# Developing fisheries enhancement in small waterbodies: lessons from Lao PDR and Northeast Thailand

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## Abstract

Culture fisheries enhancements are widely practised in small waterbodies throughout the Mekong region. Although frequently initiated by local communities, enhancements have received considerable financial and logistic support from governments and some NGOs. In this paper, we firstly review the characteristics of enhanced small waterbody fisheries in Lao PDR and NE Thailand, and evaluate their performance in terms of productivity and socio-economic as well as environmental impacts. Secondly, we assess the need and potential for improving the performance of enhancements, and explore how governmental organisations and NGOs can aid the sustainable development of enhancements through a process of participatory, adaptive learning.

Keywords: Participatory adaptive learning, enhancement, small waterbody management, uncertainty, institutions, stocking

## 1 Introduction

The resources under consideration, small waterbodies, have been defined as "small reservoirs and lakes less than 10km$^2$ in area; small ponds; canals including irrigation canals; small, seasonal, inland floodplains and swamps; and, small rivers and streams less than 100km$^2$ in length" (Anderson, 1987).

Experiences of stocking ventures in such waterbodies have shown that whilst stocking has the potential to yield substantial benefits, the actual outcomes (in terms of production, distribution of benefits, institutional sustainability etc.) are often different from those initially expected (Garaway 1995, Hartmann 1995, Garaway 1999, Cowan et al. 1997; Lorenzen and Garaway 1998, Samina and Worby 1993).

The underlying reason for the prevalence of unexpected and sometimes undesirable outcomes of stocking in small waterbodies lies in (a) the inevitably limited prior

knowledge of the physical, biological, technical and institutional characteristics of individual sites which show great variability; and (b) the complexity of the environments into which enhancements are introduced, involving dynamic interactions between the biological characteristics of the resource, the technical intervention of enhancement *and* the people who utilise or manage it.

This paper seeks to highlight these points and suggest ways in which the constraints they pose can be addressed. It reviews some of these previous experiences specifically relating to small waterbodies, and focuses on the small waterbody research experience of the authors in Udon Thani Province, N.E. Thailand (1993–1996) and Savannakhet Province, Lao PDR (1994-present).

Section 2 of this paper presents a brief review of some of the small waterbody stocking initiatives in the study countries and gives some examples of outcomes that have occurred. Section 3 highlights some of the general lessons that have been learnt from studying these processes and outcomes and, in particular, the constraints and opportunities they provide. The section ends with recommendations for an adaptive process oriented approach to management and suggests a possible role for governments and/or other external research and development agencies.

# 2 Case studies from Lao PDR and N.E. Thailand

This section provides a brief review of some of the results and conclusions of previous work by the authors. Details of this research can be found in Garaway 1995, Garaway *et al* 1997, Lorenzen & Garaway 1998, Lorenzen *et al* 1998a, Lorenzen *et al* 1998b, Garaway 1999.

## 2.1 Small waterbodies and the role they play in rural livelihoods

In Savannakhet Province, Lao PDR, small waterbodies are ubiquitous and play a very important direct role in the livelihoods of almost all rural households, primarily for subsistence needs but also, and increasingly, for income generation (Garaway 1999). Household participation in such fisheries is almost universal (Claridge 1996, Garaway 1999). The Province, like the country, is characterised by semi-independent rural villages engaged in subsistence agricultural production with rice farming being the primary economic activity, supplemented by other activities such as fishing and small livestock rearing. Personal fishing in small waterbodies accounts for, on average, at least 70% of the fish acquired by rural households (Garaway 1999).

In N.E Thailand, the growth of the agricultural sector has declined in recent years but, as in Lao PDR, rice production is still the most important sector in the region and people in rural areas combine farming with fishing activities. Small waterbodies, similarly widespread, are the important fishery resources (Fedoruk and Leelapatra 1992, Garaway 1995). In the rural areas in the Northeast, up to 80% of fish consumed was obtained from such sources (Prapertchop 1989). Whilst it is expected that reliance is less now, a less detailed but later study suggested that reliance was still high, but that it varied between households of different socio-economic status (Garaway 1995).

In both research locations, freshwater fish is believed to be the most important source of animal protein.

