NETWORK OF AQUACULTURE CENTRES IN ASIA

NACA-SF/WP/88/10

November 1988

Economic and social considerations for aquaculture site selection: an Asian perspective

NACA Head Office
National Inland Fisheries Institute
Kasetsart University Campus
Bangkhen, Bangkok
Thailand
Cable: NACABK BANGKOK 10900
Telex: 84267 NACA TH

NETWORK OF AQUACULTURE CENTRES IN ASIA

NACA-SF/WP/83/10 November 1983

Economic and social considerations for aquaculture site selection: an Asian perspective

NACA Head Office
National Inland Fisheries Institute
Kasetsart University Campus
Bangkhen, Bangkok
Thailand
Cable: NACABK BANGKOK 10900
Telex: 84267 NACA TH

ABSTRACT

This short paper discusses the major economic and social considerations for aquaculture site selection. By pointing out as well as bringing together all possible considerations from the economic and social perspectives, the author not only hopes to broaden the technical evaluation of aquacultura sites but to enrich and show the equal importance of these factors in site selection.

Both the economics of private and social costs and benefits are highlighted throughout the discussion. As GIS or Geographical Information System provides the mechanism and methodology to store, manipulate, integrate, analyse and synthesize different diverse bits and pieces of information from different sources involving many different disciplines, national aquaculture planners and policy-makers as well as potential aquaculture investors should be encouraged to apply this model.

ECONOMIC. .AND..SOCIAL..CONSIDERATIONS..FOR. AQUACULTURE SITE. .SELECTION .ANASIAN-PERSPECTIVE [1]

by

Kee-Chai Chong [2]

INTRODUCTION

In discussing sites for aquaculture, it is necessary to distinguish between (1) existing sites already developed hut not yet under production or (2) those already under production or (3) new sites [virgin areas] either to be found or (4) already located but not yet developed. In this paper, concern is limited to new sites not yet found or selected. Those sites already developed and under production or not yet under production and those to be developed are not the concerns of this paper.

Sites for aquaculture are natural resources subject to supply and demand conditions. Sites for aquaculture can be on land, in water bodies such as rivers, lakes, reservoirs, dams, lagoons, coves, sheltered or open seas. As resources, they have more than one use. These uses can be either (1) competitive, (2) compatible and (3) conflicting. Some use can be mutually exclusive, as for example aquaculture and industrial zone. The elaboration on the multiple resource use and resulting resource use conflicts is beyond the scope of this paper.

Aquaculture site has been identified by various studies as one of the main factors responsible for the failures of aquaculture to produce the output as projected. More recently, none other than the Committee on Fisheries at its 17th Session has pointed its finger at, among others, site and social environment as partly responsible for aquaculture's poor performance (FAQ, 1987).

As a result of this, the importance of site selection cannot be overlooked nor overemphasised. Every "thing" (thing is used here for lack of a better term) in the modern human existence has an (1) economic value and impact and a (2) social value and impact. To each and every "thing" is also associated with a cost. These costs e (1) private or out-of-pocket costs or (2) social costs. Social cos are the collective costs the society or community has to bear as a result of an externality created by an offending party or a negative impact an individual's action inflicted on the community.

Impact can be either positive or negative, beneficial or adverse. Sometimes impact can be neutral. In order to measure impact, one often resorts to reflect it in dollars and cents. For example, clean-up coat (incurred by the government as opposed to the offending party) in removing agricultural contaminants or industrial pollutants harmful to fish is a social cost if public expenditures are incurred. The contaminants or pollutants in and of itself are social costs because they negatively affect fish production.

However, if the law requires the agricultural farm or factory discharging the contaminants or pollutants to treat the contaminants or pollutants before discharge to the open waters, then such treatment cost is a private cost. Such private costs enter the financial accounting system of the farm or factory. These costs are then passed on to the consumers which show up as higher prices in the market.

