally important in the catches, presumably reflecting the lack of permanent dry season habitats.

■ *Fisheries management and exploitation*

Fishing activities on the *Sungei* Lumpatin are dominated by the use of *corong* flume traps, mounted in cross-river positions, and owned by the leaseholders. In 1996, at the most downstream auction unit, two traps were constructed adjacent to each other: a large one catching upstream migrants at the start of the flood, and a smaller one catching downstream migrants at the end of the flood. Various designs of relatively small meshed portable traps are also used to catch fish which migrate on to the floodplain.

The waterbody auctions in *Kecamatan* Muba are administered at the *desa* level, though most of the auction revenue still goes to the *kabupaten* as in OKI (Table 1). *Desa* in this region may have up to 5-6 waterbodies. At *Desa* Lumpatin, the *Sungei* Lumpatin actually flows through the village, and the auction units are clearly associated with that community. Anyone is entitled to bid at the auction, though, including people from outside the *desa*. In other Muba *desa*, the auction committees are entitled to place bidding restrictions on their auctions.

The 'standard' auction prices are again set by the local auction committees, but at this site the committees include a representative of the fishing community who advises on the current sustainability of the various waterbodies and their feasible lease prices. The guide prices can be increased by up to 10% over last years sale prices, or decreased for waterbodies which last year proved to be unprofitable. A 'Dutch' auction system is also used, where the price may be

further reduced until bidding is opened. In such auctions, virtually all the waterbodies with fishable stocks are usually sold.

From the auction of 600 waterbody units, a total income of Rp400m (£0.11m) was raised in *Kabupaten* Muba in 1996, less than half that in OKI. At the study site, the Lumpatin river was auctioned as four units, decreasing in value as one moves upstream, from Rp2m (£570) down to Rp0.4m (£114).

Outside the auction units, the main Musi river and the seasonal floodplain waters are both open to all fishermen. Reserves are not used in *Desa* Lumpatin, but five reserves have been established by *kabupaten* Muba in nearby locations, one since 1970, and the other 4 since 1994. These reserves, with a total area of over 300ha, were established for conservation reasons following declines in the numbers and sizes of fish, and all five are in the most heavily exploited Sekayu locality. Both monitoring and enforcement are, however, recognised by the DOF to be inadequate.

■ *Observations on the management pattern*

The seasonality of the catch in the *Sungei* Lumpatin indicates that the relatively unfishable and unleased Musi River serves as a reservoir of whitefish for its adjacent secondary rivers. The declaration of the five DOF reserves reflects their concerns about the overall sustainability of these stocks. Local fishermen are reported by the DOF to approve of the new reserves, though this could not be verified in the time available. The lack of reserves actually within *Desa* Lumpatin may be due to the lack of suitable dry season habitats in the vicinity, and the fishery's dependence on the main river whitefish stocks. Though the Lumpatin waterbodies are clearly associated with the village, the actual fish stocks exploited in them are far more wide ranging and shared with the other Muba communities. Therefore, though *Desa* Lumpatin may wish to sustain their local fishery, such fish stocks could not be protected by unilateral action by this single *desa*.

The administration of the auctions at the *desa* level, instead of the higher *kecamatan* level (as in OKI) would appear to reflect the close associations between the villages and the relatively smaller waterbodies at this site. The presence of a local fishermen's representative on the auction committee and the flexibility of the auction price would follow from the highly visible profitability of fishing activities taking place so close to villages, reducing the scope for deception or price rigging. While such an auction system may be more equitable for both the administration and the fishermen, the acceptance of outsider bidding indicates that the maximisation of auction revenues remains a high priority.

The concentration of the catch on the fish passing up the *Sungei* Lumpatin on to the floodplain explains why the value of the auction units decline with distance from the Musi. It also indicates that the leasing system here may be encouraging catch to be taken too early. Catching the fish later, after they had experienced their maximal growth period, could result in greater overall benefits from the system. One solution to this might be to lease out the whole river as a single unit, removing the fear that fish allowed through would be caught by upstream barriers on their return. The leaseholder, then, would still have to worry about catches taken on the floodplains by individuals though, and the total cost of such a large lease unit might exclude local bidders. Alternatively, the capture of fish moving upstream in the early season might be banned.

