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Water mimosa production using waste water Hanoi

Urban Aquatic Production

The cultivation of fish and aquatic plants/vegetables [1] is widespread throughout many cities in Southeast Asia and to a lesser extent in Africa and Latin America. Aquatic production is intrinsically linked with the livelihoods of a significant number of the lower-income urban households. It includes a wide array of activities, from extensive to intensive cultivation of both fish and aquatic vegetables. However, the production systems involved are generally semi-intensive often utilising wastewater from the city as a source of nutrients and fertiliser for increasing production.

Editorial

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Despite the growing importance and attention given to urban agriculture, the importance and potential of growing fish and edible aquatic plants/vegetables in and around cities remains largely unknown to the wider development audience. The term "urban aquaculture" captures a broad array of activities. Fish farming in or around cities varies from the relatively large-scale semi-extensive culture of fish in the Kolkata wastewater-fed wetlands and lagoons to the high-tech, intensive culture of tilapia in tanks in North America and Europe. Aquaculture also includes the considerable, unrecorded cultivation of edible aquatic plants/vegetables, often using wastewater, in and on the periphery of a number of cities throughout southern Asia, providing income and employment for a significant proportion of urban households. It produces fresh green foodstuffs which are consumed daily by millions of city dwellers as a regular and nutritious part of their diet. The benefits of this valuable "hidden green harvest" remain largely unrecorded. They are, for example, not listed in FAO statistics for aquaculture. The multitude of stakeholders involved in the production, harvesting and sale of aquatic vegetables thus remain largely unrepresented and unrecognised by both city planners and developmental agriculturalists.

This issue of UA Magazine draws on preliminary research findings from the PAPUSSA (Periurban Aquatic Production Systems in South-East Asia) project, which aims to give an overview of the status and impact of periurban aquatic production systems in four cities (Bangkok, Phnom Penh, Ho Chi Minh City and Hanoi). Production, livelihoods, markets and institutional aspects affecting a wide range of the stakeholders involved are discussed within the context of increasing urban migration, future sustainability and development in the sub-region; similarities and differences between the four cities are highlighted. This issue also contains a number of articles on the cultivation of fish and aquatic vegetables in other cities in Southern Asia, Africa and South America, which the reader can use as a basis for comparison.

The EU-funded PAPUSSA (Production in Aquatic Periurban Systems in SE Asia) project is a collaborative research project of European organisations and Asian partners in Hanoi and Ho Chi Minh City in Vietnam, Phnom Penh in Cambodia and Bangkok in Thailand. (see www.ruaf.org/papussa/index.html). PAPUSSA is in its second year and has the overall objective of providing a detailed, holistic situation analysis of periurban aquatic food production in these four cities. It uses a cross-disciplinary research approach, involving a range of partners from aquaculture systems, social sciences and health-related backgrounds.

William Leschen

Cultivation of water Morning Glory in Beung Cheung Ek Lake, Phnom Penh, Cambodia

PERIURBAN AQUATIC PRODUCTION

There is no universally accepted definition of the term periurban. Periurban environments and communities share many facets with those defined as urban (or intra-urban). Usually the transition or interface from rural to periurban to urban is regarded as a continuum. Due to changes in the factors that determine aquatic production systems, eg the availability of land, in general one can state that in the urban setting relatively smaller and more intensively managed aquatic production systems are more common.

In the PAPUSSA-related articles and also the other contributions to this issue, the aquatic production systems referred to are largely found in periurban areas. These periurban areas are in a state of constant change and are often characterised by having only a basic infrastructure (roads, schools, medical centres) and poor service provision, e.g. unreliable sources of water and limited access to sanitation. There are often conflicts over land and water use, and urban industries often move into these areas to escape restrictions and regulations. Periurban communities are often heterogeneous with respect to ethnicity, income levels, language and social norms and are characterised by increasing population density through migration, caused not just by rural people coming in from outside the cities, but also by the movement of urban people radiating outwards from the urban core.

TYPES OF URBAN AQUACULTURE

The classification of aquaculture systems by Coche (1982), which is based on production intensity and management demands, indicates the degree of control and surveillance operators are able to exercise, both practically and in terms of the assets upon which they have to draw. This might be particularly helpful in discussing the periurban situation.
In the case of periurban aquaculture production, the transition from extensive to semi-intensive aquatic production systems may be attributed to various factors. However, greater demand from markets combined with improved marketing channels often constitutes a particularly important driver for intensification. Control of resources and more access to production-enhancing inputs such as waste resources, food processing by-products and credit to purchase additional seed, feed and labour can also stimulate intensification. This transition from semi-intensive to intensive production appears to be driven largely by financial considerations and increased competition for resources, in particular land, but also solid organic and wastewater resources, labour, credit and markets. Intensification also appears to offer producers greater control, enabling them to better safeguard and enhance the quality of products, and also address concerns expressed by consumers regarding possible health hazards. Despite the competitive advantage associated with intensification, several barriers to such a transition and thus the sustainability of the production systems can be identified: transaction costs may be high, whilst limited access to knowledge, training, credit, markets and institutional support limit the options and opportunities available to producers.

There are of course also examples of successful semi-extensive periurban aquatic systems, such as those described in this issue, particularly in the case of aquatic vegetables. Therefore from a future planning perspective it should not always be assumed that intensification of periurban production systems is inevitable and also, perhaps more to the point, always most desirable. This drive for more intensive systems also raises questions about their long-term future. The increasingly intensive large-scale cultivation of water spinach (*Ipomea aquatica*), also commonly known as water morning glory, in and around Bangkok, involves the use of increasing amounts of chemicals in order to boost production, which has resulted in the increasing contamination of surface and groundwater supplies and degradation of the surrounding environment.

Periurban aquaculture has a number of benefits and constraints, as demonstrated with detailed findings in all of the contributions to this issue. Some of these main findings are summarised below.

BENEFITS

The cultivation of fish and aquatic vegetables in cities provides food, income and employment, particularly to lower-income urban households. These benefits aren't just limited to those who actually farm the fish and aquatic vegetables but radiate out to a network of other individuals who are involved in the marketing chain, including those who process, transport and then market the products. This chain generates income and employment at as many as six levels between the farmer and the consumer. Also, as these aquatic production systems become more intensive they utilise more inputs, e.g. brewery and chicken-farming wastes, thus adding value to, and at the same time creating market demand and generating income for such waste products. The contribution from Ghana on page 39-40 describes the potential for urban aquaculture, describing semi-intensive aquaculture production in ponds close to Kumasi, Ghana using poultry manure to fertilise ponds. Aquaculture practices that utilise food processing and agricultural by-products, such as poultry manure, are widespread and diverse, and aquaculture has an important role in recycling organic wastes from industrial and urban activities. For example, in Thailand, by-products from chicken processing plants are used to feed catfish (*Clarias gariepinus x Clarias macrocephalus*) grown in urban aquaculture systems stocked at high densities. In Peru (see page 32, treated wastewater from stabilisation ponds is used to produce tilapia (*O. niloticus*). Environmental and social benefits were mentioned in earlier issues of UA Magazine (numbers 3 and 8 for instance)

and are also discussed in the articles in this issue. Low-cost wastewater treatment on a city-wide level is described in the East Kolkatta wetlands article (page 24), but also on a more communal basis in the article on Lima, where both small and large-scale systems produce valuable foodstuffs and thus income and food security for the people working within them. From an environmental perspective, growing aquatic vegetables and fish in and around cities can fit in with the concept of cleaner and greener cities, which encourage a healthier environment for their citizens and visitors. The authorities in Hanoi are increasingly aware of the "City of Lakes'" potential for tourism and thus are now looking more closely into using the urban environment in a more sustainable and promotional way. The quality of the urban environment is also very much linked to the overall health and well-being of its citizens, and it is perhaps here that sustainably managed periurban aquaculture can act as "bio-indicators" of environmental health within communities, whilst also offering ownership and pride to a wide range of its ordinary citizens.

CONSTRAINTS

The process of urbanisation has had a negative overall effect on food production and thus aquaculture in cities. The limited access to land for the increasing numbers of people migrating to cities restricts their options. For both urban agriculture and aquaculture access to land is one of the main requirements for producing crops, fish or livestock. The attributes of the land required by the urban farmer are considerably less stringent than for the person cultivating fish or aquatic vegetables. Growing crops and even livestock can often be carried out very successfully within cities utilising relatively small areas of marginal land, which can be enhanced using chemical or organic fertilisers. However, the prospective fish or aquatic vegetable farmer has to not only find and retain access to the necessary area of land, but also obtain a source of water that is reliable both in terms of seasonal availability and quality (it does not deteriorate due to effluents from surrounding factories or other detrimental human activities). These factors can restrict and pre-determine to a large extent where more permanent periurban aquatic systems are located.

This constraint is now beginning to be addressed by the development of closed or recirculation aquatic production systems in a growing number of cities, although they exclude many potential fish farmers due to the high capital investments required to start up. These systems are still very much in their infancy in terms of food production and tend to be more commonly used for high-value species and also increasingly for ornamental fish production, as illustrated by Rana's article describing the emergence of Clarias (catfish) culture in recirculation systems in urban Lagos, and Hung's article describing the growing ornamental fish sector in Ho Chi Minh City.

Deteriorating surface and groundwater quality and also rising agrochemical use increasingly threaten the future of farming fish and aquatic vegetables in most developing cities. For urban aquaculture there is a conflict here, since increasingly intensive periurban production systems require more chemicals, pesticides and fertilisers to grow their aquatic vegetables and fish. If this trend continues and there is little effective monitoring and regulation, the resultant decline in urban water quality could bring about the eventual disappearance of these systems altogether.

Increasing contamination of domestic wastewater with industrial effluents is reducing production levels in a number of periurban aquatic systems. This also manifests itself in a reduction in quality of the product sold, e.g. water spinach produced using wastewater in the dry season in Phnom Penh is increasingly vulnerable to disease. As a result a significant proportion of this dry season crop is now sold as livestock feed.

The terms of access to land can also restrict the long-term sustainability of these systems. In Hanoi many of the city's fish farmers can obtain at most a 5-year lease for the ponds or wastewater-fed lakes they stock and harvest. These leases are often allocated through a closed auction system. Therefore these periurban fish farmers have no long-term security of tenure and as a result are less likely to invest capital in developing or even maintaining their own systems. Similarly, as illustrated in the case study from Phnom Penh, women renting plots for the cultivation of water spinach in the wastewater-fed Beung Cheung Ek Lake can be forced to move from their plots after a warning period of only two weeks.

Availability of another essential input resource, namely labour, was also found to be a considerable constraint for fish farmers in both Hanoi and HCMC (described on page 20)), especially around the time of harvesting when certain periurban communities had to import labour from other areas on the periphery of the cities to fulfill their needs. This is a good illustration of how labour markets develop through competition with urbanisation: the younger generations are more attracted to the increasingly varied and lucrative job market that a growing city offers and thus leave the cultivation of fish and aquatic vegetables to the older family members, many of whom were involved in farming during their formative years. This process tends to limit the level of innovation and subsequent uptake of new technologies, which could, if utilised, further increase yields and production of fish and aquatic vegetables.

William Leschen

Harvesting tilapia in a wastewater fed lake in Yen So, Hanoi

PAPUSSA EXPERIENCES

The overall findings thus far from the PAPUSSA project have been qualified by both the considerable differences and some similarities between the four target cities. This allows us to comparatively analyse periurban aquatic systems in these cities and the communities involved in them.

Bangkok could be seen as the "model for development" for the other three, with HCMC and Hanoi already beginning to show similarities. The evolution and translocation of aquatic production systems from the inner metropolitan area to the expanding peripheries, in the case of Bangkok to its surrounding provinces, is already underway in HCMC and Hanoi, with the gradual upgrading of the cities' respective transport and road networks as well as the growing ownership of motor vehicles amongst its citizens allowing more flexible access to markets. This is illustrated by Edwards' article (page 27) and the article on Hanoi (page 10), which at first might appear contradictory. It is likely that land areas utilised for aquatic production systems have declined within Hanoi over the last five years, however there have been corresponding increases in aquaculture on the outskirts of the city. In the case of fish culture, more intensive, higher input systems are producing larger sizes of higher-value species (e.g. red tilapia), which the urban consumer is increasingly partial to.

Of the four PAPUSSA cities, Phnom Penh has the least developed infrastructure, making it much more dependent on local production of fresh foods. Other vegetables are scarcely available and the traditional livestock sector thus relies on aquatic vegetables produced using wastewater in Beung Cheung Ek Lake to be used as feed. The city's fish farming industry is well positioned to supply the growing markets in the area because plentiful feed is available (trash fish) from the Great Lake, as well as seed (fingerlings) from nearby Vietnam. The future of the considerable water spinach production in Beung Cheung Ek Lake and its associated treatment of the city's wastewater is uncertain due to many factors including deteriorating water quality in the lake caused by pollution and growing pressures from population growth in Phnom Penh. The "illegal settler" status of most of those living around the lake can in the future allow the government to move them and redevelop this area for further industrial or residential development. To do this, however, the government would have to provide alternative methods for treatment of the city's wastewater which are both practical and comparable in cost to the present essentially low-cost biological filtration and treatment carried out by the lake.

The characterisations and delivery mechanisms of **wastewater** vary considerably among the cities studied. In Ho Chi Minh City the diffuse, tidal nature of the city's main wastewater canals differs from the more defined wastewater canals running north to south in Hanoi. Furthermore, in Hanoi fish and aquatic vegetable growers actively pump wastewater from the canals into their fishponds or fields. In Phnom Penh a large proportion (80%) of the city's wastewater is pumped into Beung Chueng Ek Lake. A number of communities located on the fringes of the lake make their living from culturing water spinach, which is a very popular edible aquatic vegetable. Water used in periurban Bangkok is derived from a series of irrigation canals, which contain both domestic and industrial wastes. Agrochemicals are now used quite intensively in many of Bangkok's aquatic vegetable production systems with studies showing that the resulting residues constitute a potential problem.

Initial **market surveys** were carried out in each of the cities in order to identify the major actors and channels for fish and aquatic vegetables. Some key findings are summarised in table 1. Bangkok has the most developed urban markets and related transport systems, with the increasing influence of supermarkets now also becoming apparent in Ho Chi Minh City and Hanoi. Adding value through packaging, presentation and certification, as well as food safety issues for aquatic products are becoming increasingly important for the urban consumer and as a consequence increasingly for those who produce them. There is also a premium associated with selling live fish and this remains the most common approach to selling fish at wholesale and many retail markets in all of the cities.

In all four of the cities the considerable demand for aquatic vegetables is met almost entirely by production in periurban areas. With the exception of Bangkok, these aquatic vegetables are being grown almost entirely using wastewater. Aquatic vegetables, particularly water spinach, can be commonly found as a daily constituent of urban people's diets in each of the four cities. Consumer surveys found that very few people have negative perceptions regarding the consumption of such aquatic vegetables produced using urban wastewater, whereas the situation regarding the consumption of fish within the cities was quite different, with most urban consumers interviewed in markets preferring to eat either marine or freshwater fish imported from outside areas. Periurban-produced fish, often cultured in wastewater, are generally consumed by lower-income urban consumers and sold directly to households or at street markets. This is probably due more to price and size considerations than preferences or availability. Results from a survey conducted in Hanoi, which are backed up by Edward's article, showed that a significant percentage of periurban wastewater-produced fish were actually transported outside the city to nearby provinces. Although the rationale behind this is not entirely clear, urban consumers appear to have concerns about eating the relatively smaller fish produced in cities due to the use of wastewater and possible health risks associated with contamination in such systems This role of wastewater-cultured fish in feeding more distant populations reflects the increasing connectedness of urban and rural production.

Within all four PAPUSSA cities the relative success and value of the marketing of periurban wastewater-cultured vegetables compared to their fish

counterparts can appear confusing, particularly if the same health and food safety perceptions are considered. We believe one reason for this difference is that the periurban farmers who produce large volumes of attractive, good-quality, fresh water spinach and other edible aquatic vegetables have little competition from provincial producers. Also the products themselves have a very short "shelf life" with freshness and quality being foremost in the minds and choices of urban consumers. Therefore distance and delivery time from production site to market is very important. Conversely, the increasing infrastructure of refrigerated, iced and oxygenated transport/ truck delivery of live or fresh fish ensures that the supply, variety and quality of fish entering urban markets is far more competitive. It is interesting to compare this with the situation in sub-Saharan Africa, as portrayed on page 36, where current market forces also very much restrict the growth of fish culture in the cities. The importation and subsequent popularity of plentiful supplies of frozen herring and mackerel at very low prices (US$ 0.40-0.60 /kg) make it very difficult for prospective periurban fish farmers to compete. As Rana explains, this price level may well influence the cost ceiling of any fish farming activity, and certainly those aiming at mass markets, making it necessary for prospective fish farmers to concentrate on more niche markets for either larger or live/fresh fish. Market forces in the PAPUSSA cities are also restricting periurban fish farmers since they are competing with not just the variety of marine and freshwater wild-caught fish but also growing production from the expanding fish farming sector in their provinces.

Aquatic Vegetable (AV) Growers

- Lacking in formal or non-formal extension/training/technology transfer compared to periurban fish farmers
- Almost nonexistent voice in the urban planning process – uncertainty as to which government ministry or department is responsible for them
- Few signs of group/association formation to protect their own interests
- Some positive urban development plans (e.g. HCMC) have set aside areas on the periphery of the city for agriculture and aquatic plants

Local Planners and District/ Commune Officials

- Some form of de-centralised administration in Bangkok metropolis, however this still doesn't give local officials much influence in planning process
- Most local officials have limited role of informing and providing statistics for higher centralised urban policy makers
- Increasing role of larger construction and real estate development in Hanoi and Phnom Penh – to a large extent this has already happened in Bangkok and HCMC
- Little planned integration of aquaculture into other urban water users' activities, e.g. leisure, city park lakes, angling

Fish Farmers

- Extension and training better than for aquatic plant growers but they still suffer from Govt/NGO's greater interest and involvement in more commercially related aquaculture development in provincial areas
- Better representation at urban planning table through Fisheries Departments but overall still little influence
- Again poor group/trade association formation to protect interests or help in marketing – some positive signs of this in Bangkok

Centralised Planners Policy Makers

- Lack information about the relative importance and benefits of urban-produced fish and aquatic vegetables to these communities, for job and income creation, for providing a localised food supply, creating a "greener" more attractive city whilst also recycling urban waste
- Limited provision for future development or even maintenance of urban fish and aquatic vegetable cultivation in previous City Development Plans. Policy of "zoning" being developed in periurban HCMC and to a lesser extent Hanoi
- Communication between main players in the urban planning process is demand driven from other more influential government ministries and outside stakeholders – political influences, construction/industry and real estate

Institutional analysis was carried out in each city to identify those institutions which were involved or related to periurban aquatic production systems. Understanding and being aware of these institutional characteristics, relationships and associated strengths and weaknesses is one step towards making a positive impact on the future of and potential for growing fish and aquatic vegetables in these cities. Findings from our institutional analyses in the four cities are summarised in the box on this page for the different stakeholder groups involved.

FUTURE PERSPECTIVES

A number of aquatic producers were found to be exhibiting risk-aversion strategies in response to the changing environments in which they were living. In Bangkok and HCMC certain fish farmers have begun to produce ornamental fish, whilst hatchery producers in HCMC have also begun cultivating ornamental (house) plants for the growing market of urban consumers. In Hanoi seasonal rotation of different aquatic vegetable species have provided farmers with higher incomes and security from seasonal fluctuations in prices of the main crop (water spinach). Other successful aquatic vegetable producers in Hanoi have set up small-scale "backyard" electro-plating workshops producing kitchen utensils. Similarly in Phnom Penh, many women cultivating water spinach also run shops and stalls where they sell food and household items. For these farmers minimization of risk will ultimately affect their future livelihoods and also the future of the aquatic production systems they currently work in.

Perhaps here a case can be made for the relative advantage of aquatic vegetable production over fish in the periurban environment. Aquatic vegetables are far less vulnerable to theft and chemical contamination; generally more land efficient, involve lower entry costs and normally require lower value inputs. Cropping cycles are also shorter than for fish culture, eg water spinach farmers can harvest three full cropping cycles throughout the year. Fish cultured in periurban areas, as illustrated in Edwards' article, are highly vulnerable to contamination from polluted water, leading to fish kills and therefore subsequent loss of the farmers' investments.

Based on preliminary findings we could conclude that the disappearance of some systems in the four cities studied is inevitable due to urbanisation, a process which also involves the gradual shift of aquatic production systems to more geographically peripheral periurban areas. This conclusion mirrors experiences in other cities around the world, where agricultural production has been displaced in a similar way. However, this process should not be seen as inevitable. There is currently huge demand for aquatic vegetables within these cities, especially water spinach, which is virtually all produced in periurban areas often using wastewater as its main nutrient input. This relatively cheap input combined with the climatic/temperature regimes of these four cities (Hanoi to a lesser extent) and their proximity to ever-increasing markets give them a considerable comparative advantage in producing and selling large volumes of fish and aquatic vegetables all year round. Also these cities have the advantage of year-round availability of commercially important waste products (e.g. brewery and canteen wastes), which are currently used as lower-cost feed inputs for periurban fish production. The availability and use of these types of inputs is likely to increase as wastewater quality continues to deteriorate.

The future potential for growing both aquatic vegetables and fish using urban wastewater will depend on city planners' ability to coordinate and develop strategies for the effective separation of industrial waste effluents from domestic sewage. This separation is also desirable for other lower-income periurban households that rely on the cultivation of land vegetables, cut-flowers and crops using wastewater as their main, often only, source of water and nutrients. Implementing such strategies of wastewater management could prove quite problematic for larger cities where the existing infrastructure appears to be more inflexible to these changes. However, there are already encouraging examples in Hanoi and HCMC of relocation and zoning of urban industries into industrial parks which allow more effective treatment and monitoring of effluents. Perhaps this perceived constraint would have fewer implications for smaller, provincial cities which still have the flexibility and potential within their infrastructure to incorporate cost-effective, longer-term aquatic production systems into their development plans.

The articles from Nigeria, Peru and Cuba illustrate the potential for the small-scale production of fish on a community, or even household level. The uptake of these systems in these areas is perhaps related mostly to differences in cultures and availability and access to water and land compared to the Asian cities studied. Small-scale systems such as those described by Afolabi, could be appropriate and cost effective for the citizens of certain southern Asian cities who have the initial capital to construct and maintain them. Perhaps more feasible and exciting is the potential for transferring the considerable knowledge, expertise and benefits in the large scale production of aquatic vegetables using wastewater from the four SE Asian study cities to their geographically and climactically similar sub-Saharan African and South/Central American counterpart cities. Whether this would be applicable would depend on a number of factors, most notably the nature and flexibility of their existing domestic wastewater removal systems to adapt, and the willingness of citizens to accept the production process and the crop itself.

Food safety for the consumer and occupational health risks for those working with wastewater also affects the future potential of growing fish and aquatic vegetables in cities. Studies on food safety/health carried out in urban communities in Phnom Penh are described by Van de Hoek, with particular reference to chronic skin problems observed amongst water spinach farmers working in the wastewater-fed Beung Cheung Ek Lake. The PAPUSSA project will also be assessing the risks to both consumers and those who work with wastewater, including an ongoing water sampling programme of inlets and outlets of different periurban aquatic production systems, which will also provide indications of the capacity of these systems for cost-effective wastewater treatment.
New guidelines from the World Health Organisation (WHO) for the safe use of domestic wastewater and excreta in aquaculture are due to be published shortly. Their main objective is the prevention of transmission of wastewater and excreta-related diseases (both from infectious agents and toxic chemicals) to farmers and their families, to local communities and to product consumers. These guidelines will be based on the development of "health-based targets" for certain levels of health protection in an exposed population. This level of health can be achieved by using a combination of management approaches, e.g. good aquaculture practice (GAP), produce restriction, human exposure control and microbial water quality targets. This approach is intended to lead to national standards and regulations that can readily be implemented and enforced, and that protect public health. More on these guidelines will be published in future issues of this magazine.