Natural resources have values if properly harnessed, and costs and negative impact if not appropriately controlled and managed. Here, reference is made to natural resources such land, water, winds and wave (tides and currents) actions and human resources (read labour). Winds and waves have a bearing on wear and tear of aquaculture sites (e.g. erosion). Rapid wear and tear have direct implications on the costs of repair and maintenance of the aquaculture site. They show up in the costs of production.

The type of aquaculture to be developed also has a direct relationship on the choice of sites and the size of operation:

a) resource-based aquaculture system or

b) technology-based aquaculture system

[1] Paper presented at the UN/FAO Workshop on the Geographical Information System (GIS), Application in Aquaculture from 5-23 December, 1988 at the Asian Institute of Technology,Bangkok, Thailand.

[2] Aquaculture economist, Seafarming Development and Demonstration Project RAS/86/Q24, Network of Aquaculture Centres, in Asia, Bangkok, Thailand.

PURPOSE

The basic purpose of this paper is to provide an overview of the economic and social considerations of site selection for aquaculture. This will complement the effort of ground truthing after a site has been identified and narrowed down to a handful of possibilities by remote sensing and/or other such similar means. In fact, the consideration of such economic and social factors in site selection will further narrow down potential sites by a process of elimination.

AQUACULTURE SITE SELECTION: AN HISTORICAL IMAGINATION

The Asian region has one of the oldest or longest history in fish farming. Fish farming or fish culture started out in the natural environmental setting where fish are found. At first, the fish were merely caught and harvested. Caught in the net were different kinds of fish and of different sizes, large ones and small ones. Over time, these "fisherfolks" observed that the smaller fish yielded less flesh. At the same time, they noticed that some fish were more tasty than others, some were more bony while others were simply unpalatable.

They soon realised that if they return the smaller fish into the water and let them grow bigger, they would be able to harvest bigger fish.

Before too long, they also realised that without some form of enclosures to confine these fish returned to the water, they would swim away, or were still, other fisherfolks would catch them.

Similarly, these fisherfolks also noticed that after the water receded following each flood, the fish were retained in natural land depressions and other similar natural "holes" in the ground (temporary inundated ponds as found in the arid Northeast of Thailand).

They also observed that these fish usually congregate in and around floating or anchored debris such as tree stumps or fallen trees or other similar collection of natural flotsam of leaves anchored to aquatic plants or weeds. These masses of tree branches, leaves and other flotsam or community of aquatic plants and weeds serve as their refuge and habitat.

It is then that these fisherfolks began to place fish shelters in the form of tree branches, twigs and other similar natural materials to protect and attract the fish to these artificial shelters. Wherever the water is shallow and/or not too swift flowing, they began to build earthen bunds, embankments or dikes to confine the fish within. Slowly flowing streams and small rivers were also dammed off as ponds.

These early humble fish rearing sites were in their natural surroundings and environment. Thus began the first rudimentary practice of fish rearing in a confined area. Later on, the fish were fed and this started the husbandry of fish. Modern day aquaculture soon evolved. New sites were found and developed. These sites were not necessarily in their natural setting but are located near a reliable and accessible source of water.

These early fisherfolks were already practising simple site selection for fish culture. Of course, site selection was not the foremost active or conscious considerations in the minds of these fisherfolks. But site selection indeed was what they were doing. This is because, without knowing it they were actually carrying out site selection. They build the fish confinement or impoundment in the area or site they consider most appropriate and suitable (based on their own set of criteria).

What are these considerations? There are obviously many considerations to be taken into account if they wish to reap and harvest the fruits of their effort and labour. In this paper, the concerns will be on economic and social considerations, especially in a modern day context in which aquaculture technology is more advanced.

For the purpose of this discussion, economic and social considerations for aquaculture site selection will be divided into two broad categories, namely, (1) resource-based aquaculture system and (2) technology-based aquaculture system.

By resource-based, it is meant that the aquaculture methods, practices and techniques emphasize the use of resources most abundant in the vicinity of the site more than the reliance on advanced or high technology. On the other hand, technology-based means the application of advanced technology and science. The latter can be expensive and requires large sums of capital and know-how.

GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GIS provides a (1) comprehensive computer-assisted means to bring and pull together diverse bits and pieces of information from different sources involving many disciplines as well as the (2) mechanism and methodology to store, manipulate, integrate, analyze and synthesize these pooled data for development planning.

The basic premise and starting point of this paper is that all the other non-economic and non-social aquaculture site selection considerations have been investigated and they satisfy its minimum requirements and criteria. In fact, all those considerations have to be taken into account simultaneously and in a holistic perspective and not in isolation of each other. Since the other papers are dealing with these topics, the main task here is to concentrate on the economic and social aspects.

NATIONAL LAND-USE PLANNING AND POLICY

One of the first consideration to be taken into account before carrying cut site selection is to familiarise (study and review) oneself with the rules and regulations governing land and water use for aquaculture, national policy, plan and government assistance for aquaculture. Such information can be very handy in cutting down site exploratory costs.

In the past, it is not altogether untrue to state that aquaculture site selection has not come under strict government monitoring and supervision. To encourage the orderly development of aquaculture, especially sites for seafarming, an aquaculture land-use body should be set up to develop criteria (technical and non-technical) and zoning laws and regulations governing the use of virgin areas for aquaculture.

As presently set up, many government bodies have direct and indirect jurisdiction over the use of land and water for fish farming. This gives rise to confusion and bureaucratic burdens to the aquaculture investors as to who has the final authority in granting a permit to start a fish farm. Sometimes, great expenses are incurred in chasing after such information and in the processing of a permit for a potential site.

Sometimes, it is also equally important to find out the long term plan of the government regarding the use of the area in which you are interested to start a fish farm. Some approximate indication on the government's plan, say 10-50 years from now for the general area is valuable. This is because governments are notoriously known for taking back land already developed for other purposes for road and highway construction by gazette. Farms, houses and factories have been demolished to make way for new roads and highways and other such public needs.

PRESENT LAND USE PATTERN

Is the site to be considered in an area or region where aquaculture is already in place? Or is it an area earmarked for fish culture? Or is it situated next to an industrial, residential or agricultural zone? These are important economic considerations to take into account. Under the topic on externality, a more detailed discussion will be presented later.

Suffice to say that if the proposed site is in a predominantly agricultural area such as the rice bowl or granary of the country or in an estate crops (rubber, oil palm) zone, concerns on agricultural run-offs (both good and bad) should receive attention. The extent of chemical fertilisers (mostly acid-based compounds) and pesticides (insecticides, fungicides, weedicides) use will affect the general water quality of the local water system through run-offs and effluence. In short, it is essential to study both the overall land use and cropping patterns of the area.

TENURIAL SYSTEM

The possible land and water body tenurial arrangement available in each country varies from country to country. Depending on the land (reform) laws or laws governing the use of water bodies or such similar natural resources existing in each country, these can range from outright purchase and ownership to lease to rental arrangement.

Except for water bodies (e.g. rivers, lakes and seas) and land adjacent to such water bodies (e.g. sea- lake- river-shores) which remain in the public domain, in many countries land are and can be owned by private citizens. In such cases, land acquisition or transaction can be negotiated with the individual owner concerned. Otherwise, land acquisition is arranged with the government.

Lease arrangement can be for short or long term, renewable and non-renewable. In China, all land and water resources are in the public domain; there is no private ownership of land in the true sense of the word. In Malaysia, large tracts of former tin-mining lands and pools are available for aquaculture under the temporary occupation land (TOL) lease system.

Depending on the (long-run) objectives of management, the type of tenurial arrangement can influence farm site development, especially capital infrastructure investments, farm hardware and software facilities (equipment, machineries).

In the case of rental system, it usually involves developed sites already under production. Thus, site selection criteria and considerations are quite different because the site already exists.