Case Studies 3-5. Rivers Batanghari / Kumpeh, Batanghari *Kabupaten*, Jambi Province

In Jambi province, fisheries management is also delegated to the *desa* or villages, one level below the *kecamatan* administration responsible for the auction system in South Sumatra.

Management systems in Jambi were known by the DOF to vary significantly between *desa*, and three separate *desa* were therefore selected for study. The three chosen sites were not randomly selected: the first two *desa* were proposed for study by the DOF - *Desa Arang Arang*, which includes the DOF's newly established reserve area, and *Desa Jambi Kecil* which has a well established traditional reserve system. The third *Desa Muara Jambi* was selected as representative of the more common situation with no reserves. The fisheries conditions and management at these three villages are now considered in turn.

Case Study 3. Jambi Province, *Desa Arang Arang*

■ *Hydrology*

Desa Arang Arang is located on the right bank of the *Sungei Kumpeh*, around 30 km upstream from its confluence with Jambi's largest river, the *Batanghari* (Figure 3). The village has exclusive control over a lake, *Danau Arang-Arang*, the largest permanent waterbody in *kabupaten* *Batanghari* (dry season area around 20ha). This is connected by a 2km channel to *Sungei Kumpeh*, where it passes through the *desa*. The seasonal expansion of the lake is accentuated by three small tributaries that extend into the forested area.

■ *Socio-economics*

There are 846 households in the *desa*. Occupations are primarily agricultural. There are large areas of *ladang* (dryland seasonal crops) and bananas that are owned and cultivated by members of the village. In recent years there has also been a growth in wage employment on local rubber estates. It is estimated that there are now around 180 fishing households.

■ *Fisheries management and exploitation*

Since at least the beginning of this century, the three channels flowing into *Danau Arang Arang*, and the main channel connecting it to *Sungei Kumpeh* were all leased and operated as separate fishing units. In 1974, in response to lobbying by local fishermen, the *lelang* auction system was abandoned and open access fishing allowed. The following season, prompted by conflicts between fishermen, the *lelang* was reintroduced on the inflow channels, while the main outflow channel remained open access. There are now a total of 10 leased waterbodies within the *desa* boundary, auctioned in April; there are also two deep '*lubuk*' pools in the river, which are only auctioned if dry season water levels become low enough to ensure their successful fishing. Auctions here, as elsewhere in Jambi, are restricted to bids from village members only.

As a result of these leasing arrangements, the outflow channel is no longer fished by a *sukam* barrier trap, as had been the case when it was leased. It is instead fished by up to 50 lift nets (*tangkul*), and by portable cylindrical traps (*lukah*), with both gears increasing in density at the lake end of the channel. The leased inflow channels are still fished using barrier gears. When sections of the *Sungei Kumpeh* are leased, they are blocked off using *empang* and then seined.

Fishing on the lake itself has always been restricted. Some small traps are allowed to operate on the lake through the year but the main effort is concentrated on one day each year, the '*hari berkarang*'. This event takes place during the low water period in mid-August, on a Sunday, to allow maximum participation. This is a major communal event to which local dignitaries are invited. The main gear is the cast net, used in conjunction with *empang* fish drives. Gill nets and seines are forbidden. Catches are large (ranging from 2t-10t), with catfish and snakeheads the most highly valued species. While each household is entitled to keep what they catch, the marketing is done through groups. The larger fish are kept alive in cages, fed with the smaller fish, and released onto the local market at a rate that does not bring down the price.

Though the lake has been operated as a reserve for many generations, it has recently been

designated a government reserve by the DOF. At the present time, the *hari berkarang* is still permitted by the DOF.

■ *Observations on the management pattern*

The history of management in the *desa* suggests a well developed awareness of both intra-seasonal management issues (and the tradeoffs involved), and of inter-seasonal (sustainability) issues.

Restricting bidding to village residents may reduce total revenue from the auction, but it means that the actual incomes from the fishery stay in the *desa* (fishing reportedly gives 60% of the total village income). Conflicts are also reduced due to the accountability of local people, and the Arang Arang community appears happy with the current balance of reserved, open-access and licensed waters.