Although research studies on the future of urban agriculture have been far more numerous, recently there have been a number of publications on the potential of growing fish and aquatic vegetables in and on the outskirts of cities. It is important to ask why we are studying or projecting the future sustainability of periurban aquatic production. Is it as an aim or objective in itself? Or do we see it as a way to fulfill the growing requirement of food to feed the rapidly expanding urban populations as well as a system to re-use and treat the cities' wastewater? Our PAPUSSA studies and also evidence from markets in sub-Saharan Africa appear to indicate that marketing periurban-produced fish is not the only answer, as market forces are differentiating in favour of other outside sources of fish. It is also pertinent to ask who will be the periurban fish and aquatic vegetable farmers of the future if periurban aquaculture is to survive and fulfill an important role? Is it our objective to help (perhaps on more a community-based level) remove constraints for , lower-income city dwellers so that aquaculture can become or remain a significant income-earning activity for their families? Or should we be promoting periurban aquaculture on a

In the first year of PAPUSSA (2003) the project partners in each of the four cities produced an overview of the status of peri-urban Aquatic Food Production Systems (AFPS) in their city based on sources of data and information from:
1. an institutional analysis relating to AFPS at city, district and commune levels
2. a marketing survey carried out throughout fish and aquatic vegetable markets
3. participatory community appraisals (PCA) in different communes indicative for AFPS
4. a state of the systems (SOS) meeting to gather and validate opinions from stakeholder systems concerned.

more commercial basis, by encouraging entrepreneurs to farm fish or aquatic vegetables using the readily available inputs of wastewater supplemented with waste products such as brewery wastes or agrochemicals where appropriate? These farmers could gradually intensify their systems to maintain or increase profits whilst also modifying their production in order to sell an attractive product to the consumer which is healthy to eat. These are two quite different approaches with the drivers and research bases needed to develop them being radically opposed. In reality both of these scenarios are unfolding in the periurban environment, as demonstrated by our PAPUSSA household baseline survey. If one looks at comparisons between Bangkok and the other cities it can be seen how overall market forces, affecting not just aquatic products but equally importantly also urban land itself, develop and change the location and focus of periurban aquaculture as well as the livelihoods of the people living in the communities and those who have moved away, either by necessity or choice. Therefore being too focused on one particular group of stakeholders, e.g. the urban poor or conversely potential entrepreneurs who have the capital to develop such systems, is not a realistic approach in looking to the future. If one's objective for the future of periurban aquaculture is to include both groups then we should be looking more constructively into possible complementarities between the two groups rather than concentrating on their differences. Finally, this century is already seeing increasing pressures on the availability of freshwater in many countries. The United Nations World Water Development Report (2003) estimated that by 2050 at worst 7 billion people in 60 countries will be considered water scarce, or at best 2 billion people in 48 countries. The Population Council predicts that world population will grow to 7.8 billion over the next 25 years, with most of this increase occurring in urban areas. The urban population will roughly double, to approximately 4.5 billion people within this time. After 2020, all population growth—and most poverty—in the developing world will be concentrated in urban areas, as rural populations decline.

Universal water supply and sanitation coverage by 2025—a now widely acknowledged goal—will mean that in urban areas an additional 1.9 billion people will need water and an additional 2.1 billion will need sanitation services. This projected urban water scarcity will inevitably increase competition and even conflict for all available water sources in cities. This future prospect demands that we develop sustainable systems which can re-use water more effectively whilst also producing safe, healthy food, providing income and employment and developing green and environmentally friendly cities.

This issue of UA Magazine presents PAPUSSA findings in conjunction with articles on periurban aquaculture from other cities and other continents to a broader non-aquaculture audience. Our findings show that more effort needs to be focused on those who are directly involved in the urban planning and development process, wastewater management, health care, marketing, food safety, environmental protection and the media. By presenting a multi-focal overview of the current and past situation in these four cities our aim is for these stakeholders to be better informed of the many diverse benefits as well as the associated problems of growing fish and aquatic vegetables in cities.

Table 1. Key findings from market surveys relating to the marketing of fish and aquatic plants
PAPUSSA Markey survey reports

	Bangkok	HCMC	Hanoi	Phnom Penh
Market transport	Well developed, good transport network. Motorised- trucks and pick-ups. Well developed road network.	Aquatic vegetables/plants (AV) now transported more by smaller trucks. Fish bymotorbikes and trucks.	AV still largely transported bybicycle/motorbike. Fish mainly by motorbike and increasingly by smaller trucks.	Motorbike and bicycle. For aquatic plants, mainly by motorbike.For fish by some smaller trucks. Poorer road system outside city.
Market infrastructure	Large centralised wholesale markets supplying retailers. Increasing growth in supermarkets.	Well developed fish wholesale sector. Increasing supermarkets.	Construction of new wholesale markets. Urban street/retail markets causing increasing traffic congestion.	Distinction between wholesale and retail less clear
Adding value/ packaging processing	AV increasingly sold packaged. Fish still sold live. Also processing + packaging for supermarkets	Beginning to change with packaging for AV + influence of supermarketsector.	Fish markets still based on selling live fish. Aquatic vegetables sold fresh and unpackaged.	No packaging for AV – sold fresh. Some sold for livestock food. Some smoking of catfish but small market. Fish sold live/fresh.

The main aquatic production systems referred to in this issue are the production of Chinese water spinach (Ipomoea aquatica Forsskal), also known as water morning glory, water convolvulus, swamp cabbage, swamp morning glory, and tropical spinach; water mimosa (Neptunia oleracea Lour.); water dropwort (Oenanthe stolonifera); water cress (Rorippa nasturtium-aquaticum); water lotus (Nelumbo nucifera) and different types of farmed fish including, among others, tilapia (Oreochromis niloticus), hybrid catfish (Clarias macrocephalus), pangasius (Pangasius bocourti/P. macrocephalus), walking catfish (Clarias batrachus), common carp (Cyprinus carpio), giant guorami (Osphromenus gourami), grass carp (Ctenopharyngodon idellus), kissing gourami (Helostoma temmincki), silver barb (Puntius gonionotus), and snakeskin gourami (Trichogaster pectoralis). Since morning glory is sometimes used to describe a very different plant species, we think Ipomoea aquatica should be referred to wherever possible as water spinach.

Notes
1) The term aquatic vegetable is used throughout this issue to describe the edible green plants water spinach (*Ipomoea aquatica*) – commonly known as water morning glory –, water mimosa (*Neptunia oleracea*), watercress (*Rorippa nasturtium-aquaticum*) and water dropwort (*Oenanthe stolonifera*), which are grown in water.

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Aquatic Food Production Systems in Bangkok

Around 10 million people now reside in densely populated communities in Bangkok. As a result, the demand for food has increased dramatically. Of the many varieties of fresh produce available, city consumers favour aquatic products such as water spinach, water mimosa and freshwater fish. These products are grown primarily in periurban areas around Bangkok.

Ruangvit Yoonpundh

Morning Glory farming on the outskirts of Bangkok

Aquatic production systems, including farming of edible aquatic vegetables and fish, play an important role in the livelihoods of many urban dwellers employed as farmers and vendors. Production from inland aquaculture increased to around 280,000 metric tons in 2002, accounting for nearly 10% of total annual fish production in Thailand (Department of Fisheries, 2004). This generated an estimated income of nearly 10,000 million Baht (US$ 250 million) a year. Around 30% of this aquatic production is concentrated and produced intensively around Bangkok periurban areas. For example, in the northern part of Bangkok in particular, hybrid catfish (Figure 1) farms produce more than 70% of the country's total production of catfish (around 80,000 tons) and extensive water mimosa farming in public canals can be found in Pathumthani province. In Nontaburi province about 40 kilometres west of Bangkok, there are vast areas of intensive water spinach – commonly known as morning glory - farms (Figure 2). About 20 kilometres south of Bangkok, mixed tilapia and carp polyculture in large ponds and intensive water mimosa farming can be found. However, recent changes in water and land uses in periurban areas, made to accommodate rapid expansion of housing projects, industrial factories and construction of a new airport, have seriously impacted on some aquatic production communities. This development is leading to changes in their traditional way of life from agricultural communities into urban and industrialised districts and suburbs of the city.

Deterioration of the aquatic environment resulting from this development is an important factor directly affecting aquatic production systems. Although the 9th (2002-2006) National Economic and Social Development Plan (NESD) has put a priority on decentralisation, aiming to increase authority at community level in order to utilise local resources more effectively and sustainably. There are limitations in the readiness and capacity of these communities to implement these plans. Capacity building should include all stakeholders, e.g., farmers, extension officers, vendors and policy makers.

A recent State of the System (SOS) workshop held with a variety of stakeholders involved in urban aquatic production systems in and around Bangkok revealed the main problems faced by farmers. These included lack of land, high cost of investment and pollution from waste water effluents from communities, factories and village estates. These environmental problems were especialy severe during the dry season due to lack of dilution and drainage within the culture areas, as well as low personal responsibility towards the public environment. These problems may be an important motivation for farmers to increase the intensity of their farming activities and systems in order to increase yields. Intensive farming, particularly in aquatic vegetable cultivation, uses large amounts of chemical fertilisers and pesticides. However many of those who cultivate water spinach and water mimosa still lack sufficient knowledge and understanding of chemical uses due to their low educational backgrounds. Also the government extension service lacks the capacity to work directly with farmers and is continually being constrained by the relatively low level research base involved in aquatic vegetable production . In addition these problems are compounded by the lack of effective mechanisms for the dissemination of information on chemical toxicity and ineffective statutory regulations and monitoring of chemical uses in the field environment.

In terms of fish culture, periurban fish farms produce mostly common commercial species such as hybrid catfish, tilapia and carps, which are sold mostly fresh except for hybrid catfish, which are sold live to markets in Bangkok. Keen competition amongst producers keeps fish prices low resulting in fish farmers attempting to source low

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cost inputs such as canteen and slaughterhouse wastes. The intensity of production together with these least cost feeding strategies undoubtedly result in water quality deterioration and after discharge from ponds can significantly degrade the water quality of local public irrigation canals.

Most aquatic vegetables and fish produced in periurban areas are transported to retail markets in Bangkok and elsewhere (Figure 3) for trading. Various middlemen are important actors in this marketing network. They can initially collect aquatic products from farmers, transport and then sell them to wholesale markets in both suburban and periurban areas. Other middlemen buy these aquatic products from the wholesale markets and sell them through to retail markets. However increasingly aquatic vegetable farmers transport their own produce directly to wholesale and retail markets, this being made possible by the increasing ownership of motorised vehicles, particularly pick up trucks, which gives the farmers more flexibility in when and to whom they can sell their produce, whilst also allowing them to cut out the middleman.. This arrangement is uncommon for freshwater fish producers in and around Bangkok with more specialised middleman transporting the fish to markets.

Expansion of the "modern trade" type market or "supermarket" in suburban

Ruangvit Yoonpundh

Morning glory is sold in retail markets

and periurban areas of Bangkok in the past five years, which has co-incided with the Thai government's policy of "food safety" awareness, has resulted in rising consumer demand for cleaner and better-quality products. Vegetables free from pesticides that are subject to food safety standards including packaging and displaying a certified quality standard are now avaialbe. In the near future, it is likely that food safety concerns and requests for certification will become increasingly common among consumers and buyers, and these demands will influence the production of aquatic vegetables such as water spinach and freshwater fish such as cultured red tilapia.

The market system can promote all types of these "food safety" labelled foods by demanding better quality standards and charging higher prices (due to higher production costs incurred in persuading farmers to produce just what the buyer or customer wants). However, aquatic products that meet this standard currently account for only a small portion of total products sold in the market. Therefore, in order to achieve sustained growth for aquatic products in these changing markets, it will be necessary to place higher priority in the near future on food safety for all aquatic foods, which includes a safe and clean production process which the urban consumer can have confidence in.

In the light of this dynamic market situation the government needs to consider how to sustain aquatic production systems in Bangkok periurban areas as they are an important source of aquatic foods and employment for the local economy. Increased co-ordination between relevant stakeholders is also important. In addition to these requirements, studies must be undertaken to develop new technologies for wastewater treatment, improved marketing mechanisms and Good Aquaculture Practice (GAP) leading on to green (or blue?) certified aquaculture products. These proposed changes will require considerable, but not insurmountable, organisation and policy analysis within not just government but also involving other related stakeholders in order to set up a platform for dialogue and promote a multidisciplinary approach to ensure the future of aquatic production systems in and around the city .

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POLICY BRIEF BANGKOK PAPUSSA

This text has been taken from a Policy Brief that is currently being prepared. This draft was formulated and produced as part of a 3 weeks interactive learning exercise in producing Policy Briefs by students from Stirlings' MSc Aquaculture and MSc Sustainable development courses in collaboration and communicating on a daily basis with PAPUSSA staff in Bangkok over an internet linkage. The PAPUSSA project will be producing finalized drafts of Policy Briefs including recommendations for each city later in the year. The scheme (Figure 1) is also from this pamphlet. The Policy Briefs for each of the four PAPUSSA study cities will be available from the website.

RECOMMENDATIONS

1. Understanding the importance of aquatic vegetables

Aquatic vegetables are an important part of the diet of both producers and consumers. They can also be used as a feed for fish or other livestock. This value should be recognised in order to support the farmers that produce these vegetables, and legitimatise their livelihood to ensure that they are not constantly forced to move due to urban development.

2. Ensure aquatic environmental quality

Wastewater which is used in periurban aquaculture is increasingly polluted. Strengthening environmental legislation would help to alleviate this problem. Discharge into public water bodies must be better monitored and regulated. Health risk minimisation strategies (also point 3) should be developed and disseminated.

3. Improve public health and food safety

Improved information and education to farmers on cleaner and more sustainable production techniques (e.g. less use of chemicals) would help them to match and satisfy consumer preferences, while maintaining environmental and health standards.

4. Increased market access

Packaging and labelling are becoming more important to consumers, as they provide some measure of food safety standards. Educating farmers on (hygienic) processing, along with a labelling system (or certification) would help to gain better prices.

Farmers' Associations, of which there are a few in the BMA, can also help to negotiate fair prices for producers and possibly to negotiate contracts directly with wholesalers and retailers.

5. Community participation

An inclusive approach is required in order to build capacity within these communities and to ensure that the decentralisation advocated by the 9th NESD is more effective in the future. The periurban landscape is changing on an almost daily basis, and the land available to farming communities is diminishing due to the residential and commercial developments. Involving these communities, who have been under-represented in decision making in the past, assists them in developing their own capacity and enable them to establish more secure livelihoods.

6. Improved farming techniques

Aquatic production is becoming more intensive in periurban areas, while access to resources becomes more limited. Research and the development of adequate technologies may improve sustainable production.

Current Status of Periurban Aquatic Production in Hanoi

With a total of 5100 ha of water surface area Hanoi has great potential for aquaculture development, not only of traditional aquaculture practiced in ponds, reservoirs, urban lakes, rice fields, and wastewater-fed areas, but also aquaculture integrated with tourism, leisure and entertainment facilities. Because of urbanisation, pond aquaculture in urban areas in Hanoi is decreasing, whilst in peri-urban areas lowland rice fields are being converted into areas for aquatic vegetable production, fish ponds and integrated farming systems.

Harvesting wastewater-fed fish

Nguyen Thi Dieu Phyuong

Hanoi is the capital and the cultural and political centre of Vietnam, and has a total area of 920.97 km^2 and 3.08 million inhabitants (early 2005). There are increasing problems with road congestion, declining living environment, employment and especially in the provision of food for the growing population. The increasing population density produces a large amount of wastewater. Under the "Hanoi city drainage and environment improvement" project increasingly water will be treated, but currently wastewater from the city flows directly into the To Lich and Kim Nguu rivers mainly to the Thanh Tri area in the south of the city where it is being used as an input for aquaculture in cultivating aquatic vegetables and fish.

The cultivation of aquatic vegetables utilising the city's wastewater has an important role in providing incomes and livelihoods for farmers in peri-urban Hanoi and is particularly prominent in Hoang Liet and Tran Phu communes. Market studies have shown considerable demand within the city for aquatic vegetables, particularly water spinach *(Ipomoea aquatica)* - commonly known as water morning glory. The agricultural systems in and around Hanoi are changing, with increasing use of wastewater for high-value crops such as mimosa, dropwort and cress rather than rice, giving peri-urban farmers increased yields and financial benefits.
Recently aquatic production in peri-urban Hanoi has been increasing in both overall area and yield. In the past 13 years, the land area used to produce fish increased from 2061 ha to 3348 ha, with the associated yield more than doubling, from 4207 to 8972 tons (Hanoi Agriculture and Rural Development Department, 2004). The majority of fish production occurs in Thanh Tri district (52%) whilst the remainder includes 15% from urban lakes, 12% in Tu Liem, 9% in Gia Lam, 7% in Dong Anh and 5% in Soc Son districts. The overall contribution of urban fish production depends on the different systems: fish ponds contributed 46%, wastewater-fed fish 31%, rice-cum-fish 13%, fish in urban lakes 7%, freshwater prawns 2% and fingerling fish nursing 1%.

AQUATIC VEGETABLES

Aquatic vegetables have a significant role in the balanced nutrition of Hanoi's citizens. In terms of production levels, water spinach is the most important aquatic vegetable produced throughout the year. Water mimosa *(Neptunia oleracea)* is cultivated only in the summer months from April to August, whilst others, primarily water dropwort *(Oenanthe stolonifera)* and water cress *(Rorippa nasturtium-aquaticum)*, are cultivated in the winter months from September to March. Aquatic vegetable production in Hanoi is mainly concentrated in Thanh Tri and Gia Lam districts (including the villages/districts Bang B, Hoang Van Thu, Yen So, Vinh Quynh, Tam Hiep,Tu Hiep and Hoang Van Thu) where they are cultivated in enclosed fields using pumped wastewater from the city as the main nutritional input. Floating water spinach is also produced in wastewater canals, and is very attractive for consumers in the city's markets. Rotation of the above crops is becoming more popular due to the benefits of increased and diversified incomes. To meet the urban consumers' increasing demands for aquatic vegetables, the producers have excavated their fields deeper and constructed enclosed "ponds" into which they supply wastewater though the pumping service provided by the local agriculture cooperative. They have also increased the use of agro-chemicals in their production cycles in order to boost production levels

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further, however this has also resulted in increasing pollution of local rivers and water sources.
In Bang B village, Hoang Liet commune, cultivation of an annual rotation of water mimosa and water dropwort contributed 90% of the highest recorded household income of 40 million VND/year (2,547.70 USD/year; 1 USD = 15,700 VND). The production of water spinach contributed 100% of the lowest recorded household income of 21 million VND/year (1,337.5 USD/year). At present about 50% of households in this village cultivate aquatic vegetables. This is also illustrated by the fact that in 2004 14 ha of former rice fields in Bang A village were converted to produce water cress and water dropwort, reusing wastewater pumped from the To Lich river (Phuong, 2004)..

FISH CULTURE.
Most periurban farmers stock a polyculture of common carp, grass carp, silver carp, Indian major carps (mrigal, *Cirrhinus mrigala*; rohu, *Labeo rohita*), bighead carp (*Aristichthys nobilis*) and mud carp (*Cirrhinus molitorella*). A relatively small number of farmers stock the high-value carnivorous black carp (*Mylopharyngodon piceus*) because there were relatively few snails available for feed. The fish culture cycle usually runs for 10-11 months, from March/April to January/February. Ponds are drained after the final harvest in January/February, dried for 1-3 weeks and then are cleaned, limed and refilled with water. Three months after stocking fish, households begin to harvest fish for domestic consumption and/or sale. Some households have two production cycles per year. Stocking densities vary widely depending on the different types of aquaculture systems, with an average of 2-3 fish/ m^{-2} for fish pond culture and 1 fish/ $2m^{-2}$ for rice fish culture. Normally fairly large fingerlings are stocked into these systems, e.g. 500g/grass carp, 15-20g/tilapia, 150-250g/common carp, 200-300g/silver carp, 150-300g/Indian carps, 150-200g/ Colossoma. sp.

Wastewater has been used in Hanoi since the 1960s by farmers as a cheap and reliable source of water and nutrients for the culture of fish. Today's Hanoi fish farmers have thus gained considerable experience in wastewater-fed aquaculture. In recent years, however, periurban areas are increasingly concerned about the contamination of domestic wastewater with industrial wastewater effluents due to the rapid development of industry in Hanoi. With a total of about 1,680 ha, most wastewater-fed fish culture areas are concentrated in the southern Thanh Tri district, such as Yen So, Tran Phu, Hoang Liet, andTan Trieu communes, as well as producing fish in the inner urban lakes. The major fish species cultured using wastewater include silver carp (*Hypophthalmichthys molitrix*), mud carp (*Cirrhinus molitorella*) and Indian carp (Rohu, Mrigal), Tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idellus*) and Colosoma. The average productivity of wastewater-fed fish culture in Hanoi is increasing from 4 tons/ha/year in 2000 to 5.4 tons/ha/year in 2004 (Baseline survey, 2004).

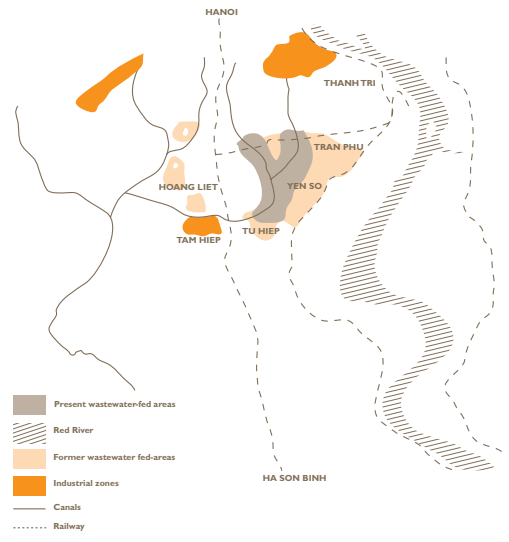
Non-waste water culture of fish also occurs in the more peripheral periurban districts of Hanoi eg. Dong Anh where relatively clean water from the Ngu Huyen Khe river, a branch of the Red River, is used in pond based polyculture systems which are often integrated with fruit and livestock production. Fish culture started to increase in Dong Anh district in the mid 1990's as farmers began to convert rice fields into integrated fish pond systems realizing they could significantly increase and diversify their incomes by doing so. However more recently water pollution has been increasing due to effluents from the growing number of local backyard metal-working workshops which has resulted in problems for the fish farmers.

Hanoi has approximately 40 lakes covering small to large areas that total about 800 ha (1999). These **urban lakes** are important in climate control, local irrigation and other (cultural) uses. Currently, however, most of these urban lakes are faced with water pollution caused mainly by unregulated effluent from surrounding residential, industrial and hospital sources. A separate wastewater collection and disposal system in the future, will enable water use for leisure/entertainment, flood control, and aquatic food production systems.
Previously, Hanoi had 10 government **hatcheries**, but there is now only one government and several private hatcheries. 500 million hatchlings are produced annually from hatcheries in Hanoi and these supply 40% of the city's fish farmers' seed demand, 15% of which is produced by the Hanoi Fish Seed Center. The remainder is supplied from the Research Institute for Aquaculture No. 1 and other neighbouring provinces such as Bac Ninh, Hung Yen, Hai Duong. Fish farmers in Dong My, Tu Hiep, Yen So, Tam Hiep communes in Thanh Tri district, some households in Dong Anh, Gia Lam districts and also some urban lakes have become specialised in nursing and producing fingerlings to supply to individual households for on-growing into food fish.

Integrated aquaculture is practised in Hanoi at the household-level and is based on the concept of the **VAC** [an acronym from the Vietnamese words for garden (*vuon*), pond (*ao*) and livestock quarters (*chuong*)] system. Some better-off periurban farmers for example in Dong My Commune, who have had access to aquaculture training use improved techniques to raise chickens, pigs and ducks adjacent to or above fish ponds, feeding them with additional formulated feeds, with the ponds also benefiting from spilled feed and manure. The pond dikes are also used for growing fruit trees and vegetables with the nutrient rich mud from the drained pond bottoms being used to spread over the pond dikes to further recycle wastes, whilst at the same time increasing yields, diversifying production and thus raising and stabilising the farmers income.

Rice-cum-fish production is concentrated in Dong Anh, Thanh Tri and Gia Lam districts. It has developed from lowland areas where uncertain annual rice production has been changed into a rotation of one rice crop followed by one fish crop per year. Feed for fish is supplied by fallen rice grain, rice stubble and some other supplementary feeds. Species stocked into these systems include common carp, major carps, and tilapia. Grass carp is also stocked but only after a rice harvest, until which time they are held in canals or ponds. Productivity in this system is low at approximately 1 ton of fish / ha^{-1} at present.

Fish and prawn culture started in Hanoi in the 1930s, but has developed since



2000 following conversion from periurban lowland rice fields into fish ponds. The water sources which supply aquaculture in Hanoi come from the wastewater-fed rivers (Thanh Tri) and irrigation systems from the Duong and the Red rivers (Dong Anh and Gia Lam). Supplementary food sources include maize, beer by-products, and rice bran; and a small proportion of households use formulated feed. Major species are Indian carps (Rohu, Mrigal), mud carp (*Cirrhinus molitorella*), grass carp (*Ctenopharyngodon idellus*), common carp (*Cyprinus carpio*), Nile tilapia (*Oreochromis niloticus*), silver carp (*Hypophthalmichthys molitrix),* Bighead carp (*Aristichthys nobilis*). Giant freshwater prawn (*M. rosenbergii)* culture started in the 1990s with more people engaging in this activity since 2000 following support from Hanoi's extension models in Thanh Tri, Gia Lam and Dong Anh districts.

MARKETS AND INSTITUTIONS INVOLVED

The study of marketing in fish and aquatic plants carried out in Hanoi from April to June 2003 showed that 90% of the freshwater fish sold in Hanoi's wholesale markets are cultured and transported in from outside provinces whilst the remaining 10% are actually produced in Hanoi. The more valuable fish from provinces around Hanoi, such as Bac Ninh, Hung Yen, Hai Duong, Ha Tay, etc., are sold in the city's markets mostly live. The smaller, cheaper fish typically produced using wastewater in Hanoi are transported out of the city to the provinces and mountainous regions.

From our markets survey it was found that Hanoi residents especially prefer to consume the aquatic vegetables water spinach, water mimosa, water dropwort and water cress. Water spinach in particular is consumed everywhere, in canteens, restaurants and private homes, and is widely offered for sale in street markets.

