

Food, incomes and urban waste water treatment in Phnom Penh, Cambodia

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Phnom Penh, the capital city of Cambodia, is surrounded by wetlands into which over 1 million m³ of the city's household waste water and storm water are discharged daily (Muong, 2003). Numerous cultivated plots located within and around these peri-urban wetlands utilise the waste water to cultivate edible aquatic vegetables that help to supply the city's food demand as well as other areas of Cambodia (Khov et al, 2005).

Boeung Cheung Ek (BCE) Lake is the largest of these water bodies, covering 3403 hectares of land 5 km South of the city centre. The lake receives 80% of the waste/sewage water from the city along with untreated effluent from 3000 small and large scale industrial enterprises. The lake is an effective, low cost means of biological treatment of the city's waste water through its aquatic vegetable production, capturing and re-utilising valuable nutrients (nitrogen and phosphorous) that otherwise would have been lost from the discharged urban waste water (Dalsgaard 2006). People who are living around the lake produce several types of aquatic vegetable, particularly water spinach (*Ipomoea aquatica*) and to a lesser extent water mimosa (*Neptunia oleracea*). Growing aquatic vegetables has been practiced in this lake since the 1960s when it only involved a few families settling near the lake. As food such as fish and other vegetable crops were readily available the villagers were not concerned about cultivation. When citizens were forcibly evacuated to the countryside for rice production during the Pol Pot regime (1975-1979) and resource utilisation was strictly prohibited, most of these resources were abandoned. After the regime people came back to the villages around the lake and started growing paddy rice. By the late 1980's more families had abandoned rice farming in order to cultivate aquatic

vegetables, particularly water spinach, when they could see more market demand and higher prices for aquatic plants (40% of all vegetables consumed in Phnom Penh are water spinach). These people realised that growing techniques were relatively simple and aquatic vegetables could be cultivated year round in the surrounding wetlands by using low cost or free resources such as urban domestic wastewater as the primary source of nutrients (RUA/UOS, PCA, 2004).

Production of water spinach on the BCE Lake

Water spinach is the most common species grown in BCE Lake in terms of aquatic vegetable production. The plants/vegetables are grown attached to a rope network floating on the surface of the lake. This production requires relatively easy growing techniques with lower labour costs compared to other cultivated plants (Papussa Aquatic Plant Growing Manual, 2005).

The farmers can begin to harvest the newly grown plants just 3 to 4 weeks after transplanted, when the propagated branches and leaves reach the preferred market size (around 50 cm long). The growers generally harvest their plants every day, rotating over a 2-3 week period due to rapid re-growth of the stems. Each household (HH) can harvest between 100 – 300 kg per day depending on farm size and labour available. Pesticides and chemicals are currently heavily applied by the farmers after each harvest to protect the plants from pests and stimulate the fast growth and good looking appearance of the plants.

Estimated annual production of water spinach in 2003 was on average 7.4 tons per household with the associated average yield being approximately 5 tons/ha/year (Khov et al, 2006). Most of the growers tend to produce between 5 to 10 tons of water spinach per year within an average 5000m² plot from which they can earn between 350 to 700 US\$ per household per year. This compares favourably with average rural and urban (Phnom Penh) household incomes of

197 and 691 US\$ per annum respectively (NIS, 1999). Water spinach producing households are often involved in other diverse income earning activities such as fishing, small scale shop and market trading, working in garment factories, construction work, and motorbike taxis, which help them to maintain and in some cases improve their livelihoods in the competitive and dynamic urban environment.