The switch from leasing to open access on the channel connecting the S.Kumpeh to Danau Arang Arang seems to have been prompted by a desire for a wider distribution of the economic value of the fishery (there were less than 100 fishermen under the *lelang* system, now there are more than 180), even if this involved a higher extraction cost and a lower total economic surplus.

The reintroduction of *lelang* on the more remote inflow channels is also instructive. The single channel out of the lake is significantly larger than any of the channels into it; and both hydrological flows and fish movements reflect this. The *lelang* system was thus reintroduced on to the less valuable parts of the waterbodies - a seemingly counterintuitive decision. The explanation given for this by the *kepala adat* traditional leader was that the conflicts which took place on the more remote channels were considerably more difficult to adjudicate. The main outflow channel is not only much closer to the village but also carries all the boat traffic between the village, the lake, and the adjacent forested areas, where villagers gather wood and other forest products etc. Conflicts between fishermen on this channel are therefore much more open to public observation and thus easier to resolve in an impartial manner.

The *hari berkarang* serves a number of fisheries management objectives. It takes a limited catch in an efficient manner with a socially equitable outcome. By limiting the type and duration of effort, it reduces the chance that the catch of the blackfish species overwintering in the lake will be unsustainable. But it does this in a way that recognises the economies of scale that are inherent in a collective fish drive when undertaken at low water. It also serves equity by allowing participation by all households from the *desa*.

The dry-season leasing of the sections of the *Sungei Kumpeh*, with no controls being placed on leaseholders, serves to underline the community's recognition that it is the preservation of local (blackfish) stocks that is important, not the preservation of fish stocks *per se*. The Arang Arang reserve protects those blackfish which could be easily overexploited in the dry season. The riverine whitefish of the *Sungei Kumpeh* are not protected as they would be recruited from stocks from the effectively unfishable main river further downstream. Delaying the auction of the two Kumpeh units until it is known whether fishing will be possible, much reduces the financial risks for the fishermen. Such risks are always transferred from the administration to the fishermen in the more valuable OKI fishery.

Patterns of management within *Desa Arang Arang*, like those studied elsewhere, can therefore be interpreted as a logical resolution of the tensions between competing fisheries management objectives in the context of local incentives, opportunities and constraints.

Case Study 4. Jambi Province, *Desa Jambi Kecil*

■ *Hydrology*

Desa Jambi Kecil is located in a wide meander of the River Batanghari, but is separated from the main river on all sides by other adjacent *desa* (Figure 3). Three small secondary rivers do, however, flow through the extensive floodplain lands, eventually leading to the Batanghari via the other *desa*. The largest of these rivers, the *Sungei Berembang*, retains some permanent water in all dry seasons. The three deepest *lubuk* sections of the river here retain an average 3.5m in the dry season providing good habitats for the survival of local blackfish. The river at this point is, however, up to 30m wide, and is potentially small enough to be fished by the efficient barriers or *ngesar* fish drives widely used in OKI.

■ *Fish ecology*

The fish species present in the *Jambi Kecil* waters included both seasonally available whitefish, migrating in from the main Batanghari River, and also locally resident blackfish such as *gabus* and *tembakan*. Detailed data are not available on total catches or productivity, but it is suspected that the local production is relatively small in comparison to that in the substantial OKI floodplains.

■ *Socio-economics*

There are fewer fishermen in *Desa Jambi Kecil* than in *Desa Arang-Arang*. Out of the 526 households in the village, only 10 were professional fishermen, with agriculture providing the main employment. Most of the other households, however, do engage in some subsistence fishing for home consumption.

■ *Fisheries management and exploitation*

There is only limited spatial management of fisheries in *Jambi Kecil*, which was the only site studied without some form of auction system. Fishing is open access in all areas, except for the three *lubuk*, known here as forbidden or sacred '*pusaka*' *lubuk*. As described below, these waters are only fished during ceremonial days, once every few years.