TARGET SPECIES

The choice of sites is also dependent on the target species to be cultured. Some species requires very exact water quality parameters and conditions in terms of salinity, pH, DO etc. while others are more forgiving. In general, target species can be classified into:

1) high value species
2) low value species
3) high value low volume species
4) low value high volume species

To some extent, the projected demand (and supply) and prices of the target species in the world (export) and local markets also determine *the* choice of site.

At present, Asian aquaculture accounts for more than three fourths of total world production at 10 million tons. Of this, about 42 and 32 *%* are from finfish and seaweeds respectively. Another 24 *%* are shellfish or crustaceans. Shrimps constitute only about 2.5 *%.* Bearing in mind that seeweeds are mostly cultivated in shallow seas, this production distribution by species group show that there is room for further development in finfish and shellfish culture.

As 80-93 *%* of the world's agricultural land is already in use, the scope for land-based aquaculture production systems is rather limited. Attention can be focused on marginal land, water-logged land and other such areas not suitable for agriculture. However, greater attention should be increasingly given to proper planning and implementation. This is where sound site selection becomes critical.

Of the 40 specie's of finfish 3nd 20 species of shellfish cultured in Asia, a large percentage (exception being some shrimp species) is of relatively low value or market price.

PRODUCTION SCALE

In site selection, attention should also be given to the scale of operation, large or medium or smallscale. The ease or difficulty with land acquisition will vary according to the proposed scale or size of farm. Under normal circumstances, it is preferred to have the entire farm in one site, including broodstook ponds, hatchery, nursery, transition and grow-out ponds. Sometimes, certain post-harvest processing facilities can also be constructed on the same site.

Such centralisation would facilitate farm management and operation. Production (e.g. labour efficiency) and cost efficiency (e.g. duplication of certain facilities like housing for workers, water storage ponds)) are more easily attainable in one location than in scattered sites.

At other times, it is also technically and economically worthwhile to separate the different production sub-systems into more than one site. There are obviously advantages and disadvantages to the two set-up. In the latter case, disease outbreak can be contained more easily.

PRODUCTION INTENSITY

The economics (i.e. costs and returns) of the level of production system intensity - between -> extensive ->semi-intensive ->intensive - also influence the profitability of the site. For example, Hirasawa (1985) demonstrated that for shrimp aquaculture in the Asian region, costs of production per unit (kg) of shrimp decline more rapidly with each increase in productivity gains for extensive and semi-intensive systems than for intensive culture. This is because the fixed costs (capital investments) of the intensive system is very high and even with improved productivity, the unit costs decline very slowly or insignificantly.

On the other hand, Shang and Rabanal (1976) argue that the percentage increase in production and revenue for intensive operation exceeds the percentage increase in coat. This means that the cost of production per unit of output is lower for intensive then for extensive operations. The authors cite the case of milkfish aquaculture in Indonesia and the Philippines where the per hectare yield under intensive operation can he increased to three (3) tiroes that of extensive culture by a doubling of the cost of production. The resulting profit or net revenue is much higher given the price of milkfish prevailing in the two countries.

Similarly, Tal and Hepher (1S37) report that the production cost per ton of common carp in an intensive system is about 40 % less than in an extensive system in Israel.

The natural, spatial, topographical, hydro(bio)logical and hydrographical features of each potential site govern the ease or difficulty with which the site can be developed for extensive, semi-intensive or intensive system.

The choice of production intensity level (extensive, semi-intensive or intensive?) also depends to a large extent on the relative costs of each of the natural resources or inputs available in the area where the aquaculture facility is to be sited. If land is abundant and thus land cost is low, the extensive method would be appropriate (as is true in some parts of Latin America). On the other hand, if land is scarce or limited and accordingly land prices are high, as in Taiwan, the intensive method is resorted to. Artificial feeding becomes the basis of production in the intensive system.

Similarly, in water-scarce Israel the production system developed there has evolved into one which recycles water and water is used intensively. In countries where labour is abundant and relatively inexpensive as in China, the Chinese integrated fish farming system is very labour-intensive. The development of capital-intensive system occurs when the supply of and demand for natural resources such as land, water, labour and other needed inputs make it uneconomical for extensive or labour-intensive systems to operate.