## 2.2 Promotion of stocking and uptake

- *Lao PDR*

In Savannakhet Province, stocking of small waterbodies, particularly with Nile tilapia *Oreochromis niloticus*, and to a lesser extent common and Indian major carp, has been actively promoted by the government since 1994, and the practice is spreading rapidly. Government policy has stated that "priority in the short, medium and long term is to be given to the reduction of declining harvests and the development of fisheries in the rivers, lakes and reservoirs..… these actions could allow the fisheries sub-sector to increase gradually its production figures from the current estimates. (Phonvisay, 1994)". The promotion of stocking in small waterbodies is seen as one way of doing this.

Waterbodies currently subject to enhancement include oxbow-lakes, natural depressions and man-made reservoirs of sizes ranging typically from 1 – 20 Ha. Typically these waterbodies are under the *de facto* ownership of one, or two closely-connected, villages and are adjacent to the villages concerned.

Government have been supporting villages through the provision of limited technical advice, through part-payment of fingerlings and through facilitating 'study tours' to villages already involved with stocking. Operational rules (including monitoring and enforcement) regarding management are predominantly devised (and carried out) by the local communities themselves and hence there is considerable variation between villages, with villages also experimenting with their own rules through time. Government staff do give advice, particularly regarding who should be the benefactors of these initiatives.

In Savannakhet Province, response to stocking in rural communities has been varied. Of thirty-one villages and waterbodies studied, twenty supplied new institutions to manage their newly enhanced waterbody, and subsequently maintained these new institutions, whilst eleven did not (Garaway 1999). The types of institutions that were supplied are discussed in the next section. Research found that communities were more likely to supply new rules when there was a commitment to do so *prior* to stocking. Such communities devised the idea themselves, or in partnership with the government fisheries department, and at least part-financed the stocking. Having information about benefits from stocking, in particular first-hand information gained from visiting other villages enhanced such commitment. Other factors encouraging supply of new rules included the presence of skilful leaders, entrepreneurs and district government staff in the village (Garaway 1999).

- *Northeast Thailand*

In Northeast Thailand, culture based fisheries in village ponds have developed since the 1980s, following the expansion of government and private fish seed production, and various programmes to build village ponds and to promote aquaculture. At the time of the research (93-96), fish culture in communal ponds and reservoirs was being promoted by the Village Fisheries Programme (VFP) of the Department of Fisheries (DOF) with one of the primary aims being the promotion of communal semi-intensive aquaculture. Again, waterbodies selected were generally under the *de facto* ownership of one, or two closely-connected, villages and were adjacent to the villages concerned. As in Lao PDR, under the programme, village communities assumed responsibility for pond management and specific decisions on operational rules, including monitoring and enforcement, were taken by the village communities. Government support included brief training in management techniques such as nursing, feeding, fertilisation, and integrated agriculture-aquaculture. Seed fish were partially subsidised in the first three years of any new village fish pond.

Department of Fisheries staff expressed dissatisfaction with the technology uptake in the VFP (Lorenzen, pers. obs.). Surveys show that many villages did continue to manage the village pond actively after the first three years, but that few villages provided significant inputs other than seed fish (which were stocked at 2-3 cm without nursing) (Lorenzen *et al*. 1998a) and therefore villagers were not operating the communal, semi-intensive aquaculture systems originally promoted.

## 2.3 The types of institutional change that stocking catalysed - a preliminary outcome of stocking.

The stocking initiatives discussed above frequently catalysed changes in how waterbodies could be used and by whom and many changes were often not anticipated by external agencies.

Commonly, in both countries, operational rules radically altered access rights and the nature of household benefits that could be obtained from resources[1]. For example, personal subsistence fishing, usually previously permitted, was commonly prohibited or very much restricted, the level of restriction depending on the extent to which individual fishers had access to other resources. Instead, the fishery became increasingly commercialised. Resources were harvested in a way that produced a village income for community development, and the allocation of fish not used for these commercial purposes, and other derived benefits from the waterbody, was determined by rules set up by local decision-makers.