Virtually 100% of aquatic vegetables grown in and around Hanoi are consumed in and meet the demand of the city itself. The main production areas which supply the city's markets are found in Hoang Liet, Tran Phu, Tu Hiep, Tam Hiep, Yen So, and Hoang Van Thu communes located in Thanh Tri & Gia Lam districts respectively. Urban consumers are mostly concerned with quality, freshness and price but seem unaware or not concerned that many aquatic vegetables are produced in wastewater often using chemicals. Periurban aquatic food production in Hanoi is regulated and affected by a combination of government and scientific research institutions at various levels: city, district, commune and household. At local level, the District Extension Unit coordinates other units within the district. The Commune People's Committee has responsibilities in administration and management of economic development. Households are more closely and directly related to the local units at commune level and also the District Extension Station, Research Institute for Aquaculture No.1 and some other universities through their training and research programmes in aquaculture as well as agriculture. Compared to fish farming, aquatic plant cultivation within periurban Hanoi is not well represented at any influential or management level within the institutions involved. Analyses of the future plans for the city and periurban districts show that land usages involving aquatic production systems will be restricted in areas near Hanoi city centre and will be encouraged and enlarged within the periurban areas further out from the city centre.

FUTURE TRENDS

Land use policy in Vietnam is changing; farmers are now allowed to convert low-lying rice fields into fish ponds, aquatic vegetable growing areas and orchards. Diversification of traditional farming activities can lead to increased farm household incomes. However, on the other hand investment in and development of small ponds near urban areas will be restricted under urbanisation, whilst wastewater-fed aquatic plant and fish culture will be affected by conventional treatment of wastewater under the city's master plan. Aquatic vegetable cultivation and increasingly intensive fish culture will be developed in areas close to the city within range of urban markets to provide high-value products for the increasingly affluent urban consumer. The continuing high demand for aquatic vegetables amongst urban consumers as well as the relative lack of outside competition in producing them should ensure that they continue to be grown in considerable quantities in the expanding periurban areas of the city.

Hanoi's aquatic production systems are still very much in a state of evolution, with the importance and safety of using wastewater in producing food for the growing population very much within the realms of present and future urban development debates. Due to the high demand and potential for locally produced aquatic food products both in Hanoi and in a wider urban context, it is in the interests of urban planners and policy makers to broaden their understanding of both the benefits and constraints regarding future development of aquatic food production systems and general urban agriculture for Hanoi city.

PROBLEMS FACED

In a meeting held in Hanoi, December 2003 the following issues were identified:
-lack of water for production, polluted wastewater,
-diseases of fish and aquatic plants
-lack of technical training and literature/booklets
-scarcity and low quality of vegetable and fish seeds
-limited duration of land leases
-limited infrastructure
-lack of capital
-occupational health aspects: skin diseases, rheumatism, backaches, headaches, sore eyes.

This article is a summary of the first year of research in the PAPUSSA project and was funded by the European Commission.

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Periurban Aquatic Food Production Systems in Phnom Penh

The numerous plots located around wetlands in peri-urban Phnom Penh, are important sources of edible aquatic vegetables and fish for the city and other areas of Cambodia. These areas are fertilised by domestic sewage/wastewater discharged from the city. The activities relating to these production systems are intrinsically linked with the livelihoods of many poor people living in and around the city.

Kuong Khov

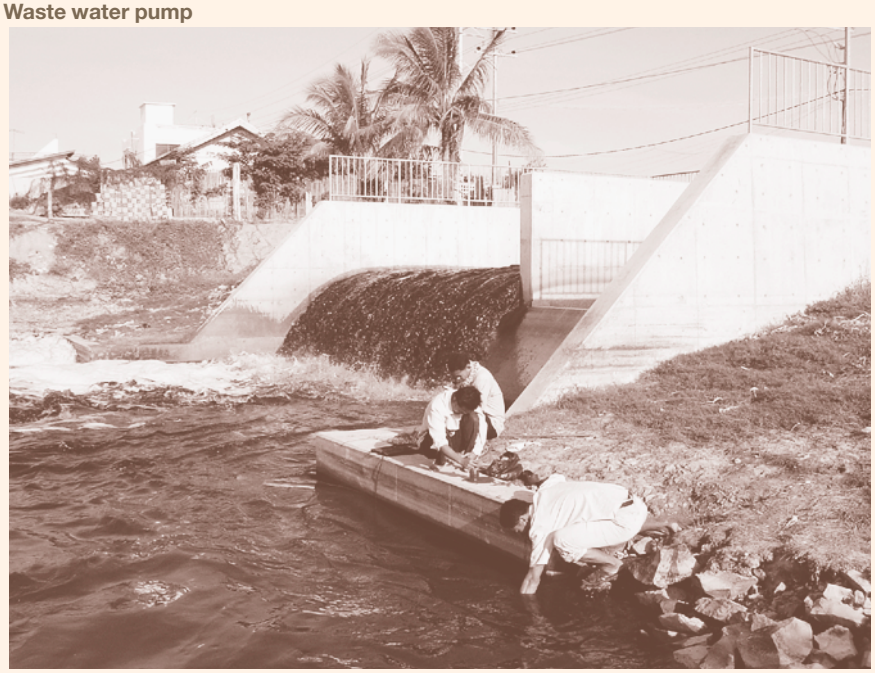
Morning Glory growing in waste water-fed lake

A study and appraisal of the value and impact of these systems was carried out in 2003 as part of an EC funded study in order to understand their sustainability within the overall future development of the city. Four major study areas in and around Phnom Penh were identified as indicative of peri-urban communities where fish and aquatic plants are cultivated. Kbal Tumnub and Thnout Chrum are two of the main villages located about 5 kilometres from the city centre around the the city's largest wastewater-fed lake (Boeung Cheung Ek, 3403 hectares). Up to 80 % of Phnom Penh's domestic wastewater is pumped into the lake, as well as industrial and chemical effluents from a growing industrial sector, which is also located around the lake. Both villages are known for the cultivation in the lake of considerable volumes of edible aquatic vegetables, especially water spinach (*Ipomooea aquatica*) – commonly known as morning glory, and water mimosa (*Neptunia oleracea*). Boeng Kok lake is a smaller urban wastewater-fed lake located closer to the city centre, where residents of the adjacent village raise snakehead (*Channa striata*), walking catfish (*Clarias batrachus*) and river catfish (*Pangasianodon hypophthalmus*) in net pen enclosures often located under their houses, which are built on the banks of the lake. The same fish species are also raised in ponds and cages in a more peri-urban communty (Prek Phnov) situated about 10 kilometres to the north of the city close to the suppliers of trash fish from the Great Lake, which are used as a seasonal input into fish feed for the farmers' production.

Commercial production of aquatic vegetables in the city was first established prior to the country's civil war (pre - 1970) when Phnom Penh was known as "The Peaceful Island", but expansions in production were hampered by poor market access. It became re-established on a more commercial scale after the Pol Pot era (1975-1979), when many people returned to both Phnom Penh and the surrounding areas after almost 10 years of relocation and severe war. Aquatic vegetables, especially water spinach, began to replace rice in Boeung Cheung Ek Lake using the city's increasing supply of sewage and as markets became re-established.

Aquatic vegetables are now intensively cultivated throughout the year. Wastewater provides most of the nutrients, but additional fertilisers and pesticides are also heavily applied. In Boeung Kok Lake, fish farmers feed canteen and restaurant waste, as well as rice and vegetable by-products, to their fish in pens. Pig pens and household

Waste water pump



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Feeding fish along the lake

latrines are also often located over pens stocked with fish, whilst in Prek Phnov trash fish from the river is the main feed used for fish grown on in ponds.

Water spinach seed is obtained from the other villagers. When the water dries up in some parts of the lake people grow water spinach on the land. These plants will then be used as the subsequent seed stock for growing on in water. River catfish seed originating from natural sources and hatcheries in Vietnam are obtained through traders. Hybrid Clarias catfish seed also mainly come from Vietnam.

The aquatic vegetables and fish produced by these communities are mostly sold fresh in marketplaces both inside and outside the city. Collectors transport these products to the marketplace where various traders are involved in buying and selling them. Aquatic vegetables account for nearly half of the total sales of vegetables in Phnom Penh.

Aquatic food products flow from producer to consumer through middlemen or the wholesalers. Sometimes the producers themselves are the wholesalers as they transport their product by motorbike directly to the markets in the city. The middlemen increasingly use small trucks for transportation from farm to market. Retailers from the provinces come to the markets in the city to take fish and aquatic vegetables back to the provinces.

Water spinach is by far the most important aquatic vegetable product sold for human consumption. Urban consumers can eat it fresh and cooked; the majority of the plants are grown in wastewater. Lower-quality water spinach is also used to feed livestock (mainly pigs) during the dry season. Some urban consumers prefer cultured fish raised around the city, since it is often sold at lower prices than other types of fish. The major species are river catfish, walking catfish and snakehead. Although the price of pangasius (river catfish) is lower, there is still little demand for this fish among higher-income consumers in Phnom Penh because of a widespread perception that it is raised in latrine ponds and pens using wastewater.

Recent studies indicate a number of health-related impacts of urban aquaculture within these communities especially affecting the poorer sections which have a seasonal dimension. These include diarrhoea and skin infections, which are at their most prevalent from April – June) at the end of the dry season and beginning of the rainy season These problems are probably due to decreasing water levels in the lakes leading to the accumulation and concentration of waste products resulting in poor water quality; this starts in January and becomes acute by March. Fishing and fish trading by people with lower incomes decline during this time of year and these people are then more likely to seek off-farm employment in construction, transportation and the logging industries. Fish farmers also tend to sell their fish at this time. The critical season for this latter group is at the onset of the cooler months (October to November) when fish disease is most likely. In the communities in which aquatic vegetables and fish are important, livelihoods are much diversified. Employment in local factories, motor taxi driving and the rearing of livestock are also all important sources of local household income.

Declining value of aquatic vegetables and availability of affordable credit are the major problems for aquatic vegetable producers. Many of them take credit from NGO micro-credit schemes administered by small associations within the communities. A large proportion of producers also take credit from private lenders at high rates of interest. Some fish farmers are also in debt to private lenders or friends and relatives. Their fish farming systems require relatively high levels of inputs, and as result credit is very important for them.

Although periurban areas are directly administrated by Phnom Penh Municipality, there are a number of other institutions which have roles and responsibilities in these areas. There is a lack of clarity about the role of some institutions with respect to urban aquatic systems in Phnom Penh, especially those concerned with, and relating to, aquatic vegetable production. These institutions usually work independently and are separate from the communities. The local people do not participate or have a voice in the planning process. The government has a policy to promote aquatic production through recycling of wastewater by using natural water bodies such as Boeung Cheung Ek. However this in not reflected

The livelihoods of the people who depend on the lake are uncertain

in any effective zoning as there are an increasing number of factories and growing industrial sector around the lake, making the future livelihoods of the people who live around and depend on the lake uncertain. Increasing urban population and demand for residential construction may also pressurise the government to implement plans to fill up **Boeng Kok** lake to make room for the construction of residental housing, which in turn would increase the volumes of waste disposal and night soil.. In contrast, fish farming in non-wastewater in Prek Phnov is likely to continue to grow in the near future as there are no immediate demands for the land and the systems are responding to high demand in the urban markets and are supported by good access to a relatively good quality water supply, and reliable supplies of fingerlings and feed.

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Water spinach producer in Beoung Cheung Ek Lake, Phnom Penh

Mrs. Kim Bunthach is one of the water spinach farmers in Kbal Tumnob village (Beoung Cheng Ek area, Phnom Penh.). During the Pol Pot era, she moved from the city to a refugee camp near Thailand's border (Saiy B). She repatriated from Saiy B to live in Kbal Tumnob Village in 1991. At 40 years of age she has seven children, four of whom attend a local public school. Two of her sons have dropped out of school to help her with her farming activities and business, whilst the two youngest (a 5-year-old daughter and a 2-year-old son) are not yet of school age. .She spends a lot of her time working in order to support her family and pay her children's studies. In the past she has requested permission for her children to study in a local NGO-funded school, but this was not permitted because her living standard is considered good enough to support them. Her husband is a government worker, who uses his free time to help in the water spinach farm.. Mrs Bunthach rents a 2500 m^2 area plot on the lake located 400 metres from her house.

Generally she spends 6 hours per day harvesting water spinach. During periods when her aquatic vegetables are not growing well and she therefore can not collect them, she spends about 2-3 hours taking care of the plot. In general there are 2-3 cropping cycles per year, because the water spinach can be destroyed by disease, bad weather or lack of water during the dry season which causes the plot to dry up. The rest of her time is spent tending to a small business at her home, however when she is busy harvesting water spinach she has no time for this, so one of her children is left in charge of the business.

Mrs. Bunthach can collect 300-400 bunches (0.3 kg per bunch) of water spinach per day, which she can do continuously for up to a week. After a week the quality of the remaining crop deteriorates, and the plants need to be sprayed to allow regeneration and new growth. Mrs Buntach can then begin harvesting again after a further two weeks. Besides harvesting, which is her main daily activity, she has to remove unneeded aquatic plants, keep the water spinach floating rafts in order, and routinely spray chemicals and pesticides. She has been farming water spinach since 1991, when the aquatic vegetable had a much lower value than it does now. Water spinach is sold by weight (3000 Riel per 10 kg – 1US$ = 4300 Riel). Since 2000 demand for the crop, and consequently its selling price, has been increasing. Mrs Bunthach thinks this is because many new garment factories are being built locally, thereby increasing the demand for food and vegetables from the growing workforce. The price of one bunch of water spinach ranges from 100-350 Riel depending on the season.

Mrs Bunthach faces challenges both as a mother and as a farmer.

The price is highest in the dry season from December to July, because of low water levels and hence poor water quality in the lake. As a result, the overall quality of the water spinach also decreases.
To marginally improve the quality of the plants in the dry season, she can pump water from the other part of lake, which does not dry up, into her water spinach plot and also spray the plants with chemicals. This lower quality water spinach can also be sold at a lower price for livestock (mainly pig) feed.

During harvesting Mrs Bunthach often hires 2-3 persons for an average of 2-3 days per month to help her.. Daily payment for hired labour depends on the external worker's effort: the more bunches they can collect, the more they earn. Generally the workers are paid 7000 Riel for 100 bunches.

Her water spinach is generally sold to regular customers, however, some is also sold to other customers when the price offered is higher. Two months ago the owner of Mrs Bunthach's plot chose to stop renting it out, so she has had to stop farming for a while, until she can find another plot to rent. She pays 40,000-50,000 Riel for the chemicals needed to spray her aquatic vegetables. This provides her with enough chemicals to spray the crop 3-4 times. Since they generally need to be sprayed twice a month, this amount will last two months.

Mrs Bunthach faces many challenges in her daily life both as a mother of many children, a working farmer and also a local business owner. Since she does not own any land and the land owner can take back her plot with little prior warning, it is risky to invest her own time and money in planting and caring for the water spinach . Competition for available land and as a result plot rental prices are also increasing. Moreover, plant diseases and poor water quality in the dry season can damage her crops, as well as storms in the rainy season, which can cause widespread flooding in the village, also making it more difficult for farmers to transport their produce to market.

When asked about the future Mrs Bunthach believes that the future of water spinach farming in peri-urban areas, especially at Beoung Cheng Ek lake, is in the hands of the government. If the government chooses to develop this area for other urban development purposes. e.g. construction of residential or industrial sectors, then the cultivation of water spinach will gradually disappear.

Production and Marketing Systems of Aquatic Products in Ho Chi Minh City

Ho Chi Minh City (HCMC) is the second city of Vietnam located in the South-Eastern part of the country. With an area of 209,370 ha, HCMC is currently inhabited by almost 6 million permanent residents. About 83.3% of the population lives within the urban area, creating a very high population density with a diverse and dynamic economic environment. Aquaculture is an important component of the city's economy, but increasingly so in the periurban areas.

Le thank thing

People are involved intensively in morning glory pre-processing

The contribution of the agriculture-aquaculture sector in GDP of the city's economy has been continuously decreasing from 2.2% in 2000 to 1.4% in 2005 and is predicted to be only 0.8% in 2010 (HCMC website). Industrial and service sectors are more important, and will increase further according to the city's development plans. Also the area available for the agriculture sector has been reduced from 128,760 ha in 2000 down to 121,235 ha in 2005 and is expected to decrease even more to 107,465 ha by 2010.

All these figures indicate that more and more pressure will be placed on urban agriculture as well as aquaculture activities in HCMC in the near future. Although the decline of agriculture and aquaculture within the "intra-urban" areas is perhaps inevitable, there is however a corresponding increase in aquatic production in "periurban" areas on the outskirts of the city. Further development in aquatic production in these areas requires the active involvement of those growing fish and aquatic plants in future urban development plans. Until now, these stakeholders have received very limited support in this area from the government and from the City Authority.

TWO MAIN SYSTEMS

Periurban aquaculture in HCMC can be classified into two major types: wastewater-fed and non-wastewater fed systems. Wastewater-fed aquaculture systems are more common because most wastewater from the city goes directly to the Saigon River, which is the main water source for the city's current aquaculture areas. The nature of the wastewater drainage system has created a wide and diffuse dispersal system of wastewater and wastewater fed aquaculture.. These aquaculture systems are usually located in lowland areas of the city, into which most of the wastewater from the city eventually flows. Without a specific and functionally constructed drainage system, this source therefore provides very good nutrient-rich wastewater especially rich in organic matter, which can be used for many types of aquatic production systems. Non-wastewater systems are located mainly in more elevated land areas of the city. Both fish and aquatic plants are cultured in these periurban aquaculture systems. Periurban aquaculture in HCMC can be

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classified into different systems based on species cultured and level of intensity. Fish are commonly raised in **monoculture** or **polyculture** pond systems. Aquatic plants including water spinach (*Ipomea aquatica*) and water mimosa (*Neptunia oleracea*) are also grown in pond systems. Both fish and aquatic plant systems can be either wastewater or non-wastewater fed.

Traditionally people in HCMC have been using untreated wastewater mainly for tilapia seed production whilst the Hanoi systems uses sewage for fish culture in a range of different aquaculture systems. Furthermore Hanoi sewage fed aquaculture is concentrated mainly in one lowland district where sewage is transferred into, whilst the wastewater of Ho Chi Minh City is discharged into many lowland districts around the city through the complicated river channels system. These distinctions between the two cities imply that HCMC may need greater effort for the future good management and planning of wastewater aquaculture.

CONTSTRAINTS

Industrial contamination of the city's wastewater from small scale-industries located within domestic areas is a major constraint to the continued viability of aquaculture in some areas.. The City Authority have attempted to relocate some of these industries into industrial parks/industrial zones located outside the city where there are properly designed and functioning wastewater treatment systems. Through these efforts, the situation has improved in some periurban areas. Da Phuoc Commune, a study site of the PAPUSSA project, is a very good example. In this commune wild fish, which had disappeared a long time ago due to pollution and over-fishing, are now starting to come back to farmers' fields. According to the farmers, fish are coming back to their fields due to water quality improvements, resulting in the relocation of these household industries.

Flooding is another constraint that farmers face every year. Aquaculture, especially wastewater-fed, is commonly practiced in lowland areas of the city where water levels change with the daily tidal regime of HCMC. In the rainy season, the impact of this tidal regime is exacerbated by considerable volumes of rainwater, causing flooding particularly in Phong Phu and Da Phuoc Communes in Binh Chanh District. (study sites of the PAPUSSA project). Flooding doesn't only cause stock losses for periurban fish farmers, it can also lead to unmanageable pollution of ponds, which has in the past caused significant fish kills. Farmers in areas which flood cannot afford to take major preventive measures against flooding other than to set up nets around their ponds which although preventing fish losses from overflows, cannot limit uncontrolled inflows of wastewater.. Support from the government is needed to help with this problem.

Although the City Authority has designated some regions of the city for agriculture/aquaculture development, aquaculture areas in many other places within the city are being developed into residential zones and used for public construction projects. Land use priority is rarely given for aquaculture purposes. Periurban aquaculture is not really on the agenda of the City Authority. This leads to uncertainty regarding the future of urban aquaculture development. Farmers also receive limited information about future city planning and thus are reluctant to take the high risk of investing further in their aquaculture activities. This lack of investment into inputs and infrastructure very definitely holds back aquaculture within the urban development process. Availability of hired labour is also a constraint in many places (e.g Da Phuoc, Phong Phu, Dong Thanh Communes) where there is a common trend that only older household members are involved directly in aquaculture activities whilst the younger generations are drawn to other non-agricultural jobs. This does create a problem of labour scarcity, especially during harvesting periods. Fish farmers in Da Phuoc Commune have to hire labour from other outside districts (e.g. Nha Be District) at higher rates. Conversely there is high availability of hired labour in Thu Duc District where water spinach growers can easily find labourers for their harvesting and preliminary processing before sale. Though this is relatively low paid labour, it is considered attractive work by local people in the District and as a result confers a relative advantage for water spinach farmers and their future in the District.

TILAPIA SEED PRODUCTION

Tilapia seed production in HCMC started very early in the 1960s in District 6, but had disappeared from this district by 1985 due to the pressures of urbanisation. Seed production moved to District 8 where it developed slowly over the years until its peak in 1998. At that time the total area of tilapia seed production in the district was nearly 200 ha, with a total of more than 100 households involved in the activity. Since then the total area and number of farmers involved has again been declining due to urbanisation and industrialisation, including wastewater pollution, changing farmers' aspirations (farmers want to improve their living conditions and sell their land for money instead of keeping it for aquaculture), increasing land prices, and the pressure of the government's urbanisation projects. As a result, tilapia seed production has now become a more minor income-earning activity in District 8, and Binh Chanh, a district located farther away from the city centre, has now evolved into the main place for wastewater-fed aquaculture systems, including tilapia seed production but also many other aquaculture products. The estimated total production of tilapia seed in this area is based on the production of about 600 tons of fingerlings, which is equivalent to 150 – 200 million tilapia seed. This is enough to meet 90% of the demand for tilapia seed in South Vietnam (Hung, 2000). These farmers not only supply tilapia seed for the south of Vietnam but also for the entire country. The "black" strain of tilapia is traditionally and commonly produced though other strains have been introduced to periurban farmers including GIFT and hybrid red tilapia strains.

Wastewater is utilised very efficiently in this type of production system. Tilapia fry are produced in plankton-rich pond water fed by nutrients from wastewater. Before stocking the fish, wastewater is usually supplied to the pond by gravity for 2 – 3 weeks allowing the water colour to change to a green colour indicating it is rich in phytoplankton. Taking advantage of the short breeding cycles of tilapia, farmers annually produce four cycles of seed and one crop of table fish per year. Brood fish are renewed by selection from newly produced seed. Using this technique the total number of

ponds for individual farmers practicing seed production is at least four and thus it requires more land than other systems. The products from this type of system are not only tilapia seed but also table fish. With high productivity and diversity of products, this system gives farmers opportunities to improve their living conditions and to stabilise their livelihoods. However, as wastewater is becoming increasingly polluted , seed producers have to manipulate the water supply to avoid production losses due to fish kills.

FISH POLYCULTURE

Many fish species with different feeding behaviours are stocked in a pond to feed on natural foods at all different layers of the pond water column. This system maximises the natural food utilisation in the culture system and therefore supplemental feeds are used very sparingly. The most commonly cultured

Water mimosa is a daily income source and fish is a longer-term income source

fish species in this system are tilapia, common carp, grass carp, silver carp, pangasius, and catfish, of which tilapia is the most preferred species. This fish polyculture system is very popular in both wastewater-fed areas (Da Phuoc, Phong Phu Commune, Binh Chanh District) and non-wastewater areas (Long Thanh My Ward, District 9; Dong Thanh Commune, Hoc Mon District). While wastewater is used as a major nutrient source, animal manures, which originate from household integrated livestock systems, e.g. from pigs, ducks, or from collection are the main sources of nutrient in non wastewater fed systems. Farmers carry out different species composition and stocking densities within their ponds based on their own knowledge and experience, and as a result their productivity and returns vary greatly between different households.

FISH MONOCULTURE

With a higher stocking density, this model can be considered as a more intensive and relatively recently new pond based system which has been driven by increasing purchasing power, in which high quality supplemental feed is required as natural foods are not able to supply the total nutrient requirement of the fish. High value fish species such as red tilapia, hybrid catfish, giant gourami, etc., are cultured in these systems using manufactured pelleted feeds. Tilapia and red tilapia are the most commonly cultured species in Phong Phu, Da Phuoc Commune, Binh Chanh District; Long Thanh and My Ward, District 9. Catfish are also used for monoculture systems in some households in Da Phuoc Commune, Binh Chanh District, in which catfish monoculture ponds are fed with trash fish and slaughterhouse waste. Giant gourami is another preferred species for monoculture systems in Dong Thanh Commune, Hoc Mon District. However, because the feeding behaviour of this species is different, nutrient sources for giant gourami monoculture ponds are mainly plant-based materials, including duckweed and grass (in Dong Thanh Commune) or water spinach leaves (in Tam Phu Commune, Thu Duc District).