Whereas in some countries such as the Philippines, Indonesia and Thailand, the three different production systems of extensive, semi-intensive and intensive culture can co-exist side by side or along side each other. This results from the different mix of resource endowment found in the different parts of the country, stage of national economic development (imbalance), farm management regime adopted, the technical, managerial and mechanical skills of the farm workers.

PROPERTY RIGHTS AND SECURITY

The foremost consideration under property rights and security is risks and uncertainty. The exposure to risks of a site can be minimized if certain precautions are instituted. These precautionary measures cost money to carry out. Exposure to loss from pilferage and theft (internal and external) is of prime importance because without the assurance of getting an economic return, the farm would fail. The costs of surveillance (guards, dogs, firearms or other electronic deterrents) show up in production costs. They are in turn translated into higher market prices.

The owner(s) of the fora should guard against such loss. Goodwill on his part and that from the surrounding community or settlement can and must be fostered. Although it has never been reported to be carried out before, informal communication of interests to start a fish farm in their area with the community elders would be a good gesture on the part of the potential investor. Furthermore, by recruiting and employing the local labour force wherever possible, would ensure goodwill and cooperation and thus alleviate part of the problem.

INSURANCE COVERAGE

Is the site to be selected insurable? Some insurance companies would not sell a policy because of the inaccessibility of the farm, An insurance policy taken out to protect against possible future loss arising from loss due to theft and pilferage, vandalism, storm damage and other climate-inflicted or natural causes (e.g. floods, diseases) is a wise investment. The location of the farm plays a role in determining whether a policy can be obtained or not.

CAPITAL INVESTMENT (FIXED) COSTS

The main consideration here is whether capital is unlimited or limited. Next, is the cost of acquisition of the piece of real estate, whether it is a piece of land or a body of water. The acquisition cost or purchase price of the site can be a limiting factor. Once the site is decided on, the cost of land clearing has to be balanced with how much forest products like wood (for making charcoal, wood chips, firewood), timber, tree barks, fruits, roof thatch and other products can be salvaged and sold for income.

Is land clearing by total burning more economical or selective burning to salvage valuable wood and timber more economical? The additional returns of each of the two alternatives must be balanced with the additional costs.

Another equally important factor to consider is the cost of developing the production site (design and layout) and cost of construction. In this regard, the main costs involved would be for pond excavation, water supply and drainage canals, dike/berm construction, water gates, water pumps, boats, generator set if no electricity supply is locally available, hatchery building (if any), office (including a modest laboratory) and storage facilities and a miscellany of water quality test kits and chemicals.

Site preparation (pre-development cost) and site development costs can be minimized by proper design and lay-out, making use of the natural land topography and keeping land remodelling (earthworks) to a minimum.

PRODUCTION (VARIABLE OR OPERATING) COSTS

As for operating or variable costs, it appears that no direct or obvious relationships exist between these costs and site selection. But there is. For example, if the site selected has high soil permeability, cost of water *and* water replenishment (pumping costs) can be quite high. Similarly, if the soil or water pH is low or looking in certain nutrients and minerals, then corrective measures have to be taken to restore it to the optimum conditions for growth.

These corrective measures involve the use of purchased inputs such as lime and fertilizers. They represent operating costs and add to the overall cost of production. Such costs would not be incurred or would bo minimal if the site selected is fertile and slightly alkaline. Other similar examples can be cited.

Various studios have shown that the main cost components of aquaculture (mostly variable costs) consist of the following:

a)	seeds	20-50 %
b)	feeds/fertilisers	30-70 %
c)	labour	15-20 %
d)	others	5-10 %

As seeds, feeds and fertilizers are not only important from the point of view of the distribution of production cost but are basic inputs, the distance between the farm site and markets or sources of inputs should be short and accessible. Transportation costs can become high if the fry grounds are situated far away or bulky inputs (e.g. organic fertilizers) have to be shipped over long distances.

