

Using a Simple GIS Model to Assess Development Patterns of Small-scale Rural Aquaculture in the Wider Environment

Simon R. Bush

Australian Mekong Resource Centre (AMRC), Division of Geography, School of Geosciences, University of Sydney, Australia

A Geographical Information System (GIS) is a tool for collection, storage, analysis and presentation of spatial data, essentially computer based mapping. There is currently much excitement over GIS as a solution to many different social, environmental and operational problems. This popularity can take away from the very functional role that a GIS, as a tool for spatial analysis, can provide.

This article discusses the role that a simple GIS can play in assessing the development patterns of fish ponds and as a low cost tool for broader social environmental analysis in an information poor country. Preliminary findings are presented as examples for analysis. These examples use fish ponds, a one-dimensional resource, as a means of representing the wider multi-dimensional environment.

The development and use of a GIS in Savannakhet province in the Lao PDR provides an example of a simple analysis of aquaculture pond development across three districts. This has been facilitated through a postgraduate research project in joint collaboration with the Regional Development Committee (RDC), Provincial Livestock and Fisheries Office and District Agriculture and Forestry Offices.

Information collected and processed through the project has been designed as a capacity building exercise in developing a system of data collection on aquaculture ponds that can be understood and developed by these local organisations. In an information poor environment such as the Lao PDR low cost, easily collected information is an aim in itself.

Background of aquaculture in Laos

Aquaculture as a means for rural development in Laos has had a relatively recent history beginning in the 1950s through USAID and Japanese foreign aid development of government hatcheries across the country^{1,2}. Later intervention in the country included three phases of a UNDP/FAO project that ran from 1980 to 2000. All three phases, although fundamentally different in terms of their immediate short-term goals, aimed to develop technical expertise at the household level^{3,4}.

The UNDP/FAO and other projects have tended to focus on the poorer northern provinces and not on the relatively fish abundant southern provinces of the country. However, there has been increasing attention on the southern provinces over the last decade through the Asian Institute of Technology's Aqua Outreach Programme (AOP) and, feeding into this work, the Provincial Aquaculture Development project (the third and final phase of UNDP/FAO involvement).

It is estimated that around 5 million fry are traded from Thailand every year to feed the local demand in the southern provinces of the Lao PDR; Khamouanne, Savannakhet, Sekong, Salavane, Attapeu and Champassak⁵. In response to such figures AOP developed two creative ways of fish culture

extension. The first was the development of a fish nursing network and the second was development of a fish-spawning network.

Such locally based systems are extremely pragmatic in a country where local capacity is low and access to many communities is difficult due to poor infrastructure. As such, low cost, small scale, planning of aquaculture is high on the agenda of the government and non-government agencies alike. It is through such development that the Department of Livestock and Fisheries hopes to achieve its aims of food security for the country by promoting the provision of fish, the main focus of which is aquaculture⁶.

Although information is becoming increasingly available in specific localities^{7,8} there remains no collective understanding of the role of aquatic resources, either wild or cultured, throughout the country.

Localised studies are essential. However, there is also a need for understanding general patterns of aquatic resource development and use on a broader scale.

Using GIS to Collect and Present Information

A major benefit of a GIS is that it can collect, store and present information at different spatial scales. This means that information can be either detailed and locally specific or general and wide scale. A GIS has the capacity to analyse and present information in either way.

Geographical Positioning System (GPS) units were used to record the latitude and longitude of each fish pond, to be loaded into a GIS program. Staff from three district Agriculture and Forestry Offices were given a half day training in the use of GPS units and then given two weeks to collect the position of every pond in their respective districts. Basic information on the fish ponds was also collected such as:

- Species stocked
- Number of fish stocked
- Area of ponds
- Types of food used
- Age of ponds
- Main uses of harvested fish

More detailed environmental information was also collected such as:

- Species of wild capture fish present
- Sources of water
- Incidence of flooding

This information was put into Microsoft Access database before being imported to the GIS where each pond is linked with the above characteristics.