WATER MIMOSA CULTURE

This type of system is usually found in two main areas in HCMC, Binh Chanh District and District 12, where the water quality has been found to be suitable for water mimosa. Low investment and simple cultivation techniques help farmers to generate high levels of income from growing water mimosa. Water mimosa needs duckweed (*Lemmna sp.*) in the pond to shade the water in order to prevent competitive phytoplankton growth. Many farmers in Binh Chanh District (Phong Phu Commune) are combining water mimosa with fish culture but in separate ponds. Fish culture can utilise the duckweed better and improve the profit of combined systems. For these farmers, water mimosa is a daily income source and fish is a longer-term income source. Tilapia is the dominant species in these systems, while kissing gourami is cultivated to maximise the potential for duckweed consumption by the fish. In Thanh Xuan ward, District 12, migrants, especially from the North, are involved in water mimosa production, which indicates that this is an attractive and lucrative source of income. Water mimosa is grown widely throughout periurban areas of HCMC, however the systems appear to be particularly affected by industrial contamination of wastewater. Disease of this vegetable is a problem and as yet there is no apparent support and research to alleviate this problem.

Water mimosa culture in District 12

Farmers therefore lack technical knowledge especially on water mimosa diseases. Water mimosa cannot be grown in heavily polluted water, so this type of aquaculture practice may collapse if water quality continues to decline through industrial pollution.

WATER SPINACH CULTURE

Morning glory is suitable for cultivating in the wastewater environment, and may also provide a good income source for farmers, especially in Tam Phu Commune, Thu Duc District. In this commune there are many lowland fields with high acidity and polluted wastewater, which are unproductive for either rice or fish culture. This large area of water spinach cultivation supplies a considerable amount of produce to the city's markets. Rice fields have been gradually converted into water spinach fields by the farmers themselves, which are more profitable. This changing land use has also led to declining rice yields in the remaining areas of rice fields that face a corresponding increase in rice field predators such as rodents, birds and snakes. Although the farmers in this commune are ambivalent about the benefits of wastewater, they do use it to fertilise their water spinach ponds since it is the only source of water supply available. This wastewater-fed aquatic production system plays a considerable role in the livelihoods of many people living in these periurban areas.

Some households combine fish culture with water spinach cultivation but in different ponds and/or places. The by-products i.e. the water spinach leaves are used as a feed input for nearby fish ponds. Because these leaves are used as the main food source for fish culture, the fish species cultured are quite different than in other systems in Binh Chanh District. The main species are giant

SWOT ANALYSIS FOR THE DEVELOPMENT OF PERIURBAN AQUACULTURE IN HO CHI MINH CITY

Strengths	Weaknesses
- Strong interest from most of the farmers involved - Technically simple and easy to practice - Low inputs required - Good way of natural resource utilization - Good way of wastewater processing, environmentally friendly activity - Farmers' main occupation - Farmers involved have strong capability	- Industrial contamination of wastewater sources - Little concern by government - Low contribution in the City's economy - High level of vulnerability from production losses - Limited choice for water supply and uncontrollable water quality
Opportunities	**Threats**
- High and increasing demand for aquatic food products from the city - Large potential future markets for aquaculture products - Ornamental fish culture – new aquaculture practice encouraged by local government to resolve the land use constraint in periurban areas - Development of proper sewerage system may reduce industrial wastewater contamination and create new places for sewage-fed aquaculture	- Pressure from urbanisation and industrialisation on land use - Industrial waste contamination - Untreated wastewater usage - Presently unknown and unquantified risks for human health -- Competition and attraction of high price of land - Availability of other food sources for the city - Availability of alternative jobs for the young generation - Development of sewerage system

gourami (*Osphronemus gouramy*) and kissing gourami (*Helostoma temmincki*), which can digest and utilise aquatic plants most effectively. Because it takes a relatively longer time for giant gourami to reach marketable size (18 – 24 months), farmers also add some other species such as tilapia, grass carp and pangasius into their ponds in order to have partial harvests which supplement their household income and food supply.

MARKETING

Collectors transport fish and aquatic vegetables from the producers to consumers in HCMC, although many other actors are significantly involved in the distribution process. Wholesalers are the key link between producers and retailers, whilst retailers are the vital link between wholesalers as well as collectors and consumers. Wholesalers are the main customers of collectors and they sell products mainly to retailers. About 66% of fish and aquatic plants produced in periurban areas are sold to consumers by retailers.. Seasonal fluctuations of price occur between the in-season and off-season production periods, especially for aquatic vegetables.. Prices of water spinach may increase from a low of 400 VND/kg in the rainy season (May–October) to a high of 3000VND/kg during the dry season (November - April), when it is much more difficult to produce.Conversely the price of fish rarely fluctuates between seasons as fish can be cultured year round and because a high proportion of supplies originate from outside of the periurban zone.

CONCLUSION

Aquaculture activities in periurban areas of HCMC are still widely and actively practiced and are important in a number of periurban communities with a variety of different aquatic production systems. However, they increasingly face constraints as the city develops. Under pressure from urbanisation, aquaculture will have to move further out from the urban areas, which will require more active and constructive efforts from both the government/city authorities and also from the farmers themselves. In the near future, the term "periurban" has to be understood in a wider context – not just limited to within the city's demarcated area but perhaps further out to parts of the neighbouring provinces.

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The Future of Periurban Aquatic Food Production Systems in Southeast Asia

Periurban aquatic food production systems are systems in transition. They are always at the cusp of change, on the point of shifting from one thing to another. New activities, physical features, agencies, institutions, populations and infrastructures colonise the periurban space, and may replace or displace existing peoples, institutions and activities, or lead them to respond and adapt to the evolving situation.

Rigg & Salamanca

Fish, people, and transport co-mingle at Hanoi's biggest early morning freshwater fish market in Thanh Tri District

Not only are they physical systems with flows of energy, inputs and outputs which determine their sustainability and productivity as ecological systems, but they are also embedded in social, economic and political contexts which can play an important, even over-riding role in driving change and determining their resilience – or sustainability – over time. The process of diversification in the periurban area is not a case of a discrete, gradual and smooth shift from one type of occupation and activity (farming) to another (non-farming). Not only does it involve a period of time – of varying lengths – during which pluriactivity is the norm, but it introduces trade-offs, tensions and conflicts.

LABOUR

Aquatic production systems are in competition for labour with other activities. Unlike some more rural contexts where *in situ* employment opportunities may be limited to farming, in periurban areas this is rarely the case. In Village 5 (Da Phuoc Commune) outside Ho Chi Minh City (HCMC), for example, a buoyant demand for local labour resulted in quite severe shortages of labour in agriculture. There is a generational aspect to work in the commune: older members of the village work on the land (and water) in agriculture and aquaculture, while younger generations engage in factory work or are employed as masons. To make up the shortfall, local land owners employ labour from Nha Be District or from provinces further a field. It is important to recognise that local agricultural labour shortages are arising not only because there may be an absolute shortage of labour but also because young people increasingly find employment outside agriculture. The importance of wage rates in driving change (and vice versa) was also evident in Village 1 in Dong Thanh Commune (Hoc Mon District, HCMC) where, local people told us, rising wages (and the rising costs of agricultural inputs) had encouraged farmers to move out of farming and into fish culture.

LAND USE CONFLICTS

While labour availability would seem to be an important issue only in some villages, a theme that unites all of the cities under investigation is the conflicts that arise between different land uses and activities. While some scholars write of 'inter-locking' livelihoods and the complementarities that exist between different activities, the evidence from the Participatory Community Appraisals (PCA) is that in periurban areas aquatic production systems are being undermined in various ways and conflicts are more pronounced than the complementarities. This is clearly an important consideration when it comes to identifying the policies necessary to support such production systems.

Village 5 (Da Phuoc Commune) reveals the conflicts that may arise in periurban areas between industrial and agricultural activities. During the dry season, water bodies and courses become increasingly polluted. Local people suspect that a local plastics factory and the Kim Hang Aluminium Factory contribute to this pollution. Skin diseases and respiratory illnesses also increase during these months. While increasing levels of pollution are problematic for aquatic system sustainability, occupying the periurban zone presents another, related, challenge: having to operate in the context of an advancing city.

At the time of the PCA, Village 5, Phong Phu Commune, had a strong aquaculture component with some 40-50% of households engaging in aquaculture at some level. Significantly, however, the village head believed that given the pattern and speed of urban development in HCMC (this village is just 17 km from the city centre), aquaculture will begin to decline in the next two to three years. Key informants in Village 5 reported that many villagers would like to continue aquaculture, but suitable land was rapidly disappearing. Moving to a new area ("relocation") where land might be available so that households could continue culturing fish and aquatic vegetables was raised as a possibility.

Similar levels of concern were expressed in Khuyen Long village (Tran Phu Commune) and Duc Tu village (Duc Tu Commune) outside Hanoi. In these villages, the pattern and pace of land conversion were threatening, farmers contended, to lead to their effective marginalisation. These worries were being translated into low levels of investment. The VAC group in Duc Tu (see page 9-11) identified insecurity of land tenure and, in particular, the short period that farmers could be sure of having control over their land as the

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most serious problem facing them. When land development costs and related investments are relatively high (for example, for dyke improvements), security and length of tenure become critical issues constraining, or otherwise affecting, the development of aquatic production systems. When concerns and worries are translated into concrete investment decisions (namely, not to invest in the improvement of aquatic systems), a loosely articulated fear is in danger of becoming a self-fulfilling prophecy.

The baseline survey lends further support to these suggestions derived from the PCAs. Of the four cities, Hanoi and HCMC are under the greatest pressure if we are to take expansion/contraction of area under aquatic production as indicative of "pressure". The apparent – and surprising – resilience of Bangkok is, we suspect, linked to the fact that the survey sites were at the extreme edge of the periurban zone while in Hanoi and HCMC sites closer to the city centre were selected for analysis.

There is a tendency to see these conflicts between land uses and activities as external to communities. In other words, that communities – implicitly portrayed as homogeneous and often also as harmonious – are in conflict with individuals, agencies and actors situated outside and beyond the "village" or "community". The debate, and the challenge, becomes easily framed in terms of a local/non-local, and, more generally, us/them dichotomy. What is clear, however, is that communities are internally differentiated and that many of the tensions and conflicts are generated from within. The process of social and economic change necessarily creates a degree of *frisson*. In Duc Tu village outside Hanoi, for example, some households have embraced steel making while the livelihoods of others are still firmly based on farming (market gardening, fish culture and livestock raising).The total income of the village has, undoubtedly, increased with this diversification into new non-farm activities, but it has brought with it higher levels of pollution which are impacting negatively on traditional, land-based livelihoods. Furthermore because it is mainly wealthier households that can access the capital to establish small steel workshops, this pattern of development will have a differential impact by class, and on the whole to the detriment of the poor. In this way, aquatic production is implicated in a wider process of social differentiation.

PAPUSSA BASELINE SURVEY

Villages with known concentrations of households directly involved in AFPS, whether fish or plants, were sampled. Table 1 shows the balance of types of production system among the sample households. Involvement in aquatic plant production dominates. We suspect that this is due to the fact that entry into small-scale aquatic plant production is not as highly capital intensive as fish culture, nor as knowledge/skill intensive. Plant-based systems use organisms – especially morning glory – that thrive in highly eutrophic environments and the infrastructure demand is limited only to a few wooden poles and a boat. Depending on the type of system, producing fish entails cages, antibiotics, seed supply, transport, and feeds. But this divide between low-entry vegetable production and relatively high-entry fish production begins to break down as the scale of production rises. Large-scale production of morning glory and water mimosa, characteristic of the extended Bangkok metropolitan region, is highly commercialised with high inputs of fertilisers and pesticides as well as preservatives to keep the plants green. Marketing is also sophisticated and capital and technology intensive with products being trucked to wholesale markets, packaged and then rapidly trans-shipped to all corners of the country.

Table 1 Types of production systems surveyed households are involved with

Type	No. of Households involved	%
Aquatic plants	329	40.3
Fish	144	17.6
Plant polyculture	22	2.7
Fish polyculture	131	16.0
Mixed (i.e. fish & plants or rice& plants)	22	2.7
Rice-fish	29	3.5
Rice	17	2.1
Land vegetables and crops	27	3.3
Integrated systems (VAC)	59	7.2
Shrimp	9	1.1
Labour provision development	10	1.2
Fish seed	13	1.6
Livestock	1	0.1
No involvement in Aquatic production	4	0.5
TOTAL	**817**	**100.0**

Rigg & Salamanca

Early afternoon morning glory market at Don Mueang Market, Bangkok

Periurban areas are, usually, zones of population attraction. More than one-fifth (22%) of the 818 heads of household surveyed in 2004 across the four cities were not born in their current place of residence and this was most pronounced in Phnom Penh where almost two-thirds (62%) of those surveyed were born elsewhere (The figures for the other cities were 21% for HCMC, 14% for Bangkok and 3% for Hanoi). The large majority (82%) of these "migrants" embraced aquatic production with no prior experience. In other words, it would seem that rather than migrants with experience of AFPS moving to new and more amenable areas to re-engage in such systems, it is far more common for such systems to attract or absorb new players. This makes the issue of knowledge acquisition more important than we anticipated. Neighbours were a particularly important source of knowledge (52%), but a substantial fraction also progressed through trial-and-error (29%). This entry of new AFPS actors was evidently far from seamless. Some 60% have changed their production system since settling, although whether this was linked to

changing market demands, changing land uses, household dynamics, or progressive learning is not clear.
While in some places, such as in HCMC and Hanoi, the lack of planning controls and weakness of institutions can impact negatively on aquatic production, often accentuating the conflicts between different forms of land use and activities in the periurban zone, the reverse can also be the case. In Phnom Penh, for example, most of the people living in the periurban zone are illegal settlers. From planning documents it would seem that the Department of Land Management, Urban Planning and Construction would like to re-settle these "squatters" elsewhere to free-up space for the planned expansion and development of the city. As yet, however, the Deparment has neither the means nor the political will to do so, thus opening up a legal and institutional space within which periurban communities can engage in aquatic food production. These communities are, however, living on borrowed time with the latent threat of eviction.

The majority of households (70%) in the four cities own less than 1 hectare of land. Hanoi is striking among these cities as nearly 95% of the households surveyed have less than 1 ha of land, although the proportion of households with no land in Phnom Penh and HCMC is higher. The exception is Bangkok where nearly all households have land and where the plot sizes are substantially bigger than in the other cities (12% of the respondents owns 4-7 hectares, 2.5% 8-10 and 2% more than 10).
In general, across the four cities, respondents echoed similar sentiments: that their plot sizes have decreased over the last five years. That said, the land uses of their owned lands have remained the same during the last five years, according to 73% of respondents. This will require further investigation.

DRIVERS OF CHANGE

In the above some of the issues facing communities engaged in aquatic food production across these four very different periurban zones are given. In the following, the factors driving and moulding the periurban zone with respect to aquatic production and the communities that engage in such production will be given (see also Table 2).

It is essential to understand the important role of institutions in shaping the pattern and development of aquatic food production systems and, therefore, in land use change. Institutions provide – in theory - a mechanism that limits, directs and promotes access to resources in periurban spaces, most obviously land but also water, credit and so forth. Urban and land use planning provides the means by which city authorities and national governments pursue certain policy agendas. These agendas may be supportive, although not necessarily so. In addition, there is often a lack of capacity or intervening factors that may limit the effectiveness of such planning or distort it in favour of other national and local interests.

When planning fails, or is poorly articulated, conflict among uses and users will arise and uncoordinated development will result, as the periurban landscape studies shows. Agricultural areas are simultaneously zones for dense human settlements and manufacturing industries. In the cities in this study, the periurban zone, in planning terms, is often treated as if it were a spill-over space that can be freely "used" to absorb surplus people and activities displaced from core urban areas. Although the cities are not necessarily spreading out in linear fashion, a typical story emerges where roads are built on once productive agricultural or aquaculture land and then

Wet food from restaurants around Bangkok's extended metropolis awaits disposal – or aptly "recycling" – at a fish farm in Pathumthani

Rigg & Salamanca

Rigg & Salamanca

New road and bridge in Ho Chi Minh City's periurban area, 2004

opened up for industries and settlement. Existing households involved in aquatic production are, in this schema, squeezed out – a trend that was evident in a number of the villages studied in Hanoi. It is for this reason that institutions and the wider planning context takes on such an important role. If the institutions do not exist or are ineffective then transition will be destructive, leading to social problems and the displacement of families whose lives and livelihoods are grafted to the land and water bodies. Where households have insecure land tenure or when the land market favours either intensive or extensive land uses such as housing estates and industries rather than small-scale aquatic food production, these problems will be exacerbated still further.

Of course, linked to any discussion of institutions is the issue of economics. Economics dictates that land uses which yield the greatest returns will be pursued. In light of this, the aquatic food production systems need to be viewed in the context of competing opportunities between land uses and, importantly, also between the activities that individuals and households choose to embrace. When households possess secure tenure to their land, they will be able to enter the land market and sell to the highest buyer. This sentiment was echoed in interviews in HCMC and Hanoi, where there are on-going government efforts to develop new towns on the urban periphery creating a vibrant market in land. In Phnom Penh, however, something rather different is underway. Here the interplay of economics, land ownership and the informality of settlement are some of the factors that, seemingly, are marking out a different trajectory of development from

Table 2 Drivers of periurban change

Driver (moulding/driving factor)	Outcome/result	Case study source
Weak planning, administration and control at the local level	Heightened risk of land use/activity conflicts and tensions	Duc Tu Village, Duc Tu Commune (Hanoi)
Weak planning, administration and control at the local level	Opportunities for aquatic food producers to develop in an unregulated fashion	Phnom Penh
Conflicts between land uses and activities	Rising levels of pollution	Village 5, Da Phuoc Commune (HCMC); Village 1, Dong Thanh Commune (HCMC)
Urban sprawl/expansion	Land conversion; reduced opportunities for aquatic production due to lack of land and rising land prices	Village 5, Phong Phu Commune (HCMC); Khuyen Long Village, Tran Phu Commune (Hanoi); Duc Tu Village, Duc Tu Commune (Hanoi)
Urban sprawl/expansion	Environmental conflicts impact negatively on aquatic production systems and on community health profiles	Village 5, Da Phuoc Commune (HCMC); Village 1, Dong Thanh Commune (HCMC)
Land conversion and weak planning controls	Reduced investment in improvements to aquatic systems	Duc Tu Village, Duc Tu Comune (Hanoi)
Availability of alternative work	Rising labour costs and shortages of agricultural labour	Village 5, Da Phuoc Commune (HCMC); Village 1, Dong Thanh Commune (HCMC)
Cultural change	Younger generations avoid farm work, including work in aquatic systems	Village 5, Da Phuoc Community (HCMC)
Pattern of immigration	Established families will have access to land, while newcomers will either work as farm labourers or in non-farm activities	Village 5, Phong Phu Commune (HCMC)

the Vietnamese cities. Households engaged in aquatic production in Phnom Penh do not have formal title to their land and their production systems exploit the availability of eutrophic nutrients within a sewage lake, a common property resource. When government policies shift against their interests, or when the value of the land appreciates, there is little scope either to resist such policies or cash in on the increasing value of their land. The result is likely to be an end to aquatic production in the area, the dislocation of the households involved, intrusion of new land uses and land users, and a loss of livelihood by the original settlers. In Bangkok there is another pattern of land use and ownership – which it is tempting to see as more "mature". There is a developed land market, producers are far from marginal, and the planning context and the institutions that support that context are well developed.

At the intersection of economics and institutions lies the household, which also has its own dynamics. As households expand and splinter, land and water bodies become fragmented, unless there is a conscious effort to accumulate them. One of the results of this process is that "off-spring" households are less likely to have access to (sufficient) land – a key resource. This generational fracture may also lead, in time, to the demise of knowledge and skills among some households while others accumulate skills and knowledge and further professionalise their engagement and involvement in aquatic food production systems.

The consumption end of the production chain also, potentially, plays an important role. The growing affluence of households, such as in Vietnam, leads to rising demand for aquatic products. But this is not, in most cases, "more of the same". The acquisition of new tastes and standards among these households may mean that the role of waste in feeding may have to be replaced, toned down or denied. There are already increasing signs in both Hanoi and HCMC that waste-fed fish are not the fare of the *nouveau riche* such that some sellers deny that their fish are sourced from ponds fed with wastes, especially human wastes. This phenomenon is also associated with the government campaign to ban the use of overhung latrines for reasons that have more to do with tourism and international public relations that with objective health concerns.

For an overview of project documents, see the Papussa website

This is an adapted and shortened version of a paper presented during the PAPUSSA special session at the 7th Asian Fisheries Forum, Penang, Malaysia, on 2 December 2004. The full version of the paper can be downloaded from http://www.ruaf.org/papussa/publications.html. Funds for the project upon which this paper is based are provided by the European Union through INCO (International Scientific Cooperation Projects, 1998-2002, Contract Number: ICA4-CT-2002-10020).

Like the other papers in this issue, to illustrate our argument we draw on surveys and Participatory Community Assessments undertaken in Bangkok, Hanoi, Ho Chi Minh City and Phnom Penh.

Planning for Aquatic Production in East Kolkata Wetlands

Wastewater aquaculture, as practised in the East Kolkata Wetlands, has attracted much international attention as a model system for the reuse of urban wastewater and resource recovery. At present the multifunctional wetland ecosystem covers approximately 12,500 ha, and is comprised mainly of 254 fisheries managed for wastewater aquaculture, agricultural land, horticultural plots and residential areas. It constitutes a unique system of resource recovery, in which nutrients are extracted from the city's wastewater through fish farming and agriculture.

Wastewater flows through fish ponds covering about 4,000 ha, within the area known or the East KolKata Wetlands, with these ponds facilitating a wide range of physical, biological and chemical processes which help improve the quality of the water. Consequently this wetland system is popularly known as the kidney of the city and has been described as one of the rare examples of environmental protection and development management in which a complex ecological process has been adopted by the local farmers for mastering resource recovery activities. The wetland also supports the livelihoods of around 60,000 residents through the fisheries and other socio-economic activities. The existing land-use pattern of the East Kolkata Wetlands (EKW) is summarised in Table 1.

Table 1. Land use in the East Kolkata Wetlands

Land use	Area
Water bodies	5,852 ha (about 3,899 ha used for fish farming)
Agricultural land	4,960 ha
Garbage farming	603 ha
Rural settlement	1,235 ha
Urban settlement	91.5 ha
Total area	12,500 ha

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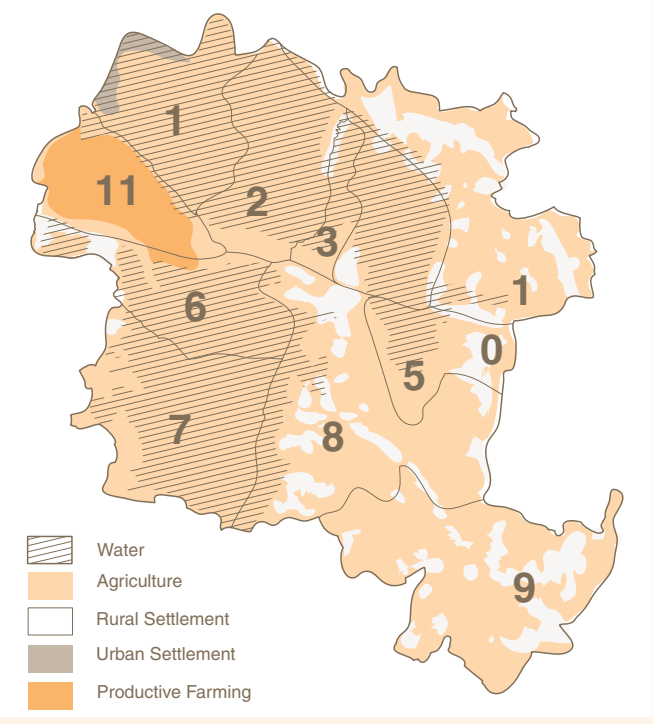
In August 2002, the EKW area was included in the list maintained by the Ramsar Bureau established under Article 8 (site no.1208) of the Ramsar Convention, which recognises the EKW as a "Wetland of International Importance". The Ramsar convention is playing a vital role by providing certain basic guidelines to draw up suitable plans for the maintenance and sustenance of the wetlands. Among these, the three most important guiding principles are:
maintenance of the special characteristics of the ecosystem,
wise use of its resources with an eye towards sustainability,
economic development for the wetland community.
The major forms of cultivation prevalent in the region are sewage-fed agriculture, garbage farming i.e. growing crops on composted or decaying garbage and sewage-fed aquaculture. In more peripheral rural areas rice paddy farming dominates production whilst potatoes and other vegetables are cultivated using traditional methods. These farming systems are central to the livelihoods of many local poor people (Bunting *et al.*, 2001 and 2002).

Garbage farming is largely confined to the Dhapa region (*Figure 1*). This area is the disposal site for garbage from the city of Kolkata, which has been used as fertiliser since cultivation began here in the 18th century. The irrigation system for vegetable cultivation is completely dependent on the city sewage in the Dhapa area. The city receives a substantial supply of vegetables from the garbage farms of the Dhapa and adjacent areas. Despite the close proximity to city markets, local farmers are reluctant to sell their produce directly to the urban markets mainly due mainly due to the costs involved and risks associated with transporting perishable products, notably live fish. It should be mentioned that since part of the wetland falls under the Kolkata Metropolitan Area (KMA) it is classified as periurban, nowever further from the city the wetlands have a more rural character.