SOURCES OF FINANCING/CREDIT

The source of capital to finance land acquisition as well as the development of the farm site has an indirect relationship to site selection. Farmers interested in fish culture can be classified into two groups. Large and small farmers. Large farmers usually have little difficulty in financing or obtaining credit. It is the small farmers who face real problems in obtaining credit. Small farmers in turn can be grouped into two. The first group usually already have a piece of land which can be developed into a fish pond(s). The other group does not have access to land or a site. They either have to buy, lease or rent a site.

Because they are normally poor or have limited financial resources, they do not have too much flexibility or choice on site selection. To encourage accelerated aquaculture development, many governments are known to provide different types of assistance. These can range from:

a) small land grant of virgin areas which have already been determined as suited for aquaculture

b) low interest credit financing either for land acquisition,capital development (pond construction) or operating costs(input purchase)

c) government land leasehold system with simple and renewable terms such as the Philippines Ordinary Fishpond Permit and Fishpond Lease Agreement

Except for (c), site selection is for all intents and purposes predetermined. The same is true for those who have to rent existing fish farms.

The reeder is reminded that under government leasehold arrangement, cost of land acquisition is normally not included in the financial cost accounting. Wealthy individuals and corporations have the luxury to engage in detailed site selection for aquaculture, which is usually not open to poor small farmers.

Besides government credit scheme, commercial lending institutions have also recently shown great interests in bankrolling aquaculture investments including land acquisition.

ACCESSIBILITY TO INPUT AND OUTPUT MARKETS

At the minimum, the existence of a modest network of dirt roads (unsurfaced and narrow) is a very important factor. If no roads exist or the site is quite far from the existing road network, additional costs (capital) would have to be incurred to build an access road linking the existing road system. Marketing costs, of which transportation costs is a major component can affect production economics.

Fair to good logistics and low cost means of transportation linking production centres to consumption centres can make or break a new aquacultural facility. Transporting needed inputs to the farm site and outputs to the markets and beyond (e.g. cold storage facility for processing and onward shipment as exports) need to be economically determined before hand.

Equi-distance concentric circles with the proposed site as the centre describing distance between the proposed site(s) and major and minor settlements (villages, towns and cities) can be drawn onto maps for calculating certain logistic cost estimates.

Many examples can be cited to illustrate this point and our favourite one comes from Indonesia. In Aceh, a province of Indonesia in the north-west part of Sumatra (production centre), milkfish can be produced in large quantities but the cost of transporting the milkfish to Jakarta (capital of Indonesia, i.e. consumption centre) is economically prohibitive. In fact, it costs more to transport one kg of milkfish to Jakarta than its cost of production.

The expected prices which the proposed aquaculture products will fetch in both the local, distant rural-urban and overseas markets have to be thoroughly studied for its long term trends and changing consumer tastes and preferences.

LABOUR SUPPLY AND COSTS

In many developing countries, land suitable for aquaculture may be found in areas where it is still sparsely populated such as in Indonesia., Thus, the availability of a reliable, low cost skilled labour supply is aritical. This is because labour costs account for about 15 to 20 % of the total costs of production for most aquaculture systems.

Because of this, many aquaculture sites are found near urban areas which are the population and consumption centres. While labour recruitment of unskilled labour can be done locally, rocruitment of semi-skilled and skilled labour may have to be done further afield. For some countries, it may be necessary to import such labour. However, this consideration has no direct relationship to site selection.

EMPLOYMENT

Many developing country governments are concerned at the number of workers entering the job market. Generating employment or income-generating opportunities is one of the top priority of government planners and policy-makers. Aquaculture is regarded as one national economic sector which can absorb the labour entering the labour market annually. In the absence of gainful employment opportunities in the rural areas, the people migrate to the urban centres in search of employment. As it is, the urban areas are already too crowded to absorb the annual wave of rural-urban migration.