The principal gears used by fishermen in *Desa Jambi Kecil*, whether professionals or subsistence, are the same, and include lift nets, cast nets, gill nets, hooks, spears and portable traps. Such gears are all small and cheap compared to the gears of the OKI group fishermen. The professional fishermen do, however, tend to use the largest *tangkal* lift nets, often with *empang* barriers to improve their efficiency. No serious conflicts were reported between professionals or subsistence fishermen, though the latter were reported to keep clear of the areas where professionals were using lift nets with *empang*. It was also said that professionals were expected to sell some of their catch to other village households at a discounted price.

Fishing in the *pusaka lubuk* takes place only during ceremonial '*hari berkarang*' days. Only spears and traditional lift and jump nets are permitted on these days; the seines used as part of the *ngesar* fish drives in OKI and in *Danau Arang Arang* are not used in *Jambi Kecil*. Local chiefs estimated that only 30% of the fish in the chamber would actually be caught in the one afternoon of fishing.

The *Jambi Kecil hari berkarang* have been practised since before living memory, and also have some religious significance, with the fish stocks being regarded as the gift of the ancestors. Assuming that the waters remain low enough, each of the three *pusaka lubuk* is fished on a separate Sunday some time after Independence Day, 17 August. The decision to fish each *lubuk* is also based on their perceived stock sizes, since the catches must be large enough to demonstrate the high status of the village: on average, the *lubuk* are only fished approximately once every three years. A fishing ceremony actually begins on Saturday morning when fish are driven 500m upstream into the *lubuk* by 50-100 spear-throwing fishermen to be finally enclosed by a bamboo fence at its lower end. On the Sunday morning, another drive brings the fish from

1km upstream down into the *lubuk*, which is finally sealed at the upstream end by another fence. In the *lubuk*, 100 lift nets are set, with village leaders and scholars etc, having the best positions, and also the rights to fish 'jump nets' stationed at gaps in the fences. Participation in the *hari berkarang* is restricted to village members and higher district leaders, and the lift net positions are determined by ancestral rights. All village people are allowed to fish though, and any lowly villagers without lift net positions may fish with spears inside the fish chamber. The afternoon of intensive fishing is preceded by a ceremonial meal, and a blessing by the '*dukun*' magician. The catch, usually around 2 tonnes, may be eaten by village members, either fresh or preserved as '*bakasam*', or sold.

■ *Observations on the management pattern*

The apparent lack of conflicts between fishermen (both professional and subsistence) in this open access situation may be due to a number of factors. Firstly, there are relatively few professional fishermen (10 households), and they do not use any of the major barrier gears (*sukam/corong*). Fishing in the main perennial *lubuk* waterbodies, in which the blackfish must survive the dry season and where conflicts might occur, is also strictly regulated for the *hari berkarang*. The fact that subsistence fishermen also expect to gain from the catch of the professionals, through access to their catch at a discounted price, also probably discourages conflict.

The three *lubuk* reserve areas are clearly managed by the village with a view to long term (inter-seasonal) fisheries sustainability. According to the *kepala adat*, fisheries within the wider area continued to be healthy because their dry season stocks were not fished for two seasons out of three. When fishing was allowed, the ancestrally determined fishing positions avoided the problems arising from competition for spatial advantage, and the catch was limited by the restrictions placed on the gears used.

In terms of the distribution of the *hari berkarang* catch between households, apart from the clear bias against outsiders, the outcome was in some ways becoming more equitable over time. Though some liftnet locations were clearly better than others, their catch was divided among the descendants of the original households, spreading their benefits across the community.

Case Study 5. Jambi Province, *Desa* Muara Jambi

■ *Hydrology*

Desa Muara Jambi lies alongside the main Batanghari River, a few km downstream from Jambi Kecil. Due to siltation, there are now no significant floodplain or lake habitats close to the main village. However, a locally important lake, *Danau Gerang*, that lies just off the Batanghari, 17km downstream from Muara Jambi and outside the *desa* boundary, is owned by the village due to a historical anomaly⁴ (Figure 3). *Danau Gerang* is attached directly to the main river via a short channel and is seasonally flooded its waters. Though the channel dries up in the dry season, the lake retains a minimum of 0.5m water depth. The Batanghari River varies in height by up to 8m over the year and is up to 1km wide at this point. This section of the river belongs to the Province, not to any *desa*, and is an important transport route linking Jambi town to the sea.