Fish cultivation in Kolkata's sewage-fed fisheries is a unique feature. There are more than 154 big fisheries or bheries, as they are known locally, although fish culture is also practised in numerous small ponds or jhils spread throughout the region. The most important function



Wetland area divided into 11 zones

performed by these wetlands is to recover nutrients from a major proportion of the 1,300 million litres of wastewater discharged from the city daily. The total area of sewage-fed fisheries is around 3,900 ha, privately owned bheris account for 93% of this area, farms managed by co-operatives cover 6% and ponds managed by the State Government account for less than 1%. Large areas of the fisheries are taken on lease and operated by commercial producers, however, several fisheries became cooperatives, either registered or non-registered, because of the inability of the owners to sustain their fishing activities owing to land reforms and past problems with the labour unions. The fisheries range in size from over 50 ha down to around 5 ha. Various sewage canals supply water to these fisheries, and the water enters the fisheries either via gravity, by siphoning or pumping.

Marketing of fish originating from the wetlands has been studied, and almost without exception the total production is sold through wholesale markets at Bantala, Bamanghata, Choubaga and Chingrighata located in the wetlands. From these four major sources fish are distributed to retail markets scattered throughout the core of the city, but there is also increasing evidence that fish are increasingly being transported out and marketed in provincial towns.

Recent field surveys showed that 8,500 people are directly engaged in sewage-fed fisheries, of which about 90% are from local villages falling within the EKW, the others mainly coming from adjoining areas of Districts 24-Parganas (North) and 24-Parganas (South), Midnapore and sometimes from neighbouring states. Fish culture presents opportunities for various types of specialised labour, including security services, harvesting work, loading, unloading, packing and distribution of fish, and as a consequence such opportunities often attract migrant labourers from other districts and states. In general however, traditional economic activities, namely sewage-fed agriculture and fish culture, primarily involve the inhabitants of the EKW. The main stakeholders are the fishermen, farmers, labourers engaged in fish culture and agriculture, night guards and carriers.

Furthermore, there are a number of people who stay in the East Kolkata Wetland area and commute to the city for their livelihoods; these people are part and parcel of the system as it has evolved.

DIFFERENT REGIONS

At present the wetland is vulnerable to a number of threats. Not every problem of the EKW can be labelled a real "threat" to the wetlands, so in the course of delineating these problems, what became apparent was the need for geographical demarcation of the entire zone into a number of parts in order to facilitate proper planning for its conservation. The East Kolkata Wetland system has been broadly divided into eleven major regions depending on the following factors: proximity to main sewage canals, type of land use, area of land use, accessibility, proximity to area of environmental hazard and proximity to areas of massive urbanisation. This has helped facilitate the preparation of detailed conservation plans in line with the Ramsar principles, and has also assisted greatly in ensuring that stakeholders in each of the regions have had the opportunity to participate in the planning process.

Since the city sewage is a major input for the periurban production systems, location of area with respect to the sewage canals is of the utmost importance. The type and size of land use in the area also constitute important criteria upon which the demarcation was based. For example, region 1 consists of larger water bodies than region 3, which is characterised by smaller, more fragmented holdings. Another factor is the accessibility of the regions to the highway or other major roads, which can have a strong influence on activities and livelihoods. Though the wetland system is also a waste-recycling region, some wastes are environmentally hazardous and cannot be treated naturally. These wastes are primarily non-biodegradable and some of them are extremely toxic, such as medical wastes and wastes from the information technology sector. These can affect both the quality and quantity of produce. Consequently possible health hazards associated with production in each of the regions must be considered. Last but not least proximity to the city makes areas more vulnerable to urbanisation and land speculation.

Ruangvit Yoonpundh

COMMON PROBLEMS

Though there are regional variations as far as constraints and threats associated with the EKW are concerned, there are certain significant issues common to all regions, for example siltation in the canals and fishponds. Siltation has reduced the quantity of sewage flowing to the fisheries and made many of the fish ponds much shallower; consequently production has reportedly declined. Chemical contamination constitutes a widespread threat and difficulties in marketing fish and agricultural products represent a further problem.

Proper planning is only possible with the participation of all stakeholders

Additionally, proper infrastructure is absent throughout most of the periurban area, and despite living in the Kolkata Municipal Area many residents do not have access to basic services such as sanitation, drainage, electricity, schools and hospitals.

Such problems are compounded by the adverse effect of notable management failures, including a failure to properly maintain sluice gates and run the pumping system regulating the storm weather flow and the dry weather flow channels of the Kolkata drainage system in line with the requirements of farmers in the area. As a consequence, sewage-fed agriculture is on the verge of collapse. A number of lift irrigation facilities installed on drainage channels which could have alleviated some of these problem' are now mostly defunct. Furthermore, a major friction point has

emerged between the Kolkata Municipal Corporation and Department of Irrigation and Waterways on the one hand, and the inhabitants of the wetlands who earn their livelihood from the cultivation of rice, fish and vegetables on the other. Many farmers have come to depend on using sewage and garbage from the city as sources of water and nutrients, however, the appropriate and reliable management of wastewater and solid organic waste originating from the city is vital for maintaining such a system. While environmentalists advocate the preservation of the wetlands, speculators are exerting increasing pressure for the right to develop areas for residential and industrial purposes. The wetland is bordered by the city of Kolkata to the west, Salt Lake township to the north-west, and the new township of Rajarhat to the north-east. The Eastern Metropolitan Bypass also runs along the western side of the wetlands making the area easily accessible. In combination these factors are making it increasingly difficult to protect the EKW from developers and real estate agents. Public agencies have also shown a tendency to encroach upon the wetland area for various developmental activities such as locating industries, commercial hubs or public utilities. It is increasingly apparent that the existing legal provisions and agencies responsible for implementing them are unable to prevent such encroachment.

INSTITUTIONS

Another source of confusion has been the existence of a plethora of agencies amongst which the control of the wetland has been distributed. They often work at cross-purposes leading to inaction or in many cases the wrong action. The Kolkata Metropolitan Development Authority was given the responsibility to coordinate developmental activities in the KMA area, which includes all municipalities and corporations coming within its jurisdiction under the Town and Country Planning Act (1979). However, only part of the EKW lies within KMA whilst the remainder is under the jurisdiction of the District Planning Organization under the Panchayats. This convergence of rural and urban governance has been far from effective in the preservation and management of the EKW. An improvement plan for the EKW must address the different types of problems related to the various land-use patterns. Such a plan should also explore possible alternative and better uses that might be permitted within the parameters of the Ramsar Convention. For example, the water courses need to be widened and de-silted in a manner which is economically viable and which meets the demands of agriculture and fish farming.

Both agriculture and fish culture are suffering due to shortage of wastewater. With proper planning and development of water courses and water bodies, and proper management of the sewage disposal system, this major constraint could be addressed. But this would only be possible by ensuring the participation of all stakeholder groups in the decision-making process and subsequent supervision of the proposed activities. In the case of the EKW, the major agencies that should facilitate conservation and development include the Department of Land and Land Records (the major regulatory authority for land transfer and registrations), the Department of Irrigation & Waterways (responsible for disposal of sewage, regulation of lock gates and maintenance of storm and sewage channels), the Ministry of Fisheries (responsible for the improvement and promotion of fish culture through the formation of fishery cooperatives), Ministry of Agriculture (involved where paddy and vegetable cultivation are concerned), and the Department of the Environment (which is responsible for the overall protection of the EKW and operates through the West Bengal Pollution Control Board [WBPCB] and Institute of Wetland Management and Ecological Design [IWMED]). Participation of the Kolkata Municipal Corporation, Panchayats, District Administration of 24-Parganas (North) and 24-Parganas (South), various NGOs and CBOs (community-based organisations) is also required. It should be emphasised in this context that ground level coordination, control and management are often impeded because of the existence of a plethora of often contradictory legislation originating from different authorities. The major pieces of legislation which are now in operation are given in the box below.

Formulation of comprehensive guidelines to protect existing practices both in the vicinity of Kolkata and rural areas is the major requirement at present; however, this also demands the provision of proper legal tools and will require administrative backing. The integrated policy initiative being proposed here should embrace the interrelated problems of waste management, air pollution abatement and livelihood problems of the local poor in a sustainable way. Sustainability is another variable that has to be kept in mind. Close observation has revealed a complex array of problems and issues facing the wetlands community, economy and ecology. With the march of urbanisation the rural context is increasingly in transition, creating a complex socioeconomic parameter. Only by understanding this complexity and by ensuring the participation of all stakeholders related to the EKW, and in particular the traditional farming communities, can any policy development or planning activity achieve success. Development and conservation cannot leave behind the populace for whom it is intended.

Legislation affecting EKW

The Environment (Protection) Act, 1986
The West Bengal Inland Fisheries Act (amended in 1993)
The West Bengal Town and Country (Planning & Development) Act, 1979
Water (Prevention and Control of Pollution) Act, 1974 (Amended 1988)
Other existing legislative provisions like the The Wildlife (Protection) Act of 1972 (as amended until 1991) and the Forest (conservation) Act of 1980, The West Bengal Land Reforms (Amendment) Act of 1981 and the National Conservation Strategy and Policy Statement on Environment and Development of 1992 are also relevant to the discussion.

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Demise of Periurban Wastewater-fed Aquaculture?

Recent field visits of the author to periurban areas in Bangladesh and Vietnam indicate that some wastewater-fed aquaculture systems may have limited prospects, while others prove difficult to extend. The major constraining factor is the limited availability of land in rapidly expanding cities.

Wastewater-fed aquaculture occurs in several countries in East, South and Southeast Asia, where it provides food, employment and income for millions of people, especially the poor. Furthermore, it provides a low-cost method to treat wastewater as well as a means to reuse both nutrients and water. The recent Hyderabad Declaration on Wastewater Use in Agriculture recommended a holistic approach to the management of wastewater in aquaculture as well as agriculture through treatment and reuse schemes to alleviate poverty in urban areas. A range of sound wastewater reuse practices in aquaculture has recently been outlined (Edwards 2002).

The reality is that very few new systems of wastewater reuse in aquaculture have been implemented; and traditional systems are threatened or in decline (Edwards 2000). Recently, as a consultant for the DFID-funded project "Capacity-building for effective decentralised wastewater management" being carried out by the UK company GHK International with partner institutions in Hanoi, Vietnam, and Khulna, Bangladesh, I witnessed the latest developments in, or what may very well be the demise of, wastewater-fed aquaculture in periurban areas of fish and duckweed/fish.

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HANOI

Wastewater in Hanoi is discharged without treatment into a network of rivers that flows to the south of the city through Thanh Tri district, and eventually into the Red River (although plans are underway to install conventional mechanical wastewater treatment plants). Based on experience accumulated over the past four decades, farmers have developed wastewater-fed aquaculture involving either a polyculture of finfish with or without rotation with rice, or aquatic vegetables (see also page 9-11)). A large number of individuals, especially people of lower socio-economic status, are involved in production and marketing of wastewater-fed produce, either part or full-time. Produce is also consumed by a large number of people, especially the poor. While men are especially involved in fish culture and in the transportation and wholesale marketing of fish, women predominate in the farming and transportation (on bicycles and motorcycles) of aquatic vegetables. Women also dominate in the selling and buying of produce in retail markets.

The author first visited wastewater-fed aquaculture in Thanh Tri district in 1991 but I was amazed recently by the current rate of change, with the rural landscape of fields and ponds rapidly being converted into one of brick and concrete. Under the first phase of the Hanoi Master Plan for sewerage, drainage and environmental improvement, wide drainage canals, storage reservoirs and a pumping station have been installed in areas recently occupied by wastewater-fed fish ponds. Buildings are sprouting like mushrooms all over the district, right up to the water's edge of fish ponds. Large blocks of buildings co-exist with the remaining fields. In interviews, women aquatic vegetable farmers expressed, without exception, fear that urbanisation will soon encroach onto their fields, resulting in the loss of their livelihood.
The old Thanh Tri district was recently divided in two. The northern half in

Encroachment of housing on wastewater-fed fish ponds in Hanoi, Vietnam.

Peter Edwards

which most wastewater reuse takes place, was renamed as a new district, Hoang Mai, and declared an urban area in November 2003. The Chairman of the People's Committee of Yen So Commune, one of the major wastewater-fed aquaculture areas, confirmed that the fish pond area had declined over the last 10 years due to use of land for construction.

While the map for 2001 in the Hanoi city Master Plan indicates large areas of fish ponds, as observed during my recent visit, none were indicated for Hoang Mai district for 2020. Most of the Hanoi government support for aquaculture is planned for high-value aquaculture species such as red tilapia, river catfish and giant freshwater prawn. The emphasis will be on new technologies in aquaculture, with incremental development expected to be in line with industrialisation and modernisation. The trend is to convert wastewater-fed fish culture into organic and intensive fish culture. The fish species component is to change, with priority being given to high-quality seed of high-value aquaculture species.

The area devoted to growing wastewater-fed terrestrial vegetables has declined even more than that of ponds and aquatic plant fields in Hoang Mai. This is because the higher and drier land formerly used to cultivate terrestrial vegetables was more likely to be built on first, before the lower water-logged land used for aquatic vegetables and fish culture. Furthermore, Hanoi has a programme to promote "safe vegetables" in three other districts of the city. Although it is recognised that use of night soil, septic tank sludge and wastewater as fertilisers on vegetables is still widespread, this practice is not recommended. Guidelines for safe vegetables specify better management of pesticides and no night soil or wastewater, although use of composted livestock manure is allowed.

Although the rapid change of land use to urban development with an associated marked increase in land value is the main factor in the on-going demise of wastewater-fed aquaculture and agriculture in Hoang Mai district, there are other factors involved. The increasing content of industrial effluents in the total wastewater stream has a significant adverse effect on both fish growth and survival. Farmers reported that fish ponds could only safely accommodate 10-30% wastewater by volume, much lower than previously, due to suspected toxic chemicals. The Chairman of the People's Committee of Yen So commune told me that farmers recently lost 2 tonnes of fish in the pond adjacent to his office because of mass mortality due to poisonous wastewater. Farmers now have to supplement low volumes of wastewater with other fertilisers such as livestock manure, although little is available, and readily available beer and wine residues as feed. As the price of pelleted feed is high, farmers lose money if they use it to raise relatively low-value wastewater-fed fish.

Furthermore, the quality of fish raised on wastewater is said to be poor, with a bad smell and taste, because of industrial chemical effluents now present in the previously mainly domestic wastewater. As most fish raised in wastewater-fed ponds are also small, they are difficult to market in the increasingly sophisticated Hanoi markets, where there is demand for large fish. Wastewater-fed fish supplied as much as 40% of Hanoi's daily requirement for freshwater fish in the past, but now they are mainly marketed in remote rural areas in central and north Vietnam, and mainly for poor people. In contrast, most wastewater-fed aquatic vegetables are marketed in Hanoi although most consumers are unaware of their origin.

KHULNA

It is a traditional Chinese practice to cultivate duckweed, using various organic fertilisers, in order to produce small green fodder for grass carp fingerlings still not large enough to consume coarse grass. A tremendous amount of research has been conducted over the last three decades on various aspects of duckweed, including its cultivation on wastewater and subsequent use to feed herbivorous fish (IHE/PRISM 1999, Iqbal 1999).

Duckweed has many positive characteristics, like high crude protein production (10 times greater than that of soybean); a high crude protein content; the ability to grow in shallow water and shade readily harvested by pole and net. Unfortunately there are also constraints involved in its production: its growth is adversely affected by both low and high temperatures, and high light intensity; occasional insect infestation; and rapid decomposition following harvest.

The NGO PRISM in Bangladesh has carried out an R&D programme focused on duckweed-based wastewater treatment and reuse through fish culture over the past 15 years. Two systems have been developed: a system fed with conventional wastewater or sewage for periurban areas; and a village-level sanitation system in which latrines are connected to small derelict ponds to treat night soil and cultivate duckweed.

The first duckweed-based conventional wastewater treatment system, which still operates, was built in 1989 at Mirzapur, Tangail district. A 0.2 ha anaerobic pond precedes the 0.7 ha duckweed-covered pond, which is constructed as a 500 m long serpentine channel with a hydraulic retention time of about 20 days. About 1,000 m^3 sewage / day are treated to such a high degree that the effluent could be used for unrestricted irrigation of vegetables according to WHO standards for wastewater reuse. Duckweed harvested daily is fed to fish in three adjacent fish ponds of 0.2 ha each. About 10-15 tonnes of fish, mainly carp, are produced each year, although probably only half the yield is based on duckweed as rice bran and oil cake are also fed to the fish. The net return is 5-10% annually, including leasing of the land and 5-year facility depreciation (Mohammed Ikramullah, Chairman of PRISM personally comment). PRISM has demonstrated that it is possible for a duckweed-based wastewater treatment system incorporating fish culture to not only achieve cost recovery but to derive a net profit.

Despite the demonstrated economic feasibility of low-cost, duckweed-based wastewater treatment and reuse, PRISM has major reservations about further dissemination of the technology in Bangladesh. The local government in Khulna, the third largest city in Bangladesh, provided 0.6 ha of land for a duckweed-based system at Sonagandha. The community-based project involving active participation of an adjacent slum community was funded by UNCDF but was destroyed only 3 years later to build a stadium for female athletes, as no other land was readily available. UNDP provided funds to build four duckweed pilot plants in Khulna, but sufficient land could be found to build only two plants. Plants built on leased land on the campus of the Agriculture Training Institute in 2000 and at Shobujbagh on private land bought by PRISM in 2003 are currently in operation. However, it is unlikely that land will become available to build additional duckweed-based plants either in Khulna, or elsewhere in Bangladesh.

The single biggest constraint to the sustainability of duckweed-based wastewater treatment and reuse is the availability of land for what is essentially a land-intensive system. The PRISM concept for duckweed was based on use of marginal and unutilised, fallow land. Earlier studies had reported that there were 250,000 ha of low-lying land in Bangladesh which could be used for natural collection, treatment and reuse of wastewater. However, the opportunity cost of land has gone up rapidly in Bangladesh, the most densely populated country in the world, excluding city states. In reality there is no shortage of land as plenty is held, especially by five bodies: municipalities, Post and Telegraph, Railways, Roads and Highways, and Water and Power Development Board. As the opportunity cost of karst (government) land has risen so much, there is pressure to use the land for various purposes, legal and illegal. Land speculation is the biggest business in Bangladesh. Although land availability is the biggest issue, other major constraints are also complex, including multiple ownership of land, limited availability of working capital, and the rapid rate of infrastructure development, which often results in water bodies being filled in. Duckweed wastewater treatment does not seem to be attractive enough to gain full government support.

PROSPECTS

Wastewater-fed aquaculture appears to be a transient phenomenon of pre-industrial and early industrial societies in which reuse of wastewater is socially acceptable because of high population pressure and scarce resources (Edwards 2000). Once the economy starts to expand rapidly, a series of factors constrains wastewater-fed aquaculture:

- increasing shortage and value of periurban land
-declining quality of wastewater as a nutrient source
-increasing and changing demands of more affluent consumers (for large and often carnivorous species of fish even though these are higher priced than wastewater-fed fish)
-ability of farmers to meet the demand for alternative farmed species because of availability of seed through R&D, rice bran and oil cakes, and pelleted feed from agro-industry.

Even in China, which has the longest tradition and had until recently the largest extent of wastewater-fed aquaculture, the practice is disappearing. Wastewater-fed aquaculture was banned in China in the 1990s because fish raised in such systems contain contaminants from industrial wastewater. Nobody likes to eat fish which smells and tastes of industrial chemicals such as phenols. As the living standards of Chinese people are improving constantly, the government is developing a movement for safe, healthy food production that includes a system of licensing and inspection.

Considering recent developments in China, Bangladesh and Vietnam, and the various constraints outlined above, it is difficult to end on a positive note regarding the future of urban wastewater-fed aquaculture. However, Vietnam has many smaller cities which are at an earlier phase of development than Hanoi; wastewater treatment and reuse through aquaculture occurs and has relevance there, at least for the near future. Despite the pressing need for low-cost wastewater treatment, and the employment opportunities and relatively cheap food produced in reuse systems for the poor, it is unlikely that such land-intensive systems will be implemented in Bangladesh. Perhaps aquaculture wastewater treatment and reuse systems could become an integral part of green belts required to make the periurban areas of rapidly expanding cities socially as well as environmentally sustainable? This would depend on the benefits of wastewater-fed aquaculture being appreciated by urban planners and sanitary/ environmental engineers. There is little evidence that this is likely in the near future.

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A pilot duckweed-based wastewater treatment system in Khulna, Bangladesh.

Peter Edwards

Skin Diseases Among People Using Urban Wastewater in Phnom Penh

The major challenge in sustainable use of wastewater in agriculture and aquaculture is to optimise the benefits of wastewater as a resource (both the water and the nutrients it contains) and to minimise the negative impacts on human health. Epidemiological studies in different countries have established that the highest risk to human health of using wastewater in agriculture and aquaculture is posed by worm infections.

In countries where wastewater and its nutrients are used to grow fish, there are important risks for infection with flukes. Foodborne trematode (fluke) infections, which often affect the functioning of the liver, are a serious and growing public health problem with an estimated 40 million persons worldwide affected, especially in Southeast Asia. Transmission to humans occurs mostly via consumption of raw freshwater fish and aquatic plants vegetables.
International guidelines for the safe use of wastewater and excreta in agriculture and aquaculture (Mara and Cairncross, 1989), are currently being revised and separate guidelines for agricultural and aquacultural use will shortly be available. The revised guidelines are based on epidemiological studies on excess risk of infection attributable to the use of wastewater and quantitative microbial risk assessment models. For agriculture guideline values are $\leq 10^3$ faecal coliform bacteria per 100 ml for irrigation water and ≤1 intestinal nematode egg per litre. For aquaculture the guideline values are $\leq 10^4$ faecal coliform bacteria per 100 ml for fishpond water and absence of viable trematode eggs. It should be noted that very little research and risk assessment have been carried out on possible transmission of trematode parasites in wastewater-fed aquaculture. Although the guidelines state that no viable trematode eggs should be present in wastewater to be used in aquaculture, standard methods for enumeration and identification of trematode eggs are not available. It is currently unknown if methods used for helminth egg enumeration may also be appropriate for trematode eggs. Furthermore, the differentiation of trematode eggs is notoriously difficult and can only be done by experienced laboratory staff. Finally, simple standardised methods for viability testing of eggs are not available. It is therefore clear that research is urgently needed on these and other issues if the actual risks for trematode parasite transmission in wastewater-fed aquaculture are to be assessed.
These serious health risks have however meant that other chronic occupational impacts of wastewater aquaculture have been relatively ignored.
Consistently, sewage treatment plant workers and farmers in Europe, North America, and developing countries mention skin irritation as a major health problem that they perceive as being related to wastewater exposure. Studies in France, Spain, the UK, Canada, and the USA have noted an increased occurrence of "itchy skin", "skin rash", or "skin irritation". But in all cases the description was rather aspecific and the cause of the perceived skin problems remained obscure. It was hypothesised that the skin problems could be related to allergic and non-allergic reactions to chemicals in the water, perhaps also involving interactions of chemicals with pathogens. However, the information available today is largely anecdotal.
There can be many substances in the water, biological and chemical, that can cause skin problems. Certain biological agents such as cercariae of animal schistosomes (cercarial dermatitis, "swimmers itch"), mycobacteria of fish, leptospira, and hookworm can cause local skin reactions. These reactions are expected to be of short (<1 week) duration but are very relevant from a public health point of view. For example cercarial dermatitis has been mentioned as an emerging disease in Europe and globally (de Gentile et al., 1996). Toxins produced by cyanobacteria can cause skin irritation from direct contact but chronic exposure through drinking water leads to more serious effects, such as liver damage. Long-lasting skin diseases could be caused by chemicals and other substances in the wastewater that have a local action on the skin, especially of hands and feet. This can lead to contact dermatitis (eczema), with clearly demarcated areas of rash at sites of exposure. One group of chemicals are irritants that directly damage the skin such as certain heavy metals (chromium, cadmium, arsenic), certain pesticides, industrial solvents, detergents, and even water itself. The other group are sensitisers (certain metals such as nickel, dyes, oils, plant materials) that can produce allergic reactions.

Anders Dalsgaard

Women preparing harvested water plants for sale to middleman

PHNOM PENH, CAMBODIA

Most of the urban domestic and industrial wastewater of Phnom Penh city drains to the Boeung Cheung (BC) Ek Lake / wetland. Cultivation of aquatic vegatables is an important activity that sustains the livelihoods of many families around this

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Main inlet Phnom Penh wastewater into the Boeung Cheung Ek Lake

lake. Water spinach (Ipomoea aquatica) is the major crop grown in BC Ek Lake. The upper part of the stem and the upper leaves with leaf stalks are used for human consumption whereas the lower part of the plant with leaf, stem and root may be used as pig feed. Water spinach or morning glory is also planted on land and watered from a pond near the village with a motor pump and hosepipe. These plants serveas seedlings and will be planted in the lake ar the water level rises. Large water surface areas near the villages are overgrown with water morning glory and to a lesser extent with water hyacinth and water mimosa. There is extensive human contact with the water during the various production activities. Women and children living nearby often harvest the plants and make bundles which are collected by middleman with a truck on a daily basis.

The official functions of the Beung Cheung Ek wetlands are flood control and removal of pollutants from Phnom Penh city before the water eventually flows into the Mekong River. A previous study found high metal concentrations in wastewater sludge especially lead and mercury, which is not surprising as the untreated effluent of more than 3000 industries drains into BC Ek Lake (Muong, 2004). A study by the Ministry of the Environment of Cambodia estimated that 20% of the total daily vegetable consumption of Phnom Penh comes from BC Ek Lake and two smaller wetlands within the city (Muong, 2004). Therefore these waste water fed aquatic vegetables are, despite their potential health risks, very important in supplying the city's vegetable markets and thus meeting the demands of the growing population of Phnom Penh,.