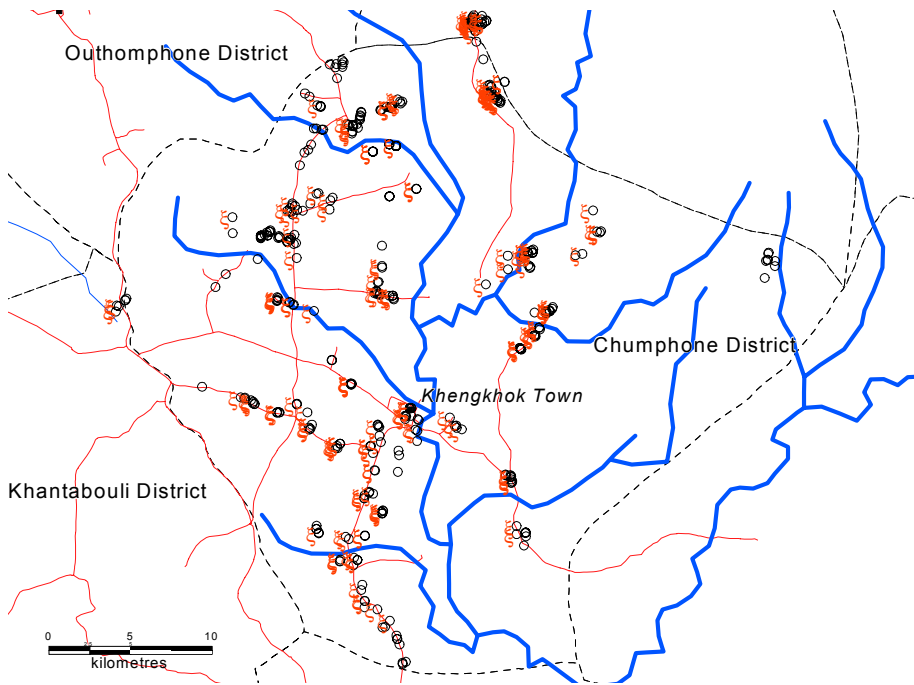


Figure 1: Distribution of Silver barb culture in Chumphon district

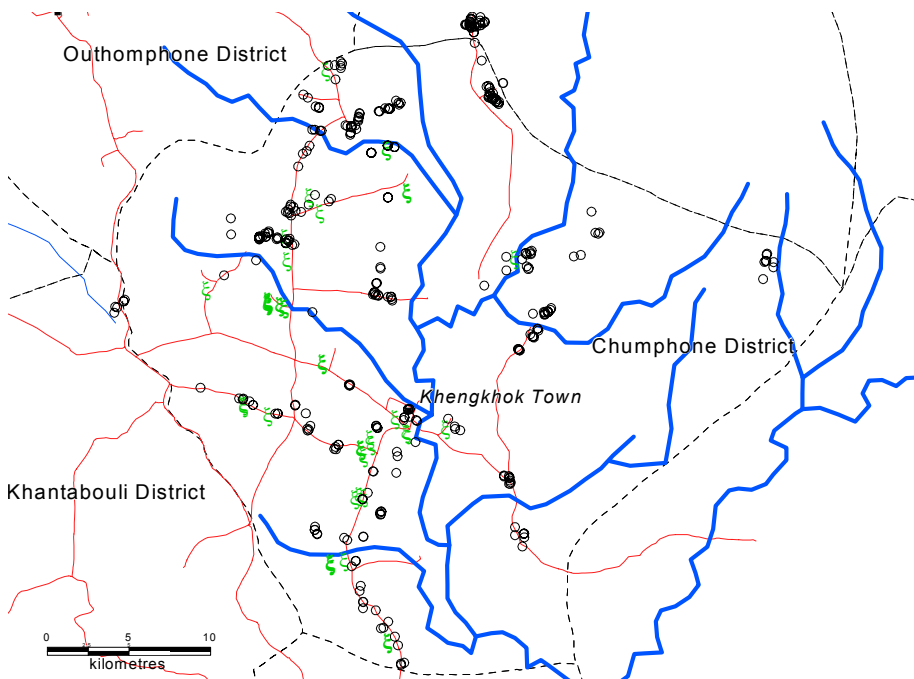


Figure 2: Distribution of Bighead carp culture in Chumphon district

Simple Visual Analysis

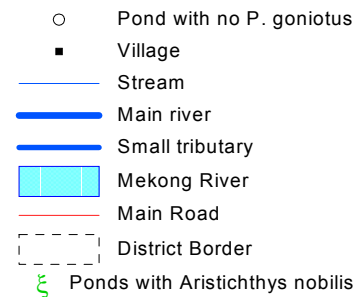
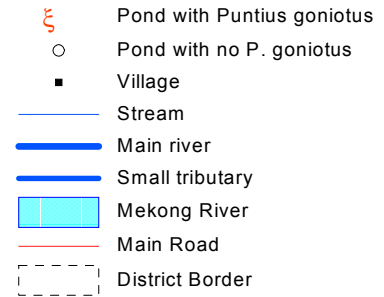
Once stored in a GIS, information can be presented in a number of ways. Firstly the general development patterns of pond construction across a landscape can be presented in a single layer or map. To analyse this distribution relative to other objects in a landscape, such as roads, streams and rivers, layers or maps of these features can be overlaid. This means that the position of fish ponds can be compared to features in a landscape that may or may not influence their construction.