■ *Fish ecology*

⁴ According to local history, sometime in the early Dutch colonial period (in the 17th or 18th Century), the fishing rights of the D.Gerang were transferred to Muara Jambi to compensate for the murder of one of its inhabitants.

Due to its floodplain position, fish catches in *Danau Gerang* contain mostly blackfish such as *gabus* and *tembakan*. Catches in the main River Batanghari, as expected, were mainly of the riverine whitefish including catfish, prawns and some cyprinids. Certain species including the valuable ornamental clown loach *botia* (Cobitidae, *Botia macracanthus*) were reported to migrate between the two habitats, eg. with *botia* juveniles in the lake nursery ground and adults in the main river.

■ *Socio-economics*

Of the 500 households and 1946 people in *Desa Muara Jambi*, 30 full time fishermen fish in the Batanghari River, and 15 in *Danau Gerang*. Like Jambi Kecil, however, most of the population (70%) do fish for their own consumption, or for the valuable *botia* fish.

■ *Fisheries management and exploitation*

Fishing on the Batanghari River is open access. The most important fishing gears include different types of hooks and lines (*tajur*, *tagang*, *rawai*), in addition to cast nets (*jala*), *pukat* drift gill nets and *lukah* traps, all fished by individual fishermen.

In contrast to the main river, *Danau Gerang* is a licensed waterbody. The auction, here held in April, has a fixed standard price set by the *desa adat* committee. This is a large committee with a wide variety of decision making functions and is made up of informal leaders, including fish traders and fishermen. The standard price is decided following a public meeting at which any member of the community may speak: for the last three years it has been only Rp500,000 (£143). The final sale price (Rp1.25m last year) is distributed entirely within the *desa*.

The leased *Danau Gerang* is fished quite differently from those licensed in OKI or Arang Arang. At this location, mainly *lukah* traps and a few *tangkal* lift nets are used, not the barriers or fish drives of OKI. Two *empang* are constructed, one at either end of the channel that connects the lake to the river, but only as simple fences without any central fyke trap (as always used in OKI). The upstream *empang*, which is around 100m long, blocks the path of the fish into the channel. A hundred or more *lukah* are then set along this barrier, at its base, with each of the 15 fisherman being allowed 1/15th of the length of the fence. As the water level drops, the upper *empang* is removed and three *tangkal* lift nets are then used along the channel to catch the snakehead moving later in the season. A small number of other individual gears are also used through the season.

Financial arrangements at this site also differ significantly from the usual OKI pattern. In *Danau Gerang*, the leaseholder pays for the individual gears used by the 15 fishermen and the materials used in the construction of the *empang*, as well as for the lease. The repayments for each fisherman are then set at an equal share of the cost of the lease and the *empang*, plus the individual amount borrowed to buy gear. These repayments are made in the form of fish, valued at 20% less than the local market price. The leaseholder claimed that his repayments were between only 5% and 20% of the total value, depending on the catch. In 1995, the fishermen had repaid their loans by July; in 1996 the final repayments were expected to be later, due to the poorer fishing. Fish catches were reported to have been falling for some years.

For the last two years, the *Danau Gerang* auction has been won by a fish trader from *Desa Muara Jambi*. For the previous 14 years, the lease had gone to inhabitants of *Desa Rukam*, the village adjacent to *Danau Gerang* to which it originally belonged. Though the lease has now changed hands, the present fifteen fishermen are still mostly from *Desa Rukam*, as the leaseholder values their greater familiarity with the waterbody.

The ceremonial *hari berkarang* fishing, used in Arang Arang and Jambi Kecil are no longer practised in Muara Jambi. One waterbody, *Danau Kelari*, close to Muara Jambi village, was

formerly operated as a reserve with a *hari berkarang*, but the event has been abandoned since the value of the fishery declined due to siltation from the Batanghari. There are now no reserves.

■ *Observations on the management pattern*

As with the Musi river, the open access to fishing on the Batanghari can be explained simply by the facts that *Desa* Muara Jambi has no authority over it, and that its shared fish stocks cannot be easily caught by any gears such as barriers or fish drives, which would require spatially exclusive fishing rights.