SURVEY OF SKIN PROBLEMS

A recent systematic study with the PAPUSSA project was implemented focussing on skin problems among wastewater users in the city of Phnom Penh, Cambodia. A total of 154 households living along the BC Ek Lake and 46 households living around a lake that received no wastewater were selected for an initial skin survey, which provided information on 713 individuals. In the households engaged in the culture of aquatic vegetables in BC Ek Lake, 134 (22%) of the members reported skin problems whilst there was only 1 person (1%) living along the non-wastewater lake that reported a skin problem. Those with skin problems were referred to a dermatologist for physical examination and treatment. The diagnosis by the dermatologist showed that contact dermatitis (74%) was the most common skin disease, followed by superficial fungal infection (18%) and urticaria (9%). Skin problems and diseases mostly

Anders Dalsgaard

Man culturing morning glory in Boeung Cheung Ek Lake

appeared on the hands (56%), feet (36%) and legs (34%).

CONCLUSIONS

Preliminary results from this ongoing study suggest that exposure to wastewater is an important risk factor for skin diseases, especially dermatitis (eczema) of the hands and legs. So far we are unaware of any single biological or chemical agent in the wastewater that could cause skin disease in Phnom Penh. As in most other places, we are most likely dealing with a mix of agents and factors affecting skin conditions that may change over time and from place to place. The skin study will be further informed by the results from other research in the same area on environmental chemistry and toxicology of heavy metals. Through screening water and sediment for heavy metals we hope to assess and compare the impacts of relevant heavy metals to the findings of the study. Also, a rapid industrial survey of sources of industrial pollution in urban drainage systems will be carried out, including mapping of industrial wastewater sources and key informant interviews, to obtain information about potentially harmful chemicals. Furthermore, the application of pesticides on crops is a well-known cause of certain skin and health problems and information about such usage will be collected and analysed in relation to the reported skin problems.

The initial findings suggest that the use of protective clothing may have potential to reduce the risk for skin problems and risk factor analyses will be used to assess the effect of such protective measures. Other similar PAPUSSA activities in Hanoi, Vietnam, show that farmers are increasingly using long rubber gloves and boots. Such protective measures were not popular in the past, but soft rubber gloves and boots that are easy to use and work with are now available at acceptable costs.

In addition to skin problem studies other research activities are being conducted or planned in Phnom Penh and Hanoi on, amongst other topics:
wastewater treatment capacity of BC Lake in Phnom Penh and wastewater-fed aquatic systems in Hanoi
microbiological (faecal pollution and enumeration of helminth eggs and protozoan parasites) and chemical (mainly toxic metals) quality of wastewater-fed fish and plants.

Acknowledgements
This study is based on collaborative research between the Royal University of Agriculture, Phnom Penh, the National Institute of Health and Epidemiology, Hanoi and the other partners of the EC funded EU-INCO-DEV (Papussa) project. ;also funding from DANIDA through the project "Sanitary Aspects of Drinking Water and Wastewater Reuse in Vietnam", grant no. 104.Dan.8.L and from the Royal Veterinary and Agricultural University, Denmark.

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The Use of Treated Sewage Water from Settlement Ponds in San Juan, Lima

The Treatment and Use of Sewage Water programme started at CEPIS twenty years ago in order to contribute to increasing the sewage water treatment network in the region using technologies that would allow for the removal of pathogenic organisms as well as organic materials. So far, CEPIS and the various Peruvian institutions have carried out a series of experiments on the treatment and use of sewage water at the Bio-Ecological Complex in San Juan, south of Lima.

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he Research and Development Project entitled "Aquaculture with treated sewage water in the San Juan settlement ponds" is one of the most important contributions of these institutions. Its aim is to study sewage water treatment using aquaculture. The use of bioengineering, health and socio-economic criteria to improve this type of integrated system aims to make it possible to produce high-quality products, after which this new technology can then be applied in other countries in the region.

Julio Morcoro

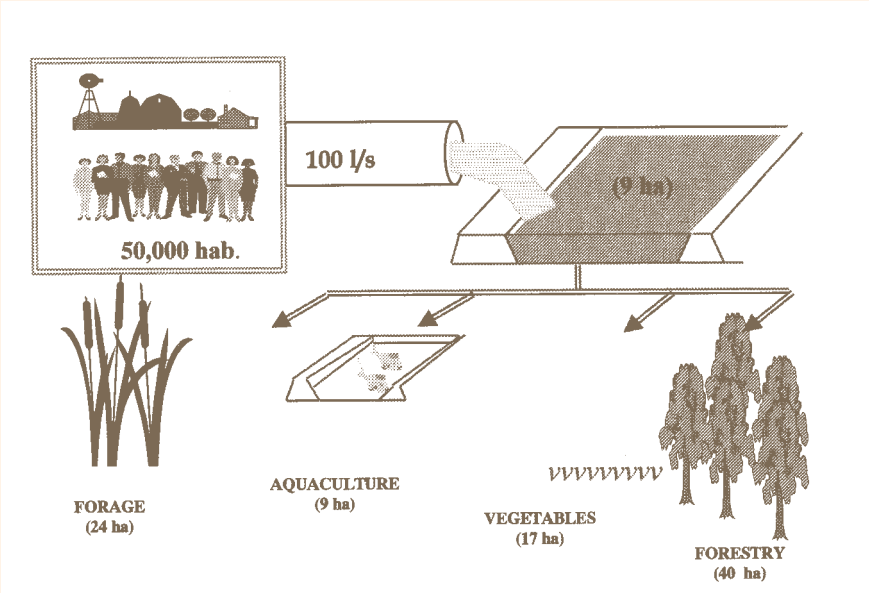
SETTLEMENT PONDS

The objective of the project was to treat sewage water in the settlement ponds to reach the appropriate quality for fish culture. The research showed the efficiency of settlement ponds in removing parasites (helminth eggs and protozoan cysts), viruses and pathogenic bacteria, including *Vibrio cholerae*. The settlement ponds in San Juan have the potential to reduce the level of faecal coliforms by 5 logarithms and attain an effluent with 10,000 MNP/100 ml levels.

Because the fish ponds were in independent systems the concentration of faecal coliforms was reduced to the level recommended by the WHO (100 MPN/100 ml)for fish culture. No other conventional system can compete with this efficiency in the removal of pathogens, unless the process of effluent disinfection is refined, which would increase costs and make the treatment process and its overall maintenance more complex.

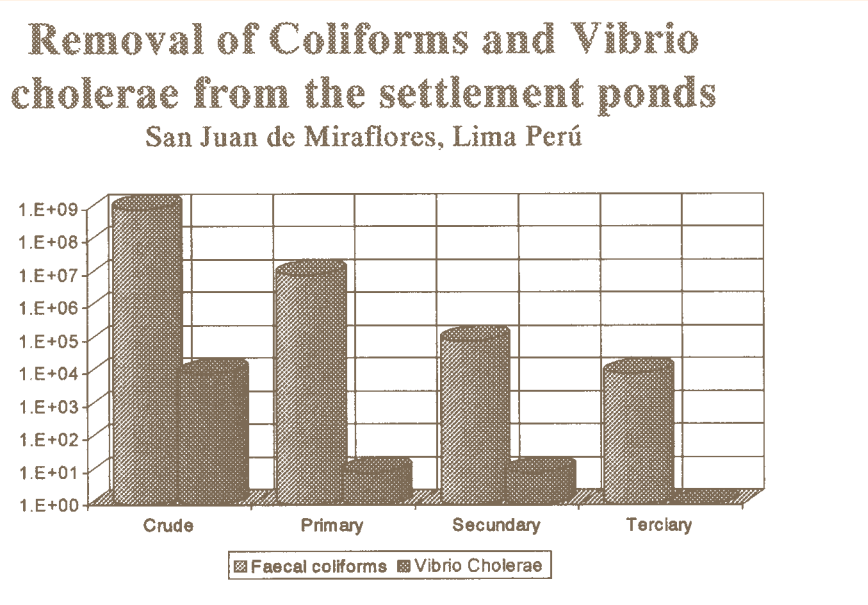
AQUACULTURE TRIALS

Some of the preliminary experimental trials in the quaternary settlement ponds were quite satisfactory for the culture of Nile tilapia 'Oreochromis niloticus' and common carp 'Cyprinus carpio', but not



for the giant freshwater prawn 'Macrobrachium rosembergii'. The Tilapia was the most resilient and best accepted by the local population. Therefore this was the species selected for our research.

These preliminary trials further showed the impracticality of using settlement ponds for fish culture because such ponds need to be totally drained for the fish harvest, thus temporarily stopping the treatment system. Also, the high levels of mud and sedimentation normally produced in the settlement ponds made it difficult to collect the fish at harvest time. Finally it was observed that the frequent fluctuations in water flow were affecting the environmental quality, which directly affected the fish growth even causing some mortalies. It was therefore recommended that in the construction and thus design of ponds, especially for tilapia culture the ponds should be supplied by tertiary effluents from the settlement ponds.



TILAPIA CULTURE IN FISH PONDS

After constructing an experimental aquaculture unit, the second stage of the project was carried out, which was based on the settlement pond's sewage water treatment, in order to guarantee the health and welfare of the cultured fish in the fish ponds. This effluent, which is rich in nutrients, made the algae blooms (phytoplankton) that were the primary natural food source for the fish.

The fish from three out of four experimental cultures were qualified as "very good". In only one experiment, 6% of the fish were rejected due to an increase in faecal coliforms (which went over the 100,000 MPN[1]/100 ml level) in the effluent that fed the fish ponds . This allowed us to propose 100,000 MPN/100 ml as the health quality standard limit for the effluent used for tilapia culture. It was also observed that tilapia in their system has a great capacity for maintaining acceptable water quality as long as the level of faecal coliforms is reduced for a minimum period of 30 days.

In subtropical climates like Lima, the growth of Nile tilapia during the warmer months is encouraging and similar to that obtained in tropical climates. Sex-reversed tilapias with an initial weight of 60 g can be cultured during the four months of warm weather at densities of 2 fish/m?, to reach a commercially acceptable size of 250 g and above. The fish ponds' maximum productivity during the summer season is higher than 30 kg/ha/day, obtained from the initial biomass of 960 kg/ha. The maximum stocking density has been set to 4,400 kg/ha, obtained exclusively with the natural feed produced by the fish ponds and with the water supplied from the settlement ponds. The high production of algae, between 700 to 1600 mg of chlorophyla per litre, demonstrated that the addition of artificial feed complements would not increase the fish biomass. Elimination of this step can reduce production costs by up to 70% and allowed us to produce the product for US $0.48/kg. In tropical areas it has been estimated that similar systems could be carried out continuously and produce three crops of tilapia a year, tripling the annual productivity per hectare and lowering the production costs even more.

AN INTEGRATED MODEL

The aquaculture project's initial results were used to elaborate a virtual model to expand commercial farms to sub-tropical and tropical regions. This model also enables economic evaluation and a sensibility analysis to study the profitability variation at different land prices, water treatments and product prices. A new version of the model incorporates the use of sewage water in other farming and forestry activities (see figure). These products allow CEPIS to promote the use of appropriate technologies in the treatment and use of domestic sewage water throughout the Latin American region, using a training programme that includes workshop courses and technical cooperation with different Latin American and Caribbean countries. All these materials are available at the Sewage Water web-page, which is part of the Virtual Library in Environmental Health web site (www.cepis.ops-oms.org).

For more than 15 years the San Juan Aquaculture Unit has been maintaining a pilot project for commercial production in order to meet the local market's demand. The project sells live tilapia weighing between 250 and 600 g for human consumption and sex-reversed juveniles to supply other commercial farms in Peru. This continuous operation proves the sustainability of these integrated systems.

The integrated system of treatment and use of sewage water is a sustainable and viable way to improve living standards in cities. It enables the adequate the lack of which is management of domestic sewage water, the main cause of aquatic environmental contamination and the spread and proliferation of intestinal and parasitic illnesses in developing countries.

NOTE

1) MPN = Maximum permissible number

Family Aquaculture in Cuba

Aquaculture is seen as an important alternative in Cuban food production. The MIP promotes aquaculture in Cuba though the concept of "Family Aquaculture" to improve the availability of food at household level, but also for the national and international market.

Aquaculture can be undertaken in monoculture or polyculture and may differ in intensity (from extensive, to semi-intensive or intensive). Extensive systems have low operational costs and density of seed. The cultured fish feed on the existing food in the usually large reservoir. Production in these systems is low and technical management is simple. Semi-intensive systems have a higher density of seed and are characterised by systematic management of fertilisers and supplementary food. Generally several species are produced (polyculture). Intensive systems use highly valued species in order to sell them at the market or for export. These systems often have a high fish density, strong water circulation, high quality of artificial food and aeration equipment.

Family aquaculture is a system in which one or more families use small concrete ponds or build simple ponds by digging , in a backyard or on common land. These concrete ponds can be, for example, the drinking tanks used in cow sheds, which have a small opening for entrance and exit of water. Using the water in reservoirs, these families can produce enough fish to contribute animal proteins to their diet, and possibly even help balance the distribution of fish in the area.

For this type of culture, Tilapia is recommended, both in monoculture or polyculture with species of the group of carps (cyprinids), such as the Common Carp, the Grass Carp, the Silver Carp and the Bighead Carp. These species live in tropical water and they can be fed with food produced by hand.

The following species are recommended: TILAPIA (Oreochomis aureus): COMMON CARP (Cyprinus carpio): GRASS CARP (Ctenophayngodon idellus): SILVER CARP (Hypothalmichtys molitrix): COLOSOMA (Colossoma macropomun): With photos

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Land and water

Sufficient land and water are needed to build a pond. The land used is between 300 m² and 0.5 ha. This size allows farmers to take better care of the fish, to catch the fish easily, and to produce enough to feed their families. The quantity and quality of water is also important. There must be a stable source of water coming from a higher place, so that it can get to the pond as a result of gravity. This water must not be affected by industrial pollution or sewage. The pond must have a slight slope so that flooding is avoided. Temperature, dissolved oxygen, transparency and ph (level of acidity or alkalinity of the water) are the four fundamental parameters to consider in quality control. Temperature is rather stable in Cuban climatic conditions, but in the summer the higher temperature can have negative effects on the oxygen, so these factors should be monitored in this season.

Furthermore, one must have access to manure and supplementary food for the fish. The soil of the ponds must be semi-permeable (with sufficient clay content) to avoid filtration.

Fish stocking

One can stock one or more species of fish. Polyculture is recommended, because it takes better advantage of the natural food in the water (small organisms). After fertilisation of the pond with animal manure, the water will start becoming green in two or three days. If the water is fertilised with vegetable waste, it will become green in one week. When the water turns green and is less transparent, it means that natural food is growing, which consists of tiny plants and organisms that grow in the water and give it this colour. At this moment, the pond is ready to receive the first fish. Table 1. Densities for the seeding of fish according to species in monoculture and polyculture (with fertilisation)

Table 1

Monoculture	
Tilapia	2-3 fish / m²
Polyculture	
Tilapia	1 fish / m²
Silver Carp	0.3 fish / m²
Bighead Carp	0.3 fish / m²
Grass Carp	0.3 fish / m²*
Common Carp	0.1 fish / m²
Colosoma	1 fish / m²

These densities are to be used in well-fertilised ponds. The recommended density of the Grass Carp depends on existing vegetation.

Fish feed

Food can be obtained from the natural elements in the water (of animal or vegetable origin), or it can be supplied by applying fertilisers to enrich the water, or by adding artificial food. Solar energy increases the nutrients in water through photosynthesis, contributing to the formation of organic material of vegetable origin, which is the basis of the food chain in the pond. To further increase nutrients and the natural food in the water, organic or inorganic fertilisers can be used. Organic fertilisers are green fertilisers or animal manure (or a combination of the two through composting). Fertilisation should be done four or five days before the fish are placed in the pond, so that the chemical conditions of the pond have stabilised and the food necessary for the fish has been formed. When the density of fish is increased, additional food should be added.

Integrated breeding

The breeding of fish can be combined in an integrated system with livestock, eg., like ducks, chickens, geese, pigs, rabbits, sheep, goats and cows. But one should always carefully consider which fertiliser to produce in the farmyards, in order to avoid pollution caused by nutrient excess. Fruit, plants and vegetables can be planted on the sides of the reservoirs to serve as food for the family, contribute

TABLE 2. Combined cultures of fish and small animals

Type of animal (Tonnes)	Density / hectare	Quantity of fish / hectare	Annual production
Pigs	40 - 100	3 000 - 10 000	0. 7 - 2
Ducks	500 - 1 500	2 000 - 4 000	1 - 3
Chickens	1000 - 3 000	3 000 – 10 000	1 - 4
Sheep	50 - 200	2 000 - 5 000	0.5 - 2

to the quality of the soil (through their waste) and avoid erosion. Examples of combined cultures of fish and other animals are listed in the table below.
After six months the fish can be harvested. If there is not enough water to refill the pond, or if only the bigger fish are to be harvested, it is not necessary to empty the pond. Partial fishing or harvesting of the pond is also done when not all the fish are of the desired size. If there is enough water and all the fish are of the same size, the pond can be emptied to harvest the fish more easily.

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Integrated Urban Aquaculture

Ten of thousands of tons of organic wastes are collected and transferred daily in the municipality of Playa to garbage disposal sites. In this way important resources are wasted, while decomposing products contaminate the coastal zone of Cuba. In addition, excessive and illegal fishing of various species (like the black sea urchin) and outbreaks of diseases cause deterioration of coral reefs and fish stock.

A dissemination project executed by the mentioned institutions below, aimed at showing urban communities, especially children and young people, how small actions from numerous groups of people can benefit the local and national environment, while at the same time stimulating food production and waste recycling. The project was carried out in a courtyard of 300 m^2 (called the "national reference" by the Cuban Movement for Urban Agriculture). In this area the production of vegetables, bananas, coffee, spices, herbs and medicinal plants is integrated with the production of earthworms, rabbits and freshwater fish (*Clarias gariepinus*, commonly known as catfish). Rainwater is collected from the roof of the house and fed into an earthen pond. Various species of fish, aquatic plants, snails and other organisms are grown in the pond, which is filtered by a biological system. The effluents, rich in nutrients, eventually return to the pond or are used in the irrigation system for the nearby vegetable garden and fruit trees. Organic wastes are used and are composted with a mixture of red African earthworms (*Eudrilus eugeneae*) and red Californian earthworms (*Eisenia foetida*). To start the culture, a breeding plot/ground was made by using a piece of asbestos roofing tile in the form of a cylinder, 2 m long and 0.9 m wide, that was covered with a makeshift ceiling including two micro-sprinklers for the irrigation. The earthworms' humus is used as fertiliser for plants and their biomass as feed for fish.

Mario Gonzalez Novo

Feeding the fish

Taking into account the confined space in which the project was developed, the results are considered to be positive. The project demonstrated that a family can satisfy part of its food needs using local resources, in a simple, healthy and environmentally sound way. The project further developed an atmosphere of social cooperation between neighbours, increased the environmental awareness and knowledge of children and young people and stimulated their commitment to the care of the coastal environment.

Information: Ricardo Sánchez, Instituto de Oceanología; Concepción Carrillo de Albornoz, Instituto Superior Politécnico José Antonio Echeverría and Jorge Sánchez, Instituto de Medicina Tropical Pedro Kourí, La Habana city, Cuba
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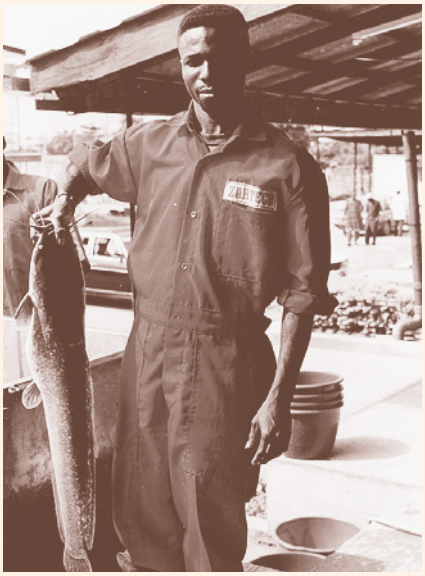
The Role of Aqua Farming in Feeding African Cities

Rapid urbanisation in Africa (of about 7-10% per year), unemployment, food insecurity in urban and periurban zones and declining fish supplies are major issues that have to be addressed by local and national governments in the region. These issues are occurring against a backdrop of changing economic forces and trade patterns in national and international food markets in the region, causing significant proportions of the urban poor to engage in farming as a livelihood and household food security option.



Krishen Rana

Large catfish farmed near Ibadan, Nigeria fetch premium prices in city markets

Research confirms the significance of urban and periurban agriculture for employment, food security and income generation (Drechsel et al., 2001; FAO, 2000). However, almost all studies relating to African urban agriculture in the past few years have excluded aquaculture (Spies, 1998; Jarlov, 2000). Consequently, its significance in and around African cities is largely unknown, but ad hoc information, especially in Nigeria, suggests it is a growing phenomenon.

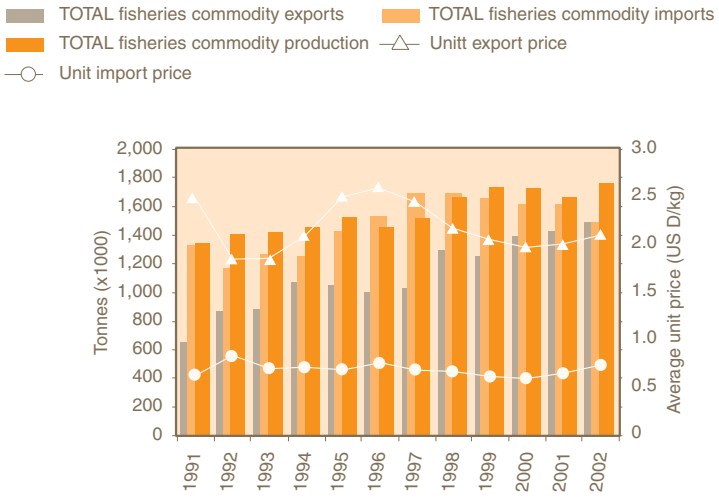
Aquaculture is regarded as being uniquely placed to reverse declining supplies from capture fisheries (mean caput fish availability in Africa declined 20% between 1990-96) and the activity has notable potential for new livelihood opportunities. It can provide the mechanism for lower-priced fish, enhanced nutritional security and employment for poor communities by servicing urban markets (Jagger and Pender, 2001). Aquaculture also provides an important opportunity to recycle wastes generated by zero grazing and other agriculture practices increasingly common in the region's urban and periurban zones. In this way it can contribute positively to growing urban waste disposal issues and add value to scarce water resources (Asomani-Boateng and Haight, 1999). Failure to engage in such opportunities could increase social costs and environmental risks, and worsen trade balances.

FISH PRODUCTION

Figure 1 highlights the growth in exports of fish products from Sub-Saharan Africa (SSA), which takes fish away from local consumption, and increases reliance on imported fish products to supplement indigenous supplies. Although the potential of aquaculture in the region and the changing impacts of urbanisation are noted, the lack of a realistic knowledge base to inform policy and planning processes to promote aquaculture is a severe constraint.

One of the challenges facing local and national planners is provision of the infrastructure and services needed to facilitate and secure food supplies for the burgeoning cities. In assessing the potential role of aquaculture to supply these open markets one needs to be realistic and to take into consideration current fish supplies, prices and products demanded.

Fishery production in SSA reached 5.3 million tonnes in 2002 with five countries accounting for 50% of production; but including a significant proportion for non-human consumption. Following globalisation in trade, however, much of the fish extracted from African waters is being exported. Exports doubled from USD 1.6 billion in 1990 to over USD 3.2 billion in 2002 whilst the value of imports remained static. SSA countries are exporting higher unit-value commodities and are importing lower unit-value products, especially cheaper frozen fish, to meet demand. Average unit prices of exports varied between USD 2-2.5/kg while the value of imported fish was only around 20 -25% of this price (Figure 1).



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If aquaculture is to meet (local) urban demands, producers will have to consider the comparative advantage of what they might produce, especially its competitive price position. Frozen herring and mackerel and other frozen fish dominate the imports, accounting for around 60-75% of total imports in 2002 (in Nigeria, Ghana, Ivory Coast and Egypt). One explanation for their popularity is their low price (USD 0.4-0.6/kg), which may well influence the cost ceiling of any aqua culture activity, and certainly if it is aimed at mass markets.

One other major constraint to the development of urban/peri-urban aquaculture in SSA has historically been the almost "tunnel-vision" focus of both large and small scale aquaculture development projects on the importance of promoting rural aquaculture primarily as a vehicle for poverty alleviation amongst poorer rural communities. As many know the results and outcomes from this developmental strategy have been mixed to say the least with many infrastructural problems resulting in low overall uptake.

It is highly likely that as long as these conditions prevail aquaculture producers in (peri)urban zones will not be able to compete with cheap imports and therefore fish farmers may have to focus on niche markets for large, live or fresh fish depending on their productivity, market preferences and investment risks of their money and time.