Not all information is available to researchers or extension workers, as is the case in an information poor environment such as the Lao PDR. However, basic information on a resource such as fish ponds can provide a basis for understanding not only aquaculture development patterns but also of wider social and environmental patterns. The use of such indicators is seen as a way of understanding complex landscapes with limited reliable information⁹.

Visual analysis is one of the simplest and potentially most powerful methods of analysing spatially presented

information¹⁰. This can pick up various spatial patterns that may not be obvious or possible with more sophisticated techniques. It is also an extremely easy form of analysis for staff with little experience in GIS or more technical statistics. This makes a GIS a useful tool for many organisations.

GIS can also reduce highly complex social and environmental information into defined parcels of information in the



form of maps, as seen in the results presented from the fishpond survey in Savannakhet province. In the absence of information on environmental or even basic agricultural statistics, concentrating on a single resource such as fishponds can give a general understanding of the wider environment.

Aquaculture development in the Lao PDR and specifically in Savannakhet province has been subject to extension projects dealing with small scale, low intensity aquaculture production that can be sustained and extended by farmers.

The pattern of pond development in Chumphone district is one example of how this development has progressed. The following maps were chosen as preliminary examples able to be analysed visually by provincial and district officials.

Figures 1 and 2 are maps of Chumphone district showing a comparison between two aquaculture species, *Puntius goniotus* (Silver Barb) and *Aristichthys nobilis* (Big Head Carp). Each of the maps highlights the

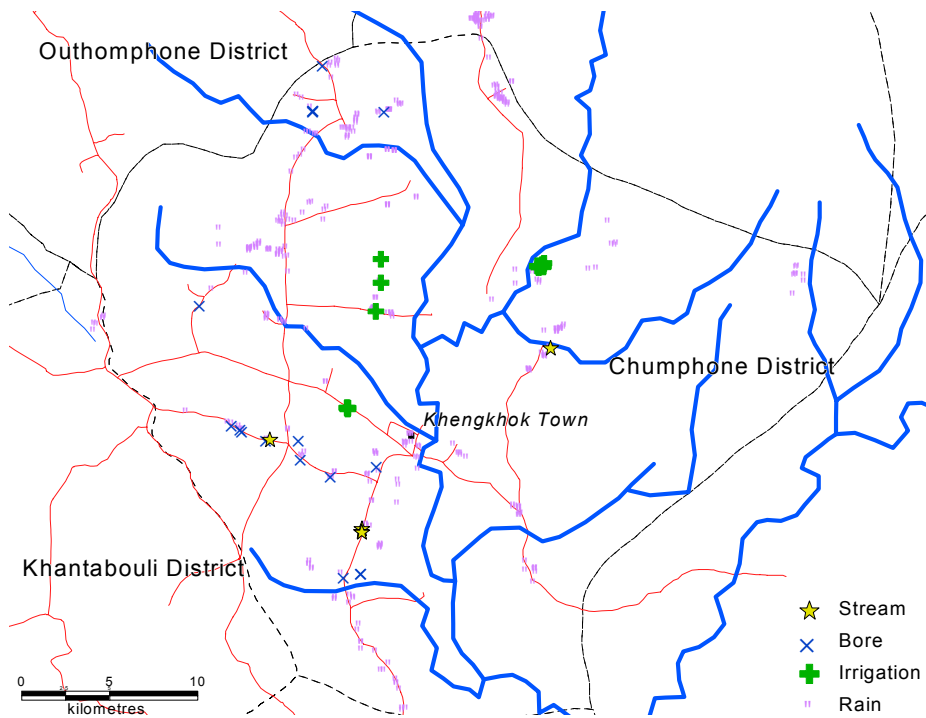


Figure 3: Distribution of water sources for filling ponds

distribution of fish culture along main roads throughout the district. The maps also highlight the very different occurrence of the two species. Whereas *P. goniotus* is found throughout the district *A. nobilis* is concentrated closer to the main roads extending from the district centre Kheng Khok to Savannakhet town and Outhomphone district to the north.