The management of *Danau Gerang* is quite different to the main water bodies in the other two Jambi case studies. While *Danau Gerang* is competitively leased, with no restrictions on the level of catch, the waterbodies in the other two *desa* are managed as reserves which support the fisheries of their surrounding areas but are fished communally with *hari berkarang*. Being located within the area of a completely separate *desa*, some distance away from the settlement of Muara Jambi, *Danau Gerang* may be either impossible to enforce as a reserve by the Muara Jambi community, or it may simply not be regarded as one of their ancestral responsibilities (unlike the now silted *Danau Kelari*).

It is not clear if the *Danau Gerang* leaseholder restricts the level of fishing effort or whether it is limited by the available supply of willing fishermen. In either case, it is probably lower than it would be under open access. Whether it is low enough to ensure that exploitation rates are sustainable is unclear, as the drop in catch could be attributable to the same siltation that had undermined the viability of the *hari berkarang* on *Danau Kelari*.

The fishing pattern in *Danau Gerang*, with many competitive *lukah* traps instead of one *sukam/corong* barrier trap may be due to both economic and social reasons. Barrier traps were reportedly disliked by the leaseholder, who took two thirds of his fish supply from *Danau Gerang*, as they significantly shorten the catch period, leading to transport and marketing difficulties. The fishermen also preferred to have an income more spread over the year. The use of a single barrier trap would also have restricted the employment opportunities of the *Desa Rukam* fishermen, many of whom had fished in *Danau Gerang* for many years.

Discussion of case studies

Many of the factors affecting riverine fish productivity, such as pollution and water levels, are largely outside the control of any local fishing community (Pollnac & Malvestuto, 1992). Other factors may be beneficially controlled by local communities, including the types of gears allowed and the spatial application of full reserves or partial closed seasons etc. The incentives to use such measures for sustainable management is strongly influenced by the degree of control that the community has over the resource. Where control is shared with other communities, resources may best be protected by either concerted joint actions, or by enforced regulations from higher authorities (Caddy, 1982).

The multispecies fish stocks of tropical floodplain rivers clearly contain some relatively immobile floodplain 'blackfish' species which could be protected at a local level, and other riverine 'whitefish' species, which are more widely distributed among the various communities of the catchment. The variable migratory patterns shown by such species has been studied by this project using mark-recapture methods, and will be published elsewhere.

This research on local management practices has shown that fishing communities are well aware of the above distinction between riverine species. Where discrete floodplain waterbodies with local 'blackfish' stocks are clearly associated with permanent villages, then the communities may take steps to conserve them. Conservation measures include reserves with various gear

restrictions, backed up by ceremonial fishing and ancestral rights (eg Jambi Kecil, Arang Arang). Other measures may also be used in such communities to ensure an equitable distribution of benefits from the fishery or to reduce conflicts in open access situations. In contrast, where larger waterbodies, such as the Lempuing River Lake District and the mainstream Musi and Batanghari Rivers, are not associated with any particular villages, and stocks are shared between spatial fishing units, then the fisheries are managed more for short-term financial gain. The mechanisms observed in these larger waterbodies have financial benefits for both the local administrations, and for the fishing communities, but currently display only nominal attention to long-term conservation issues.

Conclusions

Using a case study approach, this research has shown that the management of Sumatran river fisheries is dependent on the detailed local relationships between river morphologies, the behaviours of fish that inhabit them, and the distribution of local communities among the waterbodies.

Management strategies varied significantly between the five sites, though auction systems and reserves were each used in four of the five case studies (Table 1). The detailed strategies adopted by each community emphasised conservation and community objectives where small waterbodies were associated with local villages, and financial objectives where larger waterbodies or main rivers had no clear association with any one community.

In view of the complexity of factors affecting floodplain fisheries, and their variability between different locations, it is recommended that a unified management strategy should include elements of both spatial control by local communities for their resident floodplain 'blackfish' species, and a wider contribution by the Fisheries Department for the migratory riverine 'whitefish'. Such a *co-management* strategy could take advantage of the local management already present in traditional cultures, and would remove some of the difficulties faced by Fisheries Departments trying to impose new administrative regimes from afar, with limited resources for monitoring and enforcement (Bailey & Zerner, 1992).