THE ROLE OF URBAN AQUACULTURE

In several African countries the potential of aquaculture for urban employment, income generation and food security is being increasingly recognised, but the markets for aqua products, economic viability, typology and locations of these activities are largely undocumented. Recently, DFID (the UK Department for International Development) through its research arm, the Aquaculture and Fish Genetics Research Programme, funded a project to establish the potential role of aquaculture in selected U and PU zones in SSA. This project is being conducted jointly by the Institute of Aquaculture and World Fish Centre in Egypt with partners from Nigeria, Cameroon, Uganda, Tanzania, Malawi and South Africa. The primary focus of this collaboration is to: (i) understand the macro- and micro-economic and social environments in urban centres of demand for aquatic products, (ii) assess the market structure and aquatic products to establish the current conduciveness of urban and periurban zones for aqua farming and (iii) establish whether aqua-farmed products can compete in the marketplace. As part of this initiative the role of local institutions will be appraised, with particular regard to the policy and planning process for aqua farming.

In Nigeria, the culture of large catfish in urban and periurban zones is carried out by local residents including civil servants, teachers, engineers, and trained unemployed youth, who have developed home-grown tank and other technologies. This semi-intensive or intensive catfish farming takes place in small land areas in and around cites such as Lagos. Interestingly, many of these entrepreneurs are women with no previous knowledge of aquaculture but an enthusiasm to learn and be trained.

In these cities catfish is cultured mainly in tanks of varying sizes ranging form 1-50 m^3, which are linked to recirculation systems of varying degrees of sophistication and in earthen ponds. Since catfish are air-breathing fish they can be stocked at high densities, and these were observed to range from 10-200 kg/m^3. A further cost advantage is that fish are commonly fed on homemade feeds using local ingredients and equipment, although the lack of a viable commercial feed industry has forced some operators to use imported feeds. Although catfish are also produced in ponds in periurban zones, the problems of theft and high land costs have constricted the uptake in urban and periurban zones. Development of recirculation systems over the last decade and growing market demand has generated considerable interest even though initial capital costs are relatively high and has attracted many to invest their personal savings in catfish farming.

Many fish farmers in Dar Es Salaam considered rearing fish in ponds as an activity that increases their social status

Table 1. Characterisation of aquaculture activities by municipality in the city of Dar es Salaam, Tanzania*

Municipalities	Number of farmers**	No. of fish ponds	Total area of ponds (m^2)	Average area (m^2) per pond (range)
Kinondoni	14	18	24,315	135 (10-10,000)
Ilala	5	6	3,530	294 (80-2,400)
Temeke	13	24	21,100	879 (65-10,000)
Total	32	48	48,945	
Average	10	10	15,365	1,653

*Data are based on a field survey conducted from the 20-30 June 2002.
** Farming groups are considered as one entity.

Krishen Rana

Trout processing facility near Cape Town, SA

Aqua farming in Dar es Salaam, Tanzania, is not as well developed as in Nigeria and it differs in that tilapia is the predominant species of culture in (peri)urban areas. This may be attributable to the scarcity of and limited access to land within the Dar es Salaam metropolitan areas and lack of cost-efficient tank systems and technical know-how. A preliminary survey in three geo-political municipalities of the city of Dar Es Salaam, viz. Kinondoni, Ilala and Temeke, suggested that around 50 ha of land is used for fish farming activities. Pond size ranged from about 10 m^2 to 10,000 m^2.

In the periphery of Dar es Salaam, city aquaculture is growing fast albeit in a novel form. Periurban fish culture is combined with commercial interests with a passion for aestheticism. More than half (55%) of fish farmers interviewed considered rearing fish in ponds as an activity that increases their social status, but also one that produces tangible rewards (through selling the fish) to

supplement their income. These farmers were mostly senior (and in some cases retired) government and military officials, business personnel and elite individual farmers. This category of farmers considered fish culture as a small-scale income-generating activity but not necessarily as an important livelihood option. Local pub owners, however, believed that if they established fish ponds nearby they could supply fresh fish to their customers for immediate consumption.

Although aquaculture development in South Africa is in its infancy, many city municipalities have recognised the potential role of aquaculture in livelihood options. Several cities, such as Durban, have formulated an urban agricultural policy that includes aquaculture as an economic activity. Ornamental fish rearing is considered a possibility and trout farms are being established by disadvantaged groups in periurban zones. In view of its rich marine resources South Africa has a well-established formal and informal marketing structure. To encourage economic activity, improve sanitary conditions and encourage the distribution and sale of fish, many municipalities have constructed fish marketing sites. Recent surveys have indicated that traders are receptive to aquaculture products provided quality and price expectations are met.

A problem identified in most cities is the quality and suitability of available water for aqua farming. In the case of Dar es Salaam some water bodies may be contaminated with heavy metals such as lead and cadmium and therefore these sites may not be suitable for aqua farming. In addition in most of these zones city by-laws are not conducive for both aquaculture and agriculture. Efforts will have to be focused on local institutions to create an enabling environment to encourage ordered expansion of aqua farming to meet the rising demands from cities.

CONCLUSION

The above case studies of urban and periurban aquaculture show that it has the potential for playing an important role within the growing urban markets in SSA. Evidence suggests that there is quite diverse recognition and interest in the potential contribution of aquaculture to local food supplies, especially in market segments with comparatively few alternative competitors. Whilst the wider availability of imported frozen low unit-value pelagic species is likely to remain a serious constraint to the expansion of high volume, low-cost-focussed production systems, their very presence may well provide the financial incentive and stimulus for some expansion of current activities in the future.

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Tilapia Culture in Homestead Concrete Tanks in Periurban Nigeria

This is a shortened version of the full article, which is available at www.ruaf.org

Two major constraints to the establishment of fish culture enterprises in Nigeria include lack of initial capital input and the acquisition and ownership of land. The rental price of land suitable for modern and conventional pond fish culture becomes prohibitive and unaffordable especially in urban centres because of competing and conflicting uses. Family-scale (backyard) aquaculture in periurban areas has been recommended in Nigeria as an economical method of producing fish. The homestead concrete tank has been developed as an alternative and suitable enclosure for backyard fish culture.

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There is considerable potential for achieving Nigeria's objective of increasing fish protein production, especially in urban centres, by farming tilapia in homestead concrete tanks. The homestead concrete tank is not expensive to establish; little land space and little costs are required. It is easy to maintain and can be as functional and as productive as earthen ponds. The sites required for establishing homestead tanks demand no acquisition costs and

Krishen Rana

Simple backyard tank for catfish in Lagos, Nigeria

Krishen Rana

Informal markets selling locally produced smoked trout near Cape Town, SA

are not dependent on factors such as natural water source, topography, clay content and alkalinity of soils. Commencement of construction is possible irrespective of the prevalent season as opposed to construction of earthen ponds which takes place preferably during the dry season. Total drainage is possible and the water level is easily controlled without using additional labour during harvesting. All fish harvested are either consumed or sold locally. The enterprise can be expanded or discontinued as desired at little additional costs.

Tilapia is the most important fish used in aquaculture in Nigeria because of its hardiness and fast growth. Tilapia culture in Nigeria in tanks is a recent practice, hence there is little information available on it. The economics of this practice, especially the returns on investment, was studied by the authors to assess and determine its viability for possible development into large-scale enterprises under the "Poverty Alleviation Programme" for urban dwellers implemented by the Nigerian government. Two concrete homestead tanks were designed and constructed to study the economic and technical feasibility of hybrid tilapia culture in periurban Lagos, Nigeria.

Two leak-proof, above ground, homestead concrete tanks (6m x 4m x 1.3m) were designed and constructed at the backyard of a family house in suburban Lagos, and this was used for the study. The materials used for construction were reinforced cast concrete and cement blocks. Drainage outlets were elbow-joint PVC stand-pipes installed at the side of the tank. The tank bottoms were lined with a layer of river sand to a depth of 3 cm, with broken blocks and gravel to serve as biological filter and to maintain a stable pH of 7-8. The tanks were subsequently flooded with municipal (pipe-borne) water to a depth of 1.2 m. Water in the tanks was completely drained and refilled at the end of every month to maintain good water conditions for tilapia growth.

Due to small size and shallowness of concrete homestead tanks, the carrying capacity is low and therefore mono-sex (hybridised) tilapia fingerlings (< 50 g) were stocked at 6 fish/m^2 into the concrete tanks, and were cultured for 120 days (which is a one cycle of production). Hybrid tilapia was selected because of its hardiness, adaptability to overcrowding and availability from government fish seed multiplication centres at moderate costs. Next to indirect fish feed, poultry wastes (900 kg/ha/wk) served as organic fertiliser by spreading it over water surface. Soybean cake was used as supplementary feed and fed once daily at 5% of the total fish body weight. Complete harvesting was carried out after both tanks were drained after each production cycle lasting 120 days. Water temperature and pH in the concrete tanks were monitored throughout the culture period.

The full article will be? available at the ruaf website, including data on growth, survival and yield, etc. The hybrid tilapia used in this study are fast growing and with their omnivorous feeding habit, attained market size of > 180g after each production cycle lasting 120 days. The economic viability of the system was evaluated and a sensitivity analysis was conducted on the impact of changes in input prices and productivity on the internal rate of returns. The latter was more than 95%, and compared with bank loan interest rates of between 23% and 25% in Nigeria, the yield is higher by a very wide margin. These are substantial incentives for investment in such a project. Technically, the system could be easily adopted by urban dwellers, but it would need proper management.

The study revealed that tilapia can be successfully cultivated in peri-urban homestead concrete tanks and can be both economically and technically viable. This practice could greatly enhance the current low per-capita fish protein intake, and when widely accepted and extensively practised could reduce the existing deficit between fresh?? fish supply and demand in Nigeria. There is a need to introduce and encourage the practice nation-wide and it should be backed with adequate extension service and publicity with the aim of creating awareness.

Some Basic Assumptions for Computing Costs and Returns

- The projected amount of sales is not more than 90% of the production for the period.
- Fish mortality and loss of fish were put at 10% of stock.
- Market-size of adult tilapia was estimated to be 180 g.
- Output was estimated based on three crops of tilapia per year.
- Sales of table-size tilapia was estimated at 100/kg (US$ 1/kg) which is very conservative.
- Approximate weight of fish is obtained by average weight x total number of fish produced.
- Cost of fingerlings was calculated at current market prices.
- Poultry waste was obtained free, only transportation cost was computed.
- Increase in cost of soybean cake (feed) will take care of inflation and price changes.
- Personnel cost was not included, as household labour was readily available at no cost.
- Expected life span of homestead concrete tank was taken to be ten years.
- Cost of capital (interest rates) in Nigeria is 23-25% on loans granted by commercial banks.

Periurban Aquaculture in Ghana

Fish farming was taken up enthusiastically in the late 1970's by the Accra Metropolitan Assembly (AMA) as an alternate income-generating venture. It was seen as an important part of the "Operation Feed Yourself "(OFY) that was launched by the then government. Efforts were made to develop fish farms on all available land that could not be used for farming at that time and where water was readily available. A few of the fish farmers made successes, but due to lack of training and information the majority ran into management problems. The fish farming programme to reduce poverty in the urban and periurban community failed. Within the last five years also, fish

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Pacific Farms

farming or aquaculture as an enterprise is becoming acknowledged by both urban and rural communities, but is gaining ground especially in urban centres.

The fish farming programme could be seriously taken up again through the creation of an enabling environment and training on the right and appropriate methods to get this industry sustained. For the periurban areas, it is necessary to facilitate the integration of urban agriculture to local government programmes, which should involve all categories of urban farmers and other stakeholders. In addition it would be

necessary to treat the rivers and streams flowing through the metropolis which are currently polluted through the dumping of waste (liquid and solids). Proper zoning and locating ponds/dams together with vegetable farms would enable mutual benefit and a maximum use to be derived from the treated water. Furthermore, training of fish farmers and of Agricultural Extension Agents (AEA's) should be considered and the subsequent provision of the necessary tools and equipment will enhance their ability to extend efficient services to the fish farmers. This was the essential part that was virtually missing from the fish farming package that was brought in when the programme took off in the earlier 1970's. Urban marine fishers (as the owner of Pacific farms) could be supported to diversify during closed seasons, which will also positively impact the decline of scarce marine resources. Although not many ex fishermen tend to turn to fish farming, because of the difficult situation with land ownership. The metropolitan authority has an important role to play to facilitate re-cycling of urban wastes, education and training, poverty reduction and employment generation for both the

NANA KWAKU SAIW , A SUCCESS STORY

Martin Kumah is in his Ghanaian community better known under his traditional stool name Nana Kwaku Saiw. Martin started farming at the age of 11 but was trained at the Kumasi Technical Institute as Auto-mechanic which allowed him to take up a job at Kumasi University where he become the University's Transport Officer thanks to his dedication, good overview and hard work. But Martin also continued his agricultural pursuits. He acquired a farm, and started with poultry, rabbits, and different crops. In 1998, he received the award of the Best Urban (Metropolitan) Farmer of Kumasi during the annual Farmers Day celebration. In 1999, Martin was even the Best Regional Aquaculture Farmer of the whole Ashanti Region and resigned from his job at the university. With more time for farming, he received in 2002 the award for the Best National Aquaculture Farmer, and toppled this in 2004 with the second highest award possible in Ghana as the first runner up to the overall Best National Farmer. Hard work and diversification has paid off!
Both, urban farming and aquaculture were milestones on Martin's carrier path. As a celebrity, he presented two papers on behalf of Ghana's farmers at the UN World Summit on Sustainable Development in South Africa in 2002, on invitation by IWMI, and was supported by FAO to undertake training in Uganda and Thailand.
There are about 700 fishponds in the Ashanti region producing fish, many in valley bottoms unsuitable for construction. These ponds are mainly earthen with few being concrete. Both extensive and semi-intensive systems of fish culture are practiced but semi-intensive is the most dominant either of monoculture or more often polyculture. All fish farmers practice supplementary feeding. Feed is obtained from the local markets and these include maize bran, brewery waste, groundnut husk, groundnut paste, green leaves, coconut fibres etc. Fish feeds differ from region to region depending on staple crops grown. In our interview, Martin mentioned that specified formulated fish feed is lacking, and farmers use what is locally available. On the other side, this allows also for flexibility and independence of supply services. The most crucial part is timing of sales. In contrast to urban vegetables, free fish is abundant during the dry seasons when it is easy to catch in temporary or slow flowing water bodies. Thus without any investment in fish farming many non-fish farmers can make good business, as Martin explained. But in

the rainy season, the situation turns around, and aquaculture becomes highly competitive.
Today, Martin is specialized in fingerling breeding for other farmers starting up in aquaculture. He is specialized in tilapia and catfish and is using the water from the ponds for vegetable irrigation during the dry season. Asked which parts of his business he would drop in economic crises or when he gets old, aquaculture was not mentioned.

By Lesley Annang, Pay Drechsel, IWMI, Ghana

youth and women in the metropolitan community. Favourably to (peri)urban aquaculture producers in Accra are the high demand of fresh urban fish, better prices, and the availability of information on markets and production. An example is Pacific Farms, near Accra (see box).

PACIFIC FARM

Mr Bonney started Pacific Farms after early retirement from former national Shipping Company, the Black Star Line. Pacific farm is located at about 22 km from Accra Central, on the Nungua - Ashiaman road. It started with three earthen (non-drainable) ponds, but quickly expanded to nine ponds in 3 years and a piggery and ducks.

Because the pond cannot be drained, harvesting has always been partial. The water used is a combination of groundwater and rain floods. Pig manure mixed with urine is allowed directly into ponds.

The main harvest for the year scheduled to coincide with low fish production from marine sources (i.e. December – March/April). The farm receives continuous free technical advice from the Directorate of Fisheries and the Institute of Aquatic Biology (now part of water Research Institute), which together with the availability of good markets form the advantages of Pacific Farms.

Theft is a major problem. The farm has expanded into onions, cattle and ostrich farms-which are now the flag –ship commodities of the farm.

Urban Agriculture in Istanbul, Turkey

Turkey has been defined as a bridge between Asia and Europe. These two continents and their civilizations have left many marks on Turkey and the Turkish people. For thousands of years in Anatolia (Asian part) and Thrace (European part) life has been mostly based on agriculture. Istanbul, situated on this bridge, is growing rapidly as it attracts immigrants from rural areas. It is there that this initiative on urban agriculture is situated.

Although Turkey is developing rapidly, its population of nearly 30 million people is actively connected to agriculture and rural production. But in the rapdily growing cities one find the setting for the most important problems facing Turkey today. Turkey's unemployment rate has not dropped below 6% for the last 15 years and associated problems such as migration to the city, social adaptation of these people to city culture, adequate planning and design, and environmental pollution are especially apparent in Istanbul.

Istanbul is one of the largest and oldest cities of the world with a population of nearly 12 million. And although urban agriculture is an old tradition in Istanbul, there are currently only a few examples known of food production within the city limits. One main problem the inhabitants of Istanbul face is securing access to food. Furthermore, there are other problems, in Istanbul as well as many other cities, affecting further development of urban agriculture, like the prohibitive costs of renting land and the lack of access to (clean) water and other inputs.

A first official urban agriculture project started in Turkey in early 2004. It is coordinated by the Ulaşılabilir Yaşam Derneği, UYD (Accessible Life Association), which is one of the prominent NGOs of Turkey. UYD was founded soon after the big earthquake in the orth-western part of Turkey in 1999, and it has been implementing various projects on rehabilitation of people under risk, employment of disabled people, and social integration of cultural minorities (Gypsies, Syrian Orthodox people, etc.).

The urban agriculture project in Istanbul is seen as a model for Turkey rather than an isolated project activity. The project has started on a 40 decar (4 ha) field in Gürpınar, which is a municipality under the larger city of Istanbul. The main target of the project is to support and train unemployed, poor women of Gürpınar in developing agricultural activities and to sustain these urban agricultural activities in the future. Twenty-five women have so far been trained in organic agriculture, composting, processing and marketing, and organisation (of cooperatives for example). They have organised themselves and agreed on the production plan, which is currently being implemented in the field. After the first cultivating activities, which will take place this summer until August, all of the profit gained from the crops will be distributed among the target group. In August these initial results will be presented in a national seminar in Istanbul.

This project is a good example of (international) cooperation and participatory work. The EU is supporting this project within the framework of the "Active Labour Market Strategy Project, the New Opportunities Programme" financed by the CFCU (Central Finance and Contract Unit). ETC is collaborating with UYD by providing advice on project implementation and monitoring, and by helping to disseminate information (a first issue of the UA Magazine in Turkish has been produced by UYD). Also, ISKUR (the Government Employment Office of Turkey) has been monitoring and evaluating the project. The municipality of Gürpınar is playing a very important role in this project by allocating the field and machinery needed. Through this project and with the support of the municipality, the women farmers, and others, UYD aims to provide a strong example of the potential of urban agriculture and a realistic hope for many poor people in Istanbul and other cities in Turkey.

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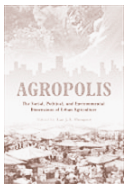
Books



The Social, Political and Environmental Dimensions of Urban Agriculture

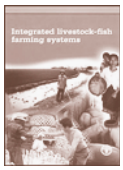
Edited by Luc J. A. Mougeot, IDRC. Publication Date: July 2005. ISBN 1844072320 or Hardback 1844072312. 320 pages

This book presents the first findings of original field research projects funded by IDRC's AGROPOLIS International Graduate Research Awards on Urban Agriculture. Countries studied include Cuba, Argentina, Botswana, France, the UK, Zimbabwe, Ivory Coast, Togo and Tunisia. Together, these studies examine concrete strategies to better integrate 'city farming' into the urban landscape. It's style, makes it accessible for policy-makers, city managers, students and general readers.

Urban Aquaculture

Costa-Pierce, B.A., A. Desbonnet, P. Edwards and D. Baker, 2005. New York Sea Grant, Cornell University, USA. CABI Publishing. 277 pages

Part history, part state-of-the-art review and part futurescape and unapologetic manifesto for more sustainable ways of living, *Urban Aquaculture* is at heart an optimistic, utopian book. Nonetheless, it deals with some thorny problems, problems that are all too often ignored. The nineteen chapters are organised into five sections: two scene-setting chapters, a section on the evolution of urban aquaculture in Asia, a parallel section on Europe and North America, a section on education and a closing synthesis. Half of the book is devoted to case studies from both developed and developing countries. These have much to teach us, not only on technical issues, but also the vitally important social and economic dimensions. This book delivers on its stated agenda of thoroughly exploring the issues surrounding the reuse of urban wastewater in aquaculture systems to provide safe, nutritious foods and biotech products. There remain many challenges, technical and otherwise, not the least of which is to gain a more solid understanding of the risks posed by the reuse of wastes in producing food. Aquaculture may not prove to be the universal answer, but it is heartening to see so much innovative investment in addressing the problem of food security. (Shortened version of a review by Malcolm Beveridge.)



Integrated Livestock-fish Farming Systems, Inland Water Resources and Aquaculture

Little, D.C. and P. Edwards, 2003. FAO. ISBN 92-5-105055-4

The various types of aquaculture form a critical component within agricultural and farming systems development that can contribute to the alleviation of food insecurity, malnutrition and poverty through the provision of food of high nutritional value, income and employment generation, decreased risk of production, improved access to water, sustainable resource management and increased farm sustainability. On a global basis, most cultured freshwater fish are produced in Asia in semi-intensive systems that depend on livestock wastes purposely used in ponds, or draining into them. Much of the vast increase in China's recent inland aquaculture production is linked to organic fertilisation, provided by the equally dramatic growth of poultry and pig production. The use of livestock wastes is still needed, even when high-quality supplementary feeds are available, and they are still widely used in more intensive aquaculture systems. The objective of the publication is to provide an analysis of the evolution and current status of integrated livestock-fish systems in Asia, particularly East and Southeast Asia, as well as to provide a sound technical basis for considering their relevance for the planning of livestock-fish systems in Africa and Latin America. http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/006/y5098e/y5098e00.htm

Eat Here, Reclaiming Homegrown Pleasures in a Global Supermarket

Halweil, B., 2004. Worldwatch Institute. W.W.Norton & Company, London. UK. www.worldwatch.org

According to this book, various urban citizens everywhere are demanding locally grown food. More and more Americans are preparing meals of vegetables, fruit, meat, and other ingredients grown and raised on nearby farms, rather than from distant agribusinesses. Local food is going mainstream. In this book, Brian Halweil explains that this simple shift in eating habits not only delivers superior taste, but is better for people's health, the livelihoods of small farmers, and the global environment.

Urban Aquaculture Ethnic Markets Sustain New Business

Ferguson, B., 2000. New Village Journal. Issue 2.

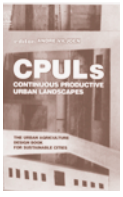
This article tells the story of Bob Biagi, an urban "aquaculturalist" in Massachusetts, who discovered an ethnic community business niche to market his fresh, aquafarm-raised tilapia. Tilapia is an easy-to-breed species that is fairly inexpensive to feed and relatively free of parasites and diseases. Biagi's programme provides fresh, high-quality fish at a fair price to local ethnic markets, along with potential jobs for vendors.

Urban Forests and Trees

Konijnendijk, C.C., K. Nilsson,T.B. Randrup,and J. Schipperijn (Eds), 2005. 516 pages. ISBN: 3-540-25126-X

This book covers all aspects of planning, designing, establishing and managing trees and forests in and near urban areas. The disciplinary backgrounds of the authors are varied, ranging from forestry and horticulture to landscape ecology, landscape architecture and even pathology. The first chapters deal with the benefits and functions of urban forests and urban trees. But main emphasis is given to the establishment of trees for urban uses, including identification and selection of species, provenances and cultivars and to the management of urban forests and urban trees. The reader will also find a chapter dealing with Geographic Information Systems as a planning and management tool in this field and another one which is dedicated to the development of management methods that ensure optimal coordination between aesthetics, infrastructure and growth rates for street trees.

Continuous Productive Urban Landscapes: Designing Urban Agriculture for Sustainable Cities



Viljoen, A. (Ed.), 2004. Architecture Research Unit, University of North London, U.K. ISBN 0750655437 Paperback 240 Pages. Price: £ 29.99

This book provides a design proposal for a new kind of sustainable urban landscape: urban agriculture. By growing food within an urban, rather than an exclusively rural environment, urban agriculture would reduce the need for industrialised production, packaging and transportation of foodstuffs to the city-dwelling consumers.

The impact that this would have on the future shape of cities could be immense. Urban design is shown in practice through international case studies and the arguments presented are supported by quantified economic, environmental and social justifications. Over 230 images give the reader a clear visual idea of the impact.

The Urban Aquaculture Manual

Woods, J., Heifer Project International and Evangelical Lutheran Church of America. http://www.webofcreation.org/Building-and-grounds/aqua/Chap1.html
This manual provides some basic knowledge about aquaculture. It tells you how to build two different aquaculture systems, a simple recalculating system and an aquaponic system. It also tells you how to maintain these systems and what to do if something goes wrong. Finally, it lists some good places to find out more about aquaculture.

Urban and Peri-urban Aquaculture

Martinez, M. (Ed.), 2003. FAO
http://www.fao.org/ag/ags/agsm/sada/asia/DOCS/DOC/WP_A6.doc
This report is part of the report on the International Conference "Feeding Asian Cities", organised by FAO in November 2000.