Spatially presented information can also show patterns of environmental constraints faced by some farmers in the district. Figure 3 shows the distribution of various sources of water for the ponds. Most of the ponds are rain fed and despite the large amount of irrigation development in the district there are only a few ponds with access.

Socio-economic patterns can also be revealed, for example, the general pattern of consumption and marketing. Fish grown near the major roads in the district are mostly sold whereas ponds from which the fish are mostly eaten by farmers are more widely dispersed.

“Spatially presented information can also show patterns of environmental constraints...”

Conclusions

The above analysis is by no means extensive but rather aims to provide a few simple examples of the type of spatial analysis a GIS can provide. By using fishponds as a reference point general social and environmental patterns can be seen and as such provide an opportunity to develop management plans and public policy.

For example, the three maps above provide the basis for not only general conclusions as to the development pattern of ponds. They build on current systems of analysis in the form of tables and description by showing the absolute distribution of not only ponds but also the various fish species grown in them. Such analysis allows provincial and district staff with little such technical experience to be able to immediately develop further (non GIS related) research questions such as:

- What areas in the district have potential for further activities by the government or development agencies?
- How and why are fingerlings of different species traded throughout the district?
- What influence does the availability of water resources have on farmer’s adoption of aquaculture?
- What are the marketing constraints and potentials for farmers in different parts of the district?

By asking such questions wider spatial socio-environmental patterns are taken into consideration and can lead to more directed, locally appropriate extension and development of aquaculture.

However, using a GIS in isolation is not a solution in itself. GIS is a tool just as Participatory Rural Appraisal and more traditional survey techniques are. Without such complimentary research or other GIS data such as land use, forest cover, flooding extent or socio-economic information its real potential remains limited. As such a GIS is only ever one part of any management or research strategy. In the case of Savannakhet province it has provided a low cost way of obtaining valuable information on aquaculture ponds and with further development has the potential to provide a system of data sharing, planning and evaluation for the Department.

References

1. Ministère-de-L’Economie-Nationale (1972). Etude sur L’Economie Lao 1967-1972. Ministère de L’Economie Nationale, Bureau des Etudes Techniques, Royame du Laos, Vientiane, Lao PDR.
2. USAID (1973). Facts of Foreign Aid to Laos: 2nd edition. Embassy of the United States of America, USAID Mission to Laos, Vientiane
3. Singh, S. B. (1994). “Fish Culture in Land-Locked Lao PDR.” FAO Aquaculture Newsletter 7: 16-18.
4. Funge-Smith, S. (2000). Provincial Aquaculture Development Project: End of Assignment Report. Provincial Aquaculture Development Project LAO/ 97/007, Vientiane. 48
5. Haitook, T. (1997). Fish Seed Supply Network and its Effect on Aquaculture Development in Savannakhet Province, Lao PDR. School of Environment, Resources and Development. Bangkok, Thailand, Asian Institute of Technology
6. Phonvisay, S. (1997). Policy Framework for Fisheries and Aquatic Resources Sub-sector in Lao PDR. Department of Livestock and Fisheries, Ministry of Agriculture and Forestry, Vientiane
7. Garaway, C. J. (1999). Small Waterbody Fisheries and the Potential for Community-Led Enhancement: Case Studies in Lao PDR. T.H. Huxley School for the Environment, Earth Sciences and Engineering, Imperial college of Science Technology and Medicine. London, University of London: 414.
8. Noraseng, P., P. Hirsch, S. Manotham and K. Tubtim (1999). A Report on Household Level Fisheries in Four Villages of Sanasomboun District, Champassak Province, Lao PDR. Indigenous Fisheries Development and Management Project Technical Report 5. Department of Livestock and Fisheries, Ministry of Agriculture and Forestry, Pakse. 7
9. Baran, E. and I. G. Baird (2001). Approaches and Tools for Sustainable Management of Fish Resources in the Mekong Basin. Presentation at the International Symposium on Biodiversity Management and Sustainable Development in the Lacang-Mekong River Basin, 4-7 December 2001, Xishuanbanna, Yunnan, China.
10. Gahegan, M. (2000). “The case for inductive and visual techniques in the analysis of spatial data.” J of Geograph Syst 2: 77-83.