In N.E. Thailand, by far the most common management regime that replaced subsistence or small-scale fishing, was the holding of an annual fishing day where tickets were sold to individuals from within and outside the village, allowing them to fish with cast nets and lift nets. As well as generating income for the village, these days were also important social occasions (Chantarawarathit 1989, Garaway 1995). Outside of this day, fishing was commonly prohibited.

[1] (In Thailand, an exception to this was where waterbodies were purpose built and in these instances, rules were created rather than altered).

More common in Lao PDR was that the resource would be fished by teams under the supervision of a management committee in a period of low agricultural labour demand (between January and May). Payment to the fishers concerned varied between villages. Outside of this time, fishing was also commonly prohibited. Why the institutions developed in Lao PDR were different to those in N.E Thailand is not known, though a possible explanation is that the opportunity costs of team fishing are far greater in Thailand than in Lao PDR. Other less common systems in Lao PDR included renting the waterbody to a group inside the village or, as in Thailand, holding an annual fishing day. (Garaway 1999)

As well as these broad variations in institutions between village communities, there were numerous smaller variations and villages also experimented with their own management rules over time, continually adapting them to local objectives and circumstances.

## 2.4 Examples of some of the outcomes of stocking initiatives

This section gives a very brief review of some of the main technical, socio-economic and environmental outcomes.

- *Technical outcomes (production potential and yields)*

In Savannakhet Province, Lao PDR, a comparative study of waterbodies under different management regimes showed that the management systems described above, with a combination of access restrictions and stocking, had a strong positive effect on both standing stocks and biological production potential (Lorenzen *et al* 1998b). However, low levels of effort, brought about by the access restrictions, and selected harvesting of the larger stocked species only, meant that overall yields were not different between enhanced and non-enhanced fisheries, i.e. the potential for increased production was not realised (Garaway 1999). On the other hand, harvesting efficiency and hence the productivity of labour in the fishery increased greatly by up to a factor of three, and this was appreciated and valued highly by stakeholders (Garaway 1999).

An institutional analysis suggested that the low levels of effort were ultimately the result of a combination of the operational rules that governed access, and low incentives for active involvement in the fishery. Crucially, whilst any of these rules could have been changed to increase effort, possibly leading to increased yields and associated benefits, all would involve increased costs or lower economic returns to labour and hence were not preferred (Garaway 1999).

In N.E Thailand, stocking, catch and related data were collected for 16 village ponds. There was large variation in technical outcomes with yields ranging from 26 to 2881 (median 652) kg/ha/year. Yields were strongly related to the trophic status of the waterbody and to stocking density (with an optimum at 9800 fish/ha/year of 2-3cm seed fish). Stocking performance varied greatly between species and was also influenced by the trophic status of the waterbody (Lorenzen *et al* 1998a). Catches were dominated by tilapia in the most fertile water bodies and by carp species in all

others, but catch species composition did not significantly influence yield when the effect of trophic status was accounted for.

The median yield of 652kg/ha/yr was far less than villagers could have obtained had they managed the waterbodies as communal, semi-intensive aquaculture systems as originally promoted, instead of culture-based fisheries. For example, data for semi-intensive aquaculture, based on recommendations for farmer pond culture (AIT, 1993) suggest yields of around two and a half times this much at 1563/kg/ha/year.

The reason why local decision-makers chose this route was suggested by an economic analysis. It showed that the culture-based fishery provided much higher returns to communal labour and finance than semi-intensive aquaculture enterprises and the fact that people opted for culture based fisheries suggests that such communal labour and finance were in short supply (Lorenzen *et al* 1998a). Therefore, operating a culture-based fishery was a successful adaptation of the extended technology to village needs.

In summary, in both these cases it can be seen that the operational rules devised by local communities had a crucial affect on what outcomes were achieved or were achievable and these rules, and consequent outcomes, were not fully anticipated by external agencies. Closer analysis of these rules suggests that they had been chosen to fit with local needs and circumstances.

- *Socio-economic outcomes of enhancement initiatives*

The section above discussed total benefits of stocking initiatives in terms of yields, and harvesting efficiency. However, given that the stocking initiatives catalysed changes in both the allocation and nature of benefits from the fishery, it is important to understand how these changes affected the distribution of the benefits amongst resource users.