The actual contribution to be made by the Fisheries Departments to the management of the riverine whitefish is not yet clear. The benefits of reserves for such migratory species, for example, need to be carefully assessed before being generally applied. Until effective conservation measures are found, the highest priority should be in monitoring stocks to determine when active management is actually necessary. Whatever measures may eventually be recommended, these should be applied in a spirit of co-management, and should not be at the expense of the already existing and successful strategies used by the communities for their local stocks.

References

- Bailey, C. and C. Zerner. 1992. Local management of fisheries resources in Indonesia: opportunities and constraints. p. 38-56 *In* Pollnac, R.B., C. Bailey and A. Poernomo, Contributions to Fishery Development Policy in Indonesia, Central Research Institute for Fisheries, Jakarta, Indonesia.
- Caddy, J.F. 1982. Some considerations relevant to the definition of shared stocks and their allocation between adjacent economic zones. FAO Fish. Circ. 749. 44pp.
- Giesen, W. and Sukotjo. 1991. Conservation and management of the Ogan-Komering lebaks, South Sumatra. PHPA/AWB Sumatra Wetland Project Report No. 8, Bogor, 66pp.
- Hoggarth, D.D. and A.D. Utomo. 1994. The fisheries ecology of the Lubuk Lampam river floodplain in

south Sumatra, Indonesia. *Fisheries Research* 20: 191-213.

Hoggarth, D.D. and G.P. Kirkwood. 1996. Technical interactions in floodplain fisheries of south and south-east Asia. p.280-292 *In* Cowx, I.G. (ed.) *Stock Assessment in Inland Fisheries*, Fishing News Books, UK.

Pollnac, R.B, and S.P. Malvestuto. 1992. Biological and socioeconomic conditions for development and management of riverine fisheries resources on the Kapuas and Musi rivers. p.24-37 *In* Pollnac, R.B., C. Bailey and A. Poernomo, *Contributions to Fishery Development Policy in Indonesia*, Central Research Institute for Fisheries, Jakarta, Indonesia.

Vaas, K.F., M. Sachlan and G. Wirwatmadja. 1953. On the ecology and fisheries of some inland waters along the rivers Ogan and Komering in SE Sumatra. *Contr. Intl. Fish. Res. Strn, Djakarta-Bogor, Indonesia* 3: 1-32.

Welcomme, R.L. 1985. *River Fisheries*. FAO Fish. Tech. Pap. 262. 330pp.

Glossary of Indonesian Terms

Administrative levels

<i>propinsi</i>	province (highest)
<i>kabupaten</i>	regency
<i>kecamatan</i>	district
<i>desa</i>	village (lowest)

Hydrological features

<i>danau</i>	lake
<i>lebak</i>	floodplain
<i>lebung</i>	floodplain lake
<i>lubuk</i>	deep river pools
<i>sungei</i>	river

Fishing gears

<i>corong</i>	river flume barrier trap
<i>empang</i>	bamboo fence
<i>jala</i>	cast net
<i>kilung</i>	floodplain barrier trap
<i>lukah</i>	cylindrical portable trap
<i>ngesar</i>	river fish drive

Fish species

<i>baung</i>	catfish, <i>Mystus nemurus</i> , whitefish
<i>udang galah</i>	giant prawn, <i>Macrobrachium rosenbergii</i> , whitefish
<i>tembakan</i>	kissing gourami, <i>Helostoma temminki</i> , blackfish
<i>palau</i>	carp, <i>Osteochilus hasselti</i> , whitefish
<i>gabus</i>	snakehead, <i>Channa striatus</i> , blackfish
<i>botia</i>	clown loach, <i>Botia macracanthus</i>

<i>ngesek</i>	lake fish drive
<i>penetak</i>	river barrier
<i>pukat</i>	drift gill net
<i>rawai</i>	long line
<i>sukam</i>	river flume barrier trap
<i>tajur, tagang</i>	individual hook
<i>tangkul</i>	lift net
<i>tuguk</i>	river trawl barrier trap