These aquatic vegetable production systems

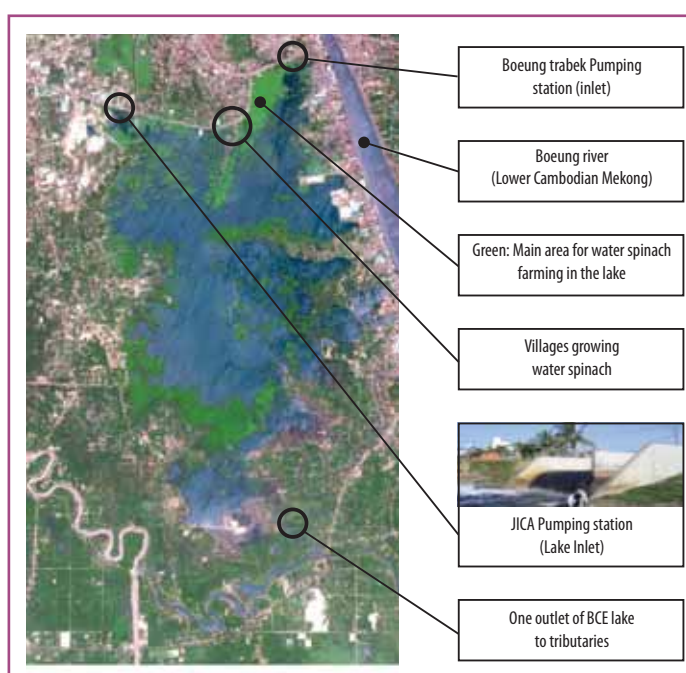


Figure 1. Satellite/GIS image illustrating encroaching urbanisation, inlets and outlet and main water spinach growing areas of Boeung Cheung Ek Lake

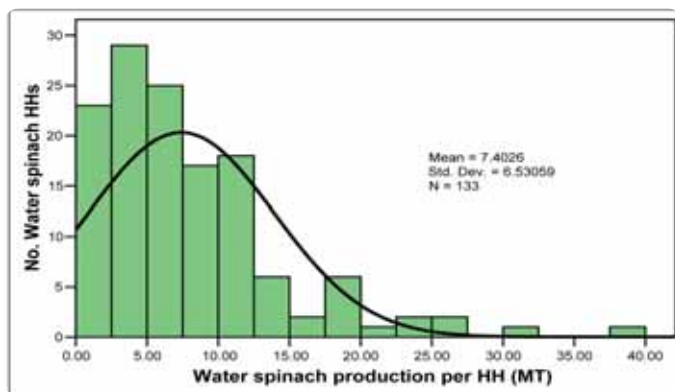
in peri-urban Phnom Penh provide many benefits, not just incomes for producers and low cost waste water treatment, but also the associated employment and income earning



Figure 2. Considerable quantities of water spinach are grown in the waste water fed Boeung Cheung Ek Lake

opportunities for the many seasonally hired labourers engaged in setting up, maintenance and harvesting of the plants. Once harvested there is a further chain of persons involved in the transportation, marketing and sale of the plants before they finally reach the consumer (Leschen et al, 2005). Production is often a family affair with household labour, often unpaid, commonly involved in regular maintenance of the plants.

One adult can harvest 50 to 100 bunches of water spinach per day for which they can earn 5000-10000 riels (1.25-2.5 US\$). Demand for labour is greatest during the peak season of plant production (May to July) when the cultivation area of plots on



the lake is at its highest. When extra time is available household members also work as paid labour for other household's plots with their earnings based on the number of bunches harvested, as mentioned earlier. Since much of the additional labour required is seasonal, migrants come to stay within the farmer's household during harvest time and return to their own provinces when labour for rural paddy farms is needed. However some of these employees diversify and supplement their incomes with other occupations whilst in the city such as construction work, motorbike taxis and loading labour.

Note: Water spinach is sold in bunches in the market. 1 bunch weighs 0.5 to 0.7 kg and varies in price from 200-400 riel (0.05-0.1US\$) per bunch depending on quality and season. (1US\$= 4215 riel)

Public health concerns

Skin conditions were the most commonly recorded occupational health problems, with the affected farmers perceiving that their condition was caused by being in daily contact with waste water. Contact dermatitis was the most common diagnosis by the dermatologist who examined referred patients from the Papussa occupational health study, the main symptoms being



Figure 3. Bunches of water spinach being transported to nearby markets. Local producers often live in elevated wooden houses on the fringes of the lake

itching, papules and dry skin. Body parts most affected were the hands followed by feet, legs, arms and the torso. However from our survey it is still uncertain what the possible longer term, chronic occupational health conditions might be related to working with waste water.

Food safety studies within the Papussa project indicated that toxic metal levels present within water spinach tissues grown in the lake constituted a low risk for human consumption (Dalsgaard et al 2006). However elevated levels of thermotolerant coliform *E.coli* and protozoans (*Giardia*,

Cryptosporidium and *Cyclospora*) were found in plants located close to the waste water inlets, constituting a potential risk to consumers if the water spinach was not well washed and cooked before consumption. Our results indicate that joint management and production zoning procedures within the lake, coupled with consumer food safety awareness campaigns would contribute considerably to reduce food safety risks for consumers.