As such, governments are interested not only to allocate lan aquaculture in the rural areas but are actively pushing its development *and* expansion. Recent experiences from the Philippines show that a job is created for every US$2,500 of aquaculture development cost based on a derived capital to direct labour ratio study (Israel, undated). It should be pointed out that this aquaculture investment analysis has not taken into account the cost of land acquisition of 40 ha. The reason given is that the land is acquired under the Philippines Fishpond Lease Agreement.

Shang and Rabanal (1978) also report that intensive milkfish culture in Indonesia and the Philippines create more job opportunities in the rural areas because of greater needs for fertilisation and frequent stocking and harvesting.

RISK OF URBAN ENCROACHMENT

The choice of a site for aquaculture also has to take into account the risk of urban encroachment in the near or short term, mid-term and long-term. This is a very real problem in many countries (developing, newly industrialized or developed) because as population numbers multiply rapidly, yaluable agricultural lands including fish farms are lost to housing or residential or industrial development. In other words, a site considered rural and away from the city centre can quickly become urban in a short five years due to spreading city limits arising from unchecked population growth.

EXTERNALITY

In selecting a site for aquaculture, it is also imperative that it be situated away from all possible sources of problems which management has no or little control over such as pollution (e.g. detergent, domestic sewage, animal wastes, agricultural run-off and industrial wastes), theft and other damages caused by the actions of others.

This means that the potential aquaculture investor should have access to information on how other resource users and producers and consumers in the vioinity and adjacent t*o* the site will influence his aquaculture activities, in particular his production coats. Likewise, he should also recognise in what way his fish culture activities would affect his neighbours, near and far. This is important in today's legal world given the opportunity for legal recourse for infractions of rights, loss, etc.

In recent years, both the quantity and quality of water have rapidly deteriorated due to population pressures on indiscriminate land and water uses. Although technology exists for treating water, the success' of aquaculture hinges quite critically on good water. Like everything else, economics has a big influence on the viability of the enterprise.

ALTERNATIVES AND SCOPE FOR EXPANSION

In site selection, it is important that more than one site be studied and ranked according to some pre-determined criteria. Final decision on which site to choose is made easier given the various alternatives available. Each alternative site has certain trade-offs in terms of advantages and disadvantages. In other words, costs and returns - private and social!

Last but not least, some attention has to be given to the possibility of and scope for expansion should the need arises. Is the site selected have available area or room for expansion?

MARGINAL LANDS

Earthen ponds are by far the most dominant form of aquaculture today. A review of available literature shows that marginal lands or sites not suited for agriculture can profitably be used for fish culture. This implies that in such cases there will be little or no competition for the use of such lands.

In recent years, good agricultural lands have been lost to salt intrusion because of changing tide levels. But more importantly, salt intrusion has arisen because of excessive draw-down of the water table either for irrigation purposes or for aquaculture. In Thailand, for example there are now an estimated 53,000 ha of abandoned padi fields no longer suitable for rice cultivation. The same is taking place in the Philippines and Indonesia. In Taiwan, especially in the south where shrimp culture has flourished unchecked until now, serious subsidence has occurred. The local government has imposed strict control on pumping underground water.

Recent moratorium on mangrove conversion to fishponds and pressing social and economic considerations dictate that alternative sites for coastal aquaculture be investigated. One possible alternative is the use of large tracts of low-yielding or old coconut plantations found mostly along the coast or beyond the mangroves for coastal aquaculture.

NON-ECONOMIC FACTORS

In the final analysis, even non-economic considerations in site-selection such as topography, soil type and permeability, water turbidity, etc have a real economic bearing on profitability. This is because such physical and biological factors affect production costs either through incurring greater expenses for more repair end maintenance, or through additional effort (inputs) to minimise adverse impact on the production system.

SUMMARY AND CONCLUSIONS

In the Asian context where land and population account for about 20 and 60 *X* respectively of the total world land area and population, and aguaculture dates back more than 2,500 years, sites available and suitable for aquaculture are scarce. They are increasingly to be found in distant or outlying regions or in some instances in the outer islands of the country. Many lessons con be learned from the 2,500 years of history in aquaculture. Even so, errors in site selection continue to be made in spite of this long history.