Growing Cities Growing Food (Translated into Chinese)

This book, published in English in 2000, by RUAF for a large group of institutions who participated in the Havana Conference in Cuba, 1999. After being translated into Spanish and French, and distributed in the West African and Latin American countries, it is now also available in Chinese to reach more students and practitioners of urban agriculture.

Websites

www.growfish.com.au

Although originating from the Gippsland Aquaculture Industry in Australia, this portal has a wealth of information, Including a report of the visit of a Chinese delegation to the Phillipines to study urban aquaculture.

http://www.organicity.org/food/urbaqua/

Rob Freudenberg of Columbia University makes a plea for urban aquaculture in the city. In order to use abandoned urban areas and create jobs, making fresh fish available to the urban community.

http://www.cityfarmer.org/fish.html#fish

Also at the cityfarmer site (of course) several links can be found on the issue of aquaculture, including a white paper on the status and prospects of New York Aquaculture by Cornell. It states that indoor food fish aquaculture in a controlled environment has the most potential economic impact, similar to how the broiler industry has evolved. Tilapia is currently successfully being raised and marketed in upstate NY, and accounts for more than 50% of the economic output for finfish production in New York. Or at **www.cityfarmer.org/fishfarm.html#fishfarm** a report of Geoff Wilson, of the Urban Agriculture Network - Western Pacific Office,
periurban acres at Figtree Pocket, 10 kilometres from the Brisbane CBD informs us about growing native fish successfully on natural foods in the urban fringe.

www.infrastructureconnect.info/index.asp

This web site provides information about the research engineering and infrastructure work of DFID, formerly under the direction of the Infrastructure and Urban Development Department (IUDD) and now, following a reorganisation, directed by the Central Research Department. Particularly of interest is the Urbanisation and Water section. "Livelihoods Connect" is another learning platform for the United Kingdom's Department for International Development (DFID). Its web site (hosted jointly by DFID and the Institute of Development Studies) aims to enable the practical implementation of the sustainable livelihoods approach through information sharing, learning, and management tools. For more information, visit http://www.livelihoods.org.

www.rainwaterharvesting.org/Urban/Urban.htm

The Centre for Science and Environment, a New Delhi based non-government organisation (NGO) promotes the revival of traditional systems of water harvesting as a practical solution for drought-proofing the affected areas. The organisation has developed a comprehensive strategy to further the impact of its campaign for a participatory, equitable and decentralised paradigm for water management.

www.searusyn.org

On this website you will find the latest project reports on the SEARUSYN project. If you would like to receive more information about the SEARUSYN project please contact the SEARUSYN project coordinator Ben Kamphuis (ben.kamphuis@wur.nl), who is based in the Hague.

http://mailman.u.washington.edu/mailman/listinfo/foodplanning

The Foodplanning@u.washington.edu mailing list is hosted by the University of Washington Department of Urban Design and Planning. It serves as an online space for planning practitioners, academics, and community members to share and develop ideas about urban planning, policy, and the food system. It is not moderated, but users are expected to follow good netiquette. To post to this list, send your email to:
foodplanning@u.washington.edu

World Urban Forum 2006 (Vancouver, Canada)

June 2006

The World Urban Forum of 2004 was held in Barcelona, Spain, where an international panel on credit and investment for urban agriculture was organised by IDRC, CIGU and UMP/IPES and supported by the RUAF (see www.unhabitat.org/wuf/2004). On request of the Canadian Government, IDRC is organising a number of sessions on urban agriculture, food security and good governance as part of the official programme of the World Urban Forum in Vancouver in 2006. IDRC invited RUAF partners MDP and ETC to participate in the preparations of two of these sessions. A Steering Committee has been formed to maintain the relations with Canadian Government, UN- HABITAT, etc., to further develop the programme for the WUF 2006, to prepare the diverse materials and to develop linkages with municipal authorities, the press, NGOs and donor agencies. We will keep you informed of further developments. More information at www.idrc.org, www.unhabitat.org or can be obtained from Marielle Dubbeling: m.dubbeling@etcnl.nl

Nature at Your Service, 2005 National Conference on Urban Ecosystems (Charlotte, North Carolina, USA)

17-18 November 2005

The urban forest is an untapped resource—one that can help cities meet regulatory requirements for clean air and water, revitalise neighbourhoods, and reduce the costs of building and maintaining infrastructure. The 2005 National Conference on Urban Ecosystems, Nature at Your Service, will show how to reconnect people to their city's natural resources. For more information contact info@amfor.org, or visit www.americanforests.org/conference/

First EMPOWERS Regional Symposium (Cairo, Egypt)

13-16 November 2005

This symposium will be organised by The Euro-Med Participatory Water Resources Scenarios (EMPOWERS Partnership 1) under the title "Sharing Experiences on Involving Users in Integrated Water Resources Management at the Local and Intermediate Levels". It aims to bring together practitioners, researchers and policy makers to share practical experiences and promising tools, methodologies and approaches for implementing local level Integrated Water Resources Management (IWRM) that involves and empowers communities and other water users. An e-conference ran from 15 February to 31 March 2005. Please stay tuned at www.empowers.info

International Conference on Circular Economy and Regional Sustainable Development (Hangzhou, China)

1-4 November 2005

The conference will be organised to discuss and express concern about the degradation of ecosystems as a result of resource exploitation, and industrial, agricultural and urban development activities. The government of China, a country with over 1.3 billion inhabitants, is currently adopting rapid development policies but it also realises and acknowledges constraints that may cause its interventions to backfire. This conference is a manifestation of the willingness of governments, higher learning institutions, NGOs, and industries in China and elsewhere in the world to challenge traditional economic values. For more information please browse the conference web site: www.2005cersd.org.cn

Socioeconomic - Environmental Issues and Interventions Addressing Urbanization in Developing Countries (Cagayan de Oro City, the Philippines)

2-30 November 2005

This one-month training course is organised by SEARSOLIN, Xavier University College of Agriculture. The College of Agriculture is one of the member agencies of PUDSEA network, which is supported by the German Academic Exchange Service (DAAD). This course is one of 10 modules related to agriculture. It will deal with urban and periurban development issues, participatory urban environmental planning and management tools, urban ecological sanitation, solid wastes management and planning and evaluation. For more information write to searsolin@xu.edu.ph or contact Dr. Robert J. Holmer, Periurban Vegetable Project, Xavier University College of Agriculture at puvep@philcom.ph, or visit the web site: http://www.puvep.com

Women in Sustainable Agriculture Conference (Burlington, Vermont, USA)

21-23 October 2005

Farmers, educators, and activists and agricultural professionals involved in sustainable agriculture are invited to meet in this national event.

Please contact Beth Holtzman, Women's Agricultural Network: beth.holtzman@uvm.edu or cowfan@metc.net

International Platform on Sustainable Urban Development (Geneva, Switzerland)

11-13 October 2005

This conference, called "S-DEV Geneva 05", will have four main themes or "poles" (technologies, governance, civil society and enterprises), which will serve as focal points, bringing all stakeholders together to exchange innovations in these areas. Discussions will centre around issues such as health, nutrition, sanitation, waste, transport, energy, integration and housing, and focus also on urban agriculture and food security.

For more information visit www.s-dev.org/

Farming Systems and Poverty: Making a Difference, A Global Learning Opportunity (Rome, Italy)

12-16 September 2005

The Global Learning Opportunity (GLO) of the International Farming Systems Association (IFSA, with FAO and IFAD) will bring together development practitioners and many others to discuss, analyse and propose strategies and options, and to identify promising opportunities to attain the Millennium Development Goals, particularly those related to rural poverty, food security, gender equity and environment sustainability. The overall theme combines the IFSA mandate with the title of the influential FAO-World Bank publication on "Farming Systems and Poverty: Farmers' Livelihoods in a Changing World". For more information visit www.fao.org/farmingsystems/pdf/IFSA_18_announcement.pdf , or contact Dr. John Dixon at john.dixon@fao.org

ICESC - 2005 (Singapore)

5-8 September 2005

The conference in Singapore will focus on all aspects of hydroponics (soilless culture) and will have feature sections on aquaponics, urban aquatic farming and organic hydroponics. The aim of ICESC-2005 is to create awareness about the increasing

importance of hydroponics and its associated aquaponics. For details about registering or participating visit www.icesc-2005.com or write to Dr. Mallick at icesc2005@singaporehydroponics.com

Training Course on Urban Agriculture in the Middle East and Northern Africa (Beirut, Lebanon)

4-26 September 2005

Food production inside and around urban areas is an ancient activity in the Middle East and North Africa (MENA) region. Urban agriculture in the MENA countries is at present a highly varied and widespread activity, yet it endures for the most part without recognition by planners, agriculturists, policy makers, researchers – even by its practitioners. After successful training events in Africa and Latin America, this year a Regional Training Course will take place in the Middle East and North Africa. This event is organised by the Environment and Sustainable Development Unit of the American University. Complete information about the training course and registration details are available on the web site www.ecosystems.org For additional information, please write to the course coordinator, Joe Nasr, at joenasr@compuserve.com or the course facilitator, Eng. Ziad Moussa at zm13@aub.edu.lb

IUFRO World Congress (Brisbane, Australia)

8-13 August 2005

The 22nd International Union of Forest Research Organizations (IUFRO) World Congress will be held 8-13 August 2005 at the Brisbane Convention & Exhibition Centre. The theme for the 2005 Congress is Forests in the Balance: Linking Tradition and Technology. For more information contact iufro2005@ozaccom.com.au or visit www.iufro2005.com

Fourth Training Programme on Urban Rainwater Harvesting

13-16 June 2005

The Centre for Science and Environment has launched its training programme on Urban Rainwater Harvesting as part of the Anil Agarwal Green College, which is currently being set up. The training course will cover, among other issues, the urban water setting, case studies of four Indian cities, rainwater harvesting systems, impact assessment, policies. The registration form is available online at: www.cseindia.org/misc/rwh_course.htm

IOBB is organizing the Internet Conference on Biotechnology and Bioengineering in Africa (http://www.iobbnet.org/icbb-africa) which will have 3 e-symposia.

* E-Symposium on Biological Nitrogen Fixation
  http://www.iobbnet.org/drupal/forum/84
* E-symposium on Economic aspects on the use of Biotechnologies and Bioengineering in Urban Agriculture by African Households
  http://www.iobbnet.org/drupal/forum/102
* E-Symposium on Phytoremediation and Water Purification
  http://www.iobbnet.org/drupal/forum/100

All participants are recommended to create their user accounts at www.iobbnet.org (if you dont have one already) and then send a request to et-w7 @ segate.sunet.se for write permissions so that you can write comments and even upload images. Please goto http://www.iobbnet.org/icbb-africa for more information, or register at..http://www.iobbnet.org/drupal/user/register

The 6th European Biennial of Towns & Town Planners (Copenhagen, Denmark)

9-11 June 2005

A unique example of new border-crossing regional and urban collaboration networks,
The Biennial will be held as a large conference with exhibitions, lectures, multimedia presentations, etc., to discuss creative cities. The conference will be organised around three sub-themes: European Cities - Challenges in a Global World; European City Life and Living; Planning the Future European City. For more information visit www.cityliving-livingcity.org/ or www.planum.net/showspace/6thbiennial.htm

Urban Green Days 2005 (Europe)

31 May – 5 June 2005

European cities and towns have responded once again to the European Commission's invitation to celebrate the annual Urban Green Days. Urban Green Days is an initiative that takes place each year during May and June, in conjunction with Brussels European Green Week (31 May-3 June) and the UN World Environment Day (5 June).. For more information on Green Week, visit http://europa.eu.int/comm/environment/greenweek.

Agricultural and Horticultural Aspects of Ecological Sanitation - Post-Conference Seminar (Durban, South Africa)

27 May 2005

The seminar was organised by Sida through EcoSanRes (www.ecosanres.org) in cooperation with CSIR (www.csir.co.za). The purpose of the seminar was to bring together persons with experience and/or interest in the reuse of urine and faeces for crop production, with a focus on networking and exchanging experiences on demonstration activities that promote reuse. For more information please visit www.buildnet.co.za/ecosan

Urban Forests: A different trademark for cities and forestry (Celje, Slovenia)

9-13 May 2005

The 8th edition of the EUFORIC/IUFRO European Forum on Urban Forestry (EFUF) was hosted by the Slovenian forest service and the city of Celje. The forum provided once again a very successful platform for European scientists and practitioners within urban forestry and urban greening to meet each other and exchange ideas. More information, including a summary of the main findings, will be available shortly at: www.efuf.org
Next year's forum will be organised in Florence, Italy.

CABERNET 2005 - The International Conference on Managing Urban Land (Belfast, Northern Ireland, UK)

13-15 April 2005

The International Conference on Managing Urban Land was organised by CABERNET (Concerted Action on Brownfield and Economic Regeneration Network www.cabernet.org.uk), Laganside Corporation (www.laganside.com) and the University of Nottingham, UK. The aim of the conference was to share "good practice" experience, problem-solving

Events

knowledge, and the application of new techniques and tools. For more information visit: www.cabernet.org.uk/conference2005

E-Symposium on "Economic aspects of the use of Biotechnologies and Bioengineering in Urban Agriculture by African Households"
1-30 June 2005
This e-symposium focuses on how African households use biotechnology and bioengineering methods in urban agriculture to increase income generation and to ensure their food security. The e-symposium has been organised so that you can interact with the authors of seven papers, which cover technological, economic and public policy aspects of urban agriculture in Africa. A second parallel activity of the e-symposium focuses on the end-users. It is being organised by the International Organization for Biotechnology and Bioengineering www.iobbnet.org

International Seminar: Building Sustainable Cities (Mexico City, Mexico)
28-30 April 2005
For more information on this fourth assembly of the Latin American network on urban agriculture visit www.ipes.org/aguila/

Third Urban Research Symposium on "Land Development, Urban Policy and Poverty Reduction" (Brasilia, DF, Brazil)
4-6 April 2005
This event was organised jointly by The World Bank Institute of Applied Economic Research and IPEA, Brazil. The conference took a long-term perspective on urban development as it relates to poverty reduction and economic growth both at the local and national level. See: www.worldbank.org/urban/symposium2005/

Emerging Issues Along Urban/Rural Interfaces: Linking Science and Society (Atlanta, Georgia, USA)
13-16 March 2005
This meeting highlighted approaches that focus on integrating socioeconomic and ecological research. See for more details: www.sfws.auburn.edu/urbanruralinterfaces/

Effective Land-Water Interface Management for Solving Agriculture-Fishery-Aquaculture Conflicts in Coastal Zones (Bac Lieu, Vietnam)
1-3 March 2005
Results from the conference contribute to the Comprehensive Assessment of Water Management in Agriculture (http://www.iwmi.cgiar.org/assessment)
For more information contact Dr. Chu Thai Hoanh, IWMI, cthoanh@cgiar.org or Dr. Mark Prein (WorldFish), m.prein@cgiar.org.

News and Partners

PRODWAT
The PRODWAT thematic group was established in 2003 in order to contribute to the reduction of poverty and increased gender equity through the better recognition of productive uses of domestic water supplies, and the improved delivery of multiple use water services at the household level. PRODWAT thematic group provides information on productive uses of domestic water and the provision of multiple use water services on its portal website http://www.prodwat.watsan.net/. The PRODWAT Case Study Award is open to researchers, practitioners and students working in the South on a theme within the areas of interest of the PRODWAT group. The AWARD of €1000 will support further research on the best case study submitted to the PRODWAT website.

KAMPALA ORDINANCE TO PROMOTE AQUACULTURE
Kampala City Council has budgeted Shs7 million to sensitise women and the youth to the importance of urban farming. KCC will encourage fish farming and educate communities near landing sites on proper fishing methods and marketing. The Secretary for Social Improvement, Ms Winnie Makumbi, said that "we want to create jobs, fight food insecurity but at the same time protect the environment. The Kampala City Council is targeting the youth and women first". The KCC passed the Kampala Urban Agriculture Ordinance that allows residents to plant crops and rear animals in their yards. For more information visit
http://allafrica.com/stories/200505100811.html

WORLDFISH CENTER PROMOTION IN MALAWI
WorldFish Center researchers have been working on the use of Integrated Aquaculture-Agriculture (IAA) technologies, systems of farming that support the recycling of nutrients by growing fish alongside conventional cropping regimes. In Malawi, WorldFish has been undertaking basic field research and helping to implement these IAA technologies since the mid-1980s in cooperation with the Department of Fisheries. On a national level, total annual fish production from all fish ponds combined has increased more than ten times, from 90 to more than 1,000 tonnes per year. These results from Malawi are very positive, and the new IAA technologies are now also being adopted by Cameroon, Mozambique and Zambia. For more information visit
www.cgiar.org/enews/march2005/story_05.html#

Workshop on Multi-stakeholder Action Planning and Policy Making marks start of RUAF second phase

In the last issue of UA Magazine (December 2004), we informed you about the approval of the second phase of the RUAF programme by the Netherlands Ministry of Development Cooperation. Meanwhile IDRC has also committed its support for the next four years of **Cities Farming for the Future (CFF)**, as the second phase is called.

The RUAF partners met in the Netherlands in April for a two-week start-up workshop and subsequent coordinators meeting to officially kick off the new phase and prepare for the first year of the CFF programme.
In the new phase the emphasis will be on capacity development and on facilitating policy formulation and action planning on urban agriculture. To that effect, in each of the RUAF regions (Latin America, Francophone West Africa, Anglophone West Africa, Southern and East Africa, South and Southeast Asia, China and possibly a renewed initiative in the Middle East and Northern Africa) 3-4 pilot cities have been selected, 20 in total, which have shown a commitment to integrate urban agriculture into their local policies and planning. It is in these pilot cities that RUAF-CFF will concentrate its main activities in the coming four years, including training of local stakeholders, provision of support for local diagnosis and participatory action planning, and monitoring of changes in policies and actions of local stakeholders, focusing particularly on impacts these have on the livelihoods of the urban poor. Aside from technical and training support each pilot city will receive some matching funds for one or more small pilot projects. In each of the pilot cities a multi-stakeholder working group will guide and facilitate the action research and planning process. For an overview of the selected cities see the box below. In addition, 6-10 dissemination cities have been selected in each region, 46 in total, that will participate in certain capacity development activities, policy seminars, and in the exchange of the results with the pilot cities. RUAF will also continue its networking and information dissemination activities, particularly through the regional resource centres on urban agriculture and food security.

The Start-up workshop focused mainly on the methodological aspects of the RUAF-CFF programme, especially the training of local stakeholders and the facilitation of the multi-stakeholder processes for action planning and policy design. Representatives of the international and regional RUAF partners as well as representatives of local partners from pilot cities participated in the workshop. Different aspects of urban agriculture, policy development, project formulation and monitoring, gender, and other relevant issues were discussed, and at the end of the two weeks each regional group presented their draft work plan.

We will be sure to keep you informed of our progress in following issues of *UA Magazine* and on the RUAF web site. . If you would like more information on the workshop or on the Cities Farming for the Future Programme you are advised to visit the RUAF web site www.ruaf.org

René van Veenhuizen

RUAF-CFF Cities

Region	Pilot Cities	Dissemination Cities
China	Beijing, Fushun, Yuncheng	Shanghai, Guangzhou, Shenzhen, Jinan, Wuhan, Xi'an, Chengdu, Kunming, Handan, Tangshan, Benxi Datong, Linfen, Xingtai Banshan
S-SE Asia	Hyderabad, Bangalore, Kathmandu	Coimbatoire, Bangalore, Mehsana, Pune, Indore Jaipur, Bhaktapur, Dhaka, Faislabad, Bangkok
SE Africa	Bulawayo, Lusaka, Maputo	Mutare, Kabwe, Manhica, Msunduzi , Gaberone, Lilongwe, Blantyre, Manzini, Dar es Salaam, Addis Ababa
W Africa (Anglophone)	Accra, Ibadan, Freetown	Kumasi, Tamale, Lagos, Jos, Banjul, Bamenda
W Africa (Francophone)	Pikine-Dakar, Cotonou, Ouagadougou	Porto Novo, Bobo Dioulasso, Nouakchott, Niamey, Conakry Bamako, Yaounde, Kigali
Latin America	Lima, Neiva, Guanilhos, Guatemala City	Villa El Salvador (Lima), San Juan de Miraflores (Lima), Quetzaltenango, Bogota, Santa Maria, Cotacachi, Montevideo, New Amsterdam, Panama, Mar del Plata, Maracaibo
Middle East and Northern Africa (in preparation)	Istanbul, Beirut, Amman, West Bank Palestina (among other options)	To be selected

Forthcoming Issues

The second phase of the RUAF programme started in January 2005 under the title: **Cities Farming for the Future**. The RUAF partners decided, in their meeting in April 2005, to publish two issues of the *UA Magazine* each year as well as a series of regional and international working materials. Thus, in addition to the current issue, one more regular issue will be published this year (see below). The RUAF partners have also decided on a list of issues to consider for the forthcoming year, and of course you are cordially invited to start submitting your contributions

No. 15: Multifunctional Land Use: building food secure neighbourhoods

November 2005

Deadline for submissions is 15 September 2005.

Growing cities that are expanding their borders and absorbing rural areas have to cope with the diversity of claims of their citizens. In many of these cities urban policy makers and planners still view the surrounding rural areas merely as a reserve for future expansion. But modern urban policy makers and planners have come to realise the importance of open green spaces in and around the city for a variety of urban needs. They realise that such urban open spaces, and the farmers who live in them, are crucial not only for securing a daily supply of fresh perishable food (e.g. vegetables, milk, meat) but also for creating a better urban living environment that provides opportunities for citizens' leisure and sports and a connection to the rural and natural environment (so that their children can know where milk comes from, for example). Municipal authorities in developed countries as well in developing countries have come to understand the role urban and periurban farmers can play in maintaining green zones in the city, keeping areas that are less suitable for building (like flood plains) free from construction, managing parks and periurban areas that hold important natural resources, etc. Likewise, innovative farmers in and around cities are increasingly aware of the needs of the urban population and have started to come up with creative responses to the city dwellers' demands by offering recreational services to urban tourists (lodging, meals, participation in farm work, horse riding, guides), food and educational services to schools (school milk/meals, environmental education), health services (on-farm care and remedial activities for people with psychological or physical problems), and nursery facilities that grow ornamental plants and tree seedlings for urban home gardens, streets and parks.

As a consequence, in the open urban spaces of such cities the traditional agricultural function of food production is combined with other functions of importance to the city and the citizens, which has been labeled **multi-functional land use**.

We welcome your contributions describing examples of multi-functional land use, the diverse functions of urban open spaces, innovative planning and design approaches, new alliances among farmers and other stakeholders, financial mechanisms to realise such multi-functional use and lessons learned regarding the management of such multi-functional open urban spaces.

A call went out already last year for this theme but the issue was cancelled last year due to the ending of RUAF phase 1. Those of you who already submitted an article will be notified and your article will be considered for this new issue.

Future issues of *UA Magazine*

Thanks to the limited but sufficient number of responses we received to the question posed in the last issue: "What are the major topics or questions that you would like to see discussed in *UA magazine* in the coming years?", as well as the contributions of the RUAF Regional Partners regarding what themes they would like to see addressed in the future, we have been able to plan the following three future issues of *UA Magazine*.

2006

16: Policies, Norms and Regulations (which will focus on the World Urban Forum 2006 in Vancouver, Canada)

17: Optimisation of Water Use for Urban Agriculture: collection, storage, nutrients, treatment, etc.

2007

18: Micro-enterprise development, processing, marketing and farmer organisation: the role of private initiatives and involvement.

Topics for special materials and possible future issues:

HIV/Aids and urban agriculture; Institutions; Children and Youth; Health and Food Security; Education; and Economic Impacts.

We welcome articles on urban agriculture that consist of approximately 2,500 words (three pages), 1,700 words (two pages), or 800 words (one page), preferably accompanied by an abstract, references (maximum of 5), figures and digital images or photographs of good quality. The articles should be written in a manner that is readily understood by a wide variety of stakeholders all over the world. We also invite you to submit information on recent publications, journals, videos, photographs, cartoons, letters, technology descriptions and assessments, workshops, training courses, conferences, networks, web-links, etc.

Urban Agriculture Magazine

URBAN AQUATIC PRODUCTION

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The **RUAF Partners** are
* Latin America: **IPES** Promoción del Desarrollo Sostenible, Lima Peru; email: au@ipes.org.pe; **Magazine in Spanish**: www.ipes.org
* French Speaking West Africa: **IAGU** Institut Africain de Gestion Urbaine, Dakar, Senegal; email: moussa@iagu.org; **Magazine in French**: www.iagu.org
* English Speaking West Africa: International Water Management Institute, IWMI-Ghana; email: o.cofie@cgiar.org
* East and Southern Africa: **MDP** Municipal Development Partnership (MDP); email: smushamba@mdpesa.org
* South and South East Asia: International Water Management Institute, IWMI-India; email: r.simmons@cgiar.org
* North Africa and Middle East: American University of Beirut, email: zm13@aub.edu.lb; **Magazine in Arabic:** www.ecosystems.org/esduhomepage.php
* China: **IGSNRR** Institute of Geographical Sciences and Natural Resource Research of the Chinese Academy of Sciences; email: caijm@igsnrr.ac.cn; **Magazine in Chinese:** www.cnruaf.com
* Coordination and Support: **ETC Foundation**; email: ruaf@etcnl.nl; **Magazine in English:** www.ruaf.org

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