Others

<i>adat</i>	traditional
<i>bakasam</i>	preserved fish
<i>Dinas Perikanan</i>	Dept. of Fisheries
<i>dukun</i>	magician
<i>hari berkarang</i>	ceremonial fishing day
<i>kepala adat</i>	traditional leader
<i>ladang</i>	dryland seasonal crops
<i>lelang</i>	auction
<i>pondok</i>	temporary house
<i>pusaka</i>	sacred
<i>retribusi</i>	commodity flow tax

Table 1. Comparative summary of research observations at the five case study sites.

Case Study	1. River Lempuing	2. Muba	3. Arang Arang	4. Jambi Kecil	5. Muara Jambi
Location Province (<i>Propinsi</i>) Regency (<i>Kabupaten</i>) District (<i>Kecamatan</i>) Village (<i>Desa</i>)	South Sumatra Ogan Komering Ilir (OKI) Pedamaran/Tugo Mulyo Several	South Sumatra Musi Banyuasin (Muba) Sekayu Lumpatin	Jambi Batanghari Perwakilan Kumpeh Ulu Arang Arang	Jambi Batanghari Marosebo Jambi Kecil	Jambi Batanghari Marosebo Muara Jambi
Floodplain morphology Size/type of flood plain Proximity to main river Location of villages	Large, internal delta ~5-35km upstream Away from waterbodies	Small, fringing Adjacent Among waterbodies	Small, fringing ~10km upstream Among waterbodies	Small, fringing Adjacent Among waterbodies	Small, fringing Adjacent Among waterbodies
Spatial Management Licensing Units Reserves Open access areas Subsistence areas	35 auction units 1 DOF reserve River through main town All waters	~600 units in Muba 5 DOF reserves in Muba, none in <i>Desa</i> Lumpatin Main river + open floodplains All waters	10 - 12 auction units 1 DOF reserve (est. 93) River through village + channel to lake All waters	None 3 <i>pusaka lubuk</i> (traditional) All other waters All waters	One auction unit No reserves All other waters All waters
Waterbody Licensing Method of allocation Pricing mechanism Committee Membership Revenue distribution <i>Retribusi</i> tax	Open auction Constant/increasing minimum price + closed bid system Community leaders only 60% <i>kabupaten</i> , 30% <i>desa</i> , 5% DOF, 5% auction committee 15%, introduced 1983	Open auction Flexible guide price (not minimum, 'Dutch' auction) Community leaders + fishermen 65.8% <i>kabupaten</i> , 29.7% <i>desa</i> , 3.5% DOF, 1% auction committee None	Within-village auction Flexible minimum price Community leaders + fishermen 95% <i>desa</i> , 5% DOF None	None None	Open auction Flexible minimum price Community leaders +fishermen 100% to <i>desa</i> None
Other locally-imposed Regulations	Decided by leaseholders, vary between waters	?	Lift & gill nets only in <i>hari berkarang</i> ; no barriers in open- access channel	Lift nets and spears only in <i>hari berkarang</i> ; no seine nets	No barrier traps in leased channel to auction unit
Fishing Gears Used	Large barriers & fish drives used by lease-holding groups; small traps & hooks etc used by sub-licensed individuals	Large barriers catching mostly upstream migrants from main river, also traps and hooks	Liftnets (replaced old barrier), small traps & hooks used by individuals; fish drives in leased areas around reserve.	Liftnets with small barriers, hooks, traps & spears, used by individuals	Liftnets, hooks and traps fished by sub-licensed individuals, (competitive, positioned against barrier)
Ceremonial Fishing	None	None	<i>Hari berkarang</i> one day per year in reserve, hydrology permitting	<i>Hari berkarang</i> 1d/yr in reserve, hydrology & stock permitting	No <i>hari berkarang</i> now, water- body silted up

Figure 1. Location of the five case study sites in Sumatra, Indonesia.

Figure 2. Waterbodies and fishing settlements at the River Lempuing case study site.

Figure 3. Waterbodies and communities at the three case study sites in Jambi Province.