This paper has presented an overview of the economic and social considerations in site selection for aquaculture. Lest the reader may think that it is a simple procedure or process, let him be forewarned that it is not as straightforward as this paper may have presented. The success of aquaculture depends to a large degree on site-specific factors. While the biotechnical factors describe the production possibilities or production frontier, economic and market forces shape the profitability of aquaculture.

By pointing out as well as bringing together all possible considerations from the economic and social perspectives, the technical evaluation of aquaculture sites can be broadened and enriched. In the past, aquaculture site selection has been dominated by technical considerations. Economic and social considerations are equally important.

Both the economics of private and social costs and benefits have been highlighted. As GIS or Geographical Information System provides the mechanism and methodology to store, manipulate, integrate, analyze and synthesize different diverse bits and pieces of information from different sources involving many different disciplines, national planners and policy-makers and potential aquaculture investors should be encouraged to apply this model in aquaculture investments.

Site selection and land acquisition are closely interrelated and cannot be considered separately or in isolation.

REFERENCES

1. FAD. 1384. Report of the Ninth International Training Course on Applications of Remote Sensing to Aquaculture and Inland Fisheries. Remote Sensing Centre, Rome, 10-23 September 1984. Rome, Italy.

2. FAO. 1987. Aquaculture Development. Committee on Fisheries, 17th Session, Rome, 18-22 May, 1987. Rome. Italy.

3. Hirasawa, Y. 1985. Economics of Shrimp Culture in Asia. Proc. First Int. Conf. Culture Penaeid Prawns and Shrimps, SEAFDEC, Philippines.

4. Israel, D. (undated). A Project Feasibility Study on Prawn Farming, Lecture Notes on Aquaculture Economics, UBDP/FAO/SEAFDEC/UPV-NACA Training Course for Senior Aquaculturists, Philippines.

5. Kapetsky, J.M., L. McGregor and H. Nanne E. 1987. A Geograp hical Information System and Satellite Remote Sensing to Plan for Aquaculture Development. A FAO - UNEF/GRID Cooperative Study in Costa Rica. FAO Fish. Tech. Pap. 287, FAO/UN, Rome, Italy.

PUBLICATIONS AND DOCUMENTS OF THE REGIONAL SEAFARMING DEVELOPMENT AND DEMONSTRATION PROJECT

Working Papers

NACA - SF/WP/87/1. Lovatelli, A. Status of scallop farming: A review of techniques. 22 p.

NACA - SF/WP/88/2. Lovatelli, A. Status of oyster culture in selected Asian countries. 98 p.

NACA - SF/WP/88/3. Lovatelli, A. and P. B. Bueno, (Eds). Seminar report on the status of oyster culture in China, Indonesia, Malaysia, Philippines and Thailand. 55 p.

NACA - SF/WP/88/4. Lovatelli, A. Status of mollusc culture in selected Asian countries. 75 p.

NACA - SF/WP/88/5. Lovatelli, A. and P. B. Bueno, (Eds). Seminar report on the status of seaweed culture in China, India, Indonesia, ROK, Malaysia, Philippines and Thailand. 79 p.

NACA - SF/WP/88/6. Lovatelli, A. and P. B. Bueno, (Eds). Seminar report on the status of finfish culture in China, DPRK, Indonesia, ROK, Malaysia and Singapore. 53 p.

NACA - SF/WP/88/7. Lovatelli, A. Seafarming production statistics from China, Indonesia, ROK, Philippines, Singapore and Thailand. 37 p.

NACA - SF/WP/88/8. Lovatelli, A. Site selection for mollusc culture. 25 p.

NACA - SF/WP/88/9. Lovatelli, A. and P. B. Bueno, (Eds). Seminar report on the status of marine finfish netcage culture in China, DPRK, Indonesia, ROK, Malaysia, Philippines, Singapore and Thailand. 56 p.