As mentioned previously, the principal benefit from these stocking initiatives was the production of village income for community development. This is very different from the benefits from capture fisheries and demonstrates that stocking can catalyse a fundamental shift in the role and function of small waterbodies. In a detailed study of four villages managing stocking initiatives in Savannakhet Province, household benefits from the stocked waterbodies were found to include: a cheap source of good quality fish; decreased personal cash contributions to the community development fund; increased community income for improved community services (in some cases); decreased personal fish contributions for when the village entertained guests; and payment (in fish or sometimes cash) for communal harvesting and marketing. Selling fish cheaply to individuals from surrounding villages, and entertaining guests, fulfilled a traditional social function of strengthening links between villages (Garaway 1999).

Regarding the distribution of these benefits, with their higher capacity to buy fish, richer households were able to take more advantage of the new market supply of fish than the poorest socio-economic groups. However, this saving was small at less than US$2/household/season. In addition, it could be argued that the poorest households, with less household economic surplus, benefited more relatively from

the decreased personal cash and fish contribution needed to fulfil community obligations. In summary, it is believed that no socio-economic group was benefiting substantially more than others. (Garaway 1999)

However, research showed that members of the poorest rural households utilised local fishery resources for their own purposes the most and therefore had the highest total annual catches. This suggested that, if they did not have access to suitable alternatives, they would have the most to lose from the restriction of individual access to small waterbody resources brought about by stocking initiatives. Whilst this was the case, it should be noted that variation between the socio-economic groups in terms of utilisation of the fishery was not large and was found to be far greater between villages (Garaway 1999).

In fact, despite loss of personal use, villagers did not perceive they had been adversely affected by access restrictions. This was because either they had other convenient places to fish or, when this was not the case, it had been taken into consideration by the rule designers and the access restrictions were correspondingly less severe.

There is less information available on the benefits of stocked waterbodies and their distribution in N.E. Thailand, but they did not seem as wide-ranging as those in Lao PDR, with the main benefit being community income, the social occasion of the fish catching day and the use of water for buffalo and vegetable irrigation. There is little information on whether these benefits were distributed evenly. One study suggested that some of the poorer households did not participate in the fish catching day because of the ticket price. However this did not appear to be common (Garaway 1995). Regarding the costs of lost access to previous fishing resources, the same study suggested that, contrary to the situation in Lao PDR, it was middle income farmers rather than poorer farmers that utilised local fishery resources the most, and would therefore be most affected by access restrictions (Garaway 1995). Again though, in the area studied, the loss of only one of many fishery resources was not perceived to have had a deleterious effect by resource users.

Evidence suggests therefore, that whilst the nature of benefits had changed, local rules have been chosen that distributed the new benefits evenly across socio-economic groups and accounted for local fishing for subsistence needs.

- *Environmental outcomes*

Information on environmental impacts is only available for Lao PDR.

In the comparative study of waterbodies under access restrictions and/or stocking or neither, it was shown that access restrictions, even in combination with the stocking of exotic species, had a significant positive effect on the standing stocks of *wild* fish, and there was no evidence of negative effects on their diversity (Lorenzen *et al*, 1998b). This was an unexpected outcome, brought about by the access restrictions, and selected harvesting of the larger stocked species only for selling and entertaining guests with. While stocking is not necessary for communities to introduce and enforce access restrictions, it has certainly facilitated such steps, and the net effect has been a rapid proliferation of restricted access fisheries in

Savannakhet. Increased stocks in perennial small waterbodies are likely to have positive effects on the yield from seasonal habitats such as paddies, and may also have conservation benefits.

Again then, it can be seen that the changes to operational rules catalysed by stocking, had a profound and unanticipated affect on fishing practices which in turn lead to unexpected and in this case possibly desirable environmental outcomes.

# 3 Discussion

These results show that stocking initiatives have provided benefits due to both, (1) direct biological effects of stocking (increased recruitment of valuable species), and (2) indirect effects due to institutional change resulting from the investment into common pool resources (e.g. incentives for sustainable use, reduced fishing pressure and higher returns to labour).

However, as is also shown, outcomes have often been unpredictable, different to what has been anticipated or less than optimal presence of unexpected outcomes is caused by the fact that there is still a great deal of uncertainty surrounding both the direct and indirect effects of stocking.

## 3.1 Uncertainty associated with enhancement management

Firstly, uncertainty may result from the fact that the underlying biological processes are still not fully understood (such as species interactions) or they are subject to 'random' variation linked to variation in external conditions (such as rainfall). Another problem is that even in cases when processes are understood, external agents, such as governments, are constrained by a lack of location specific information (e.g. waterbody productivity, species composition and biomass), as resources for widespread research at such a specific and local level are often lacking. All these factors result in there being considerable *technical* uncertainty associated with stocking initiatives.

The same sources of uncertainty (lack of understanding about the underlying processes and lack of location-specific information) are also relevant when considering the institutional aspects of stocking initiatives. The act of stocking often catalyses institutional change but such rule changes are frequently not considered or not anticipated pre-intervention, and the rules and their consequent effects rarely studied in a systematic way in ongoing initiatives. Because of this, there is still very little information about the underlying factors and processes that motivate different types of human action, actions that ultimately result in certain types of rules being devised and/or certain levels of rule compliance. This creates much *institutional* uncertainty about what changes are likely to accompany which type of initiative and what institutions are likely to provide the more optimal outcomes in any given set of ecological and social circumstances.

This lack of understanding is exacerbated by the fact that in many cases, even when there are resources to collect this type of information, many analysts are unaware of

the value of doing so, instead relying on technical information only. Studying technical and biological interactions, whilst essential, does not enable us to understand, predict or improve outcomes in real settings, without understanding how they are affected by, or in turn affect, the institutions put in place to govern use (& investment). Even technical outcomes cannot be understood with reference to technical variables alone. Integrated research recognising the inter-relationship between the technical intervention, the nature of institutions, the resource and community characteristics is urgently required to address this.

All this uncertainty makes it difficult for external agencies to come up with context specific management guidelines that will produce predictable and desirable outcomes. The question that needs to be addressed is, what approach could such agencies take that would deal with or reduce these uncertainties so as to increase the chances of this happening.

## 3.2 Dealing with uncertainty through participatory adaptive learning

Some of these uncertainties could be reduced just by having more knowledge pre-intervention whilst others, which may be termed dynamic uncertainties (i.e. the response of certain variables to change), can only be resolved by actually observing them, either through time, or across systems under different management. Other uncertainties, such as 'random' variation in external conditions can not easily be reduced at all.

It is suggested here that much could be gained and much uncertainty reduced by external agencies and local communities combining their strengths through a process of participatory adaptive learning, as described in Lorenzen & Garaway, 1998.

Adaptive learning has been described as a structured process of 'learning by doing' that involves learning processes in management rather than single solutions, or control, through management. The approach provides for an increase in knowledge about the resource systems in question that will, in turn, enable management policy to be refined. To produce this knowledge, and thereby reduce uncertainty, management is treated as an experimental process, aimed at yielding crucial information for the improvement of management regimes as well as more immediate benefits for the participating stakeholders. *Participatory* adaptive learning requires that the communities affected by the stocking initiatives take an active and equal role in the experimental process.

It is believed that such an approach could help to reduce the reducible uncertainties in the type of small waterbody enhancement management described in this paper, more quickly and at a lower cost. Such an approach is possible because of the opportunities that the resource management systems described here provide.

### 3.3 Attributes of resource systems that facilitate adaptive learning

- *The ubiquitous nature of small waterbodies*

Small waterbodies are ubiquitous throughout the environments being considered and therefore there are opportunities to observe differences across different entities at the same time, thereby reducing the time required for knowledge to accumulate. If this were done in a systematic way, there would be great opportunities for reducing dynamic uncertainties, by first identifying precisely what information is required to reduce the uncertainty and secondly carefully selecting sites that will yield this information.

- *The presence of variation that enables comparative study*

The resource systems in question already show great variability in terms of their biology *and* the institutions set up to govern use. This means that much can be learnt from the careful selection and study of *existing* management resource systems without the need for any further intervention (so-called passive experimentation). There may be cases where more active experimentation would yield substantially more information and in these cases, where such intervention can be implemented at appropriate levels of cost and risk and with the full participation of local communities, such an approach would be appropriate.

- *The time and place knowledge of local users*

One of the major uncertainties to be addressed is the lack of location specific information. Whilst external agencies do not have the resources to collect this information themselves, it should be recognised that local communities already have extensive knowledge about their resources, their communities and the institutions they use to govern resource use. Such knowledge should be utilised.

This research has shown that under certain circumstances, communities can and do manage stocking initiatives in a way that produces satisfactory, if not necessarily optimal, outcomes. They can do this because of their considerable local knowledge of the resources available to them and the communities that utilise them. Crucially, they have a far better understanding of local needs and local patterns of behaviour, knowledge that they can use when considering the design of operational rules for management. This means, in particular, that compared to external agencies they are far more likely to be able to predict whether certain operational rules are likely to be workable or not (i.e. meet the needs of users, be acceptable, be monitorable and be enforceable). External agencies could learn much from this information.

- *The experimental approach of communities to resource management*

Research has also shown that, given the opportunity to do so, communities will experiment with management through time, continually learning and changing rules to better adapt them to local needs and circumstances. This suggests that the idea of experimentation is one that communities would embrace under certain circumstances (e.g. suitable levels of risk, information about the possible benefits of such experimentation). Communities particularly experiment with rules that distribute benefits and rules that motivate different types of human action. Experimentation with technical aspects, such as stocking densities and species combinations is less common, as technical knowledge is limited and, particularly in Lao PDR, actions are dependant on what is available and affordable. Currently, with communities experimenting in isolation and without the same technical knowledge as external agencies, their process of learning is slow. However, external agencies could have a prominent role to play in changing this.

- *The wider reach and technical knowledge of external agencies*

As suggested in the last section, external agencies have two vital attributes that complement communities' extensive local knowledge. Firstly, they have technical scientific knowledge (or access to it). Secondly, they have knowledge of, and access to, a large number of communities who are managing enhanced waterbodies. Were external agencies to facilitate communication and information exchange between communities, (and between communities and external agencies) this could greatly increase the knowledge base of local communities.

- *The community interest in learning from the experience of other local communities*

Finally, following from this last point, the research conducted in Lao PDR has shown that communities have a great interest in, and benefit significantly from, communicating with other communities. This was one of the major factors that increased the chance of successful uptake of new enhancement technology in the Province. Given this interest, it is expected that, were communities fully aware of the objectives of participatory adaptive learning, they would be interested in participating in an experimental approach that brought together a larger number of communities' experiences and ultimately provided them with better information for the management of their own enhanced fisheries.

## 3.4 The role of external agencies in a participatory adaptive learning approach

To best support an adaptive learning approach and hence reduce the considerable uncertainties associated with small waterbody enhancement, it is suggested that external agencies take the following steps.

- Collect initial information on key attributes of the resource systems under consideration (biological, social, and institutional) and current outcomes, with

the full participation of local communities through participatory appraisals. This should include identifying the objectives of enhancement management on the part of the user community.

- With the aid of scientific analysis, identify where the greatest uncertainties (technical and institutional) are in the first instance and discuss with participating communities what experimental strategies are most likely to reduce these uncertainties at an appropriate level of risk, whilst still achieving beneficial outcomes. It is at this stage that the local knowledge of communities and the technical knowledge of externally agencies can be most fruitfully combined.
- Facilitate local experimentation and then local monitoring of the outcomes of the process.
- Facilitate learning between communities, and between communities and external agencies, through scientific analysis, 'study tours' and workshops.
- Repeat the process until it is believed that the costs of further experimentation outweigh the benefits that can be gained from further reducing uncertainty.

The process is a continual one of adaptation, experimentation and learning. By repeating this process, uncertainty can be further reduced and management strategies further refined to produce greater benefits that meet the needs of the user community. Such a process has rarely been tried in the field of enhancement, and more research is required to assess the efficacy of the approach. Such research is now being carried out in a DfID funded project in Savannakhet Province, Lao PDR in a joint collaboration between RDC, Savannakhet and MRAG Ltd, London. The project started in 1999 and is due to end in February 2002.

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