Administration of water spinach production in Boeung Cheung Ek Lake

More than half (62%) of water spinach producers in BCE Lake rent their plots in the lake from either other local households or an absentee landlord in the city. Farmers prefer to have short term leases, mainly for the length

of one growing season, as they try to avoid the risk of a break in production during the months of the highest flooding levels when production levels, and thus income, drop.

Greater access to micro-credit is increasing credit use amongst agricultural producers and other small business enterprises, with more than half of the water spinach producers in BCE Lake taking credit when they require capital at the beginning of their production cycle for renting the plots and buying the necessary inputs for production. NGO micro-credit schemes and private lenders are the most popular for people to turn to for provision of credit.

Future of water spinach production in BCE Lake

Rapid urbanisation and industrialisation can be seen as the main future threat for the continued production of aquatic vegetables in this large, peri-urban waste water fed lake. Many of the aquatic vegetable farmers have uncertain legal status in terms of the land they are both living and farming on. This brings limitations in their mid to long term plans for their production as they are increasingly concerned about government re-possession of the land/wetlands area for future urban development. Whilst many lower income households are living very much dependent



Figure 4. A farmer with contact dermatitis of the hand

on BCE lake, the municipality has set up a plan (Phnom Penh Strategic Orientation by 2020) to reduce by more than half the area of the lake to make way for a new industrial development, leaving around 1500 hectares for the continual treatment of the city's waste water. However, it is not clear whether and when this could happen - perhaps in 10 years time - depending on the financial capacity of the government or support from donors such as the Japanese International Co-operation Agency (JICA). Concerns are already being expressed if the reduced, narrower area of the lake as planned could serve as effectively in its capacity as a bio-treatment area for 80% of Phnom Penh's waste water as well as industrial and chemical effluents from the increasing industry located around the lake. Drainage, landfill and construction on such urban wetlands could also exacerbate the city's already severe problems caused by seasonal flooding. Another concern would

be the significant reduction in the supply of aquatic vegetables consumed on a daily basis by Phnom Penh's citizens. Finally the lake is a unique functioning example of multifunctional, integrated re-use of (waste) water within the confines and pressures of a rapidly growing Southeast Asian city, which is surely worth preserving. What will be the future in terms of the livelihoods of the many households currently living and depending on the lake and its capacity to provide income from aquatic vegetable production whilst also performing as a low cost, environmentally friendly bio-treatment facility for the city's waste water?

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Acknowledgment

This article is based on the results from the multidisciplinary household baseline and monitoring surveys of the European Union-funded Papussa project. The lead author would like to express a heartfelt thanks to the funding agencies and collaborative institutions, especially University of Stirling (UK) for all subsequent support. All correspondence to Kuong Khov k_kuong@yahoo.com. Further findings from the EC funded Papussa project can be found at www.papussa.org including a video (Sewage Farm) on the water spinach growers of BCE lake.

First Latin American & Third Mexican Conference on Culture of Native Fish Species

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Biodiversity is extremely rich in much of Central and South America and so uncontrolled introductions of exotic fishes, or any other species for that matter, are cause for concern. Many Latin American countries are facing up to this reality and, for example, in Chile (the biggest aquaculture producer in the region by far) biodiversity issues are already a prime consideration with introductions and translocations now being very tightly regulated.

Through a series of conferences associated with collaborative projects on the endangered pescado blanco *Chirostoma estor estor*, reported in Aquaculture News 31, Professor Lindsay Ross, Dr Carlos Martinez Palacios and partners have raised the profile of the need for sustainable aquaculture development while conserving and protecting indigenous species. These projects have received significant funding from the Darwin Initiative, who further supported the previously Mexican focused conferences that have now been broadened to include all Latin American countries. Hence between 18th and 20th October 2006, the First Latin American and Third Mexican Conference on Native Fish Species for Aquaculture were jointly held in the "Casa de Gobierno", Morelia, Mexico.

The meeting

The conference was extremely successful and was attended by approximately 100 researchers. A series of 10 talks by invited keynote speakers from Mexico, Cuba, Brazil, Argentina, Chile, Japan, Canada and UK was interspersed with 24 selected experience papers from across the continent covering a wide range of species and subject areas. In order to reach as wide an audience in the continent as possible, both during and after the conference, almost all talks were given in Spanish or in "Portuñol".

The first half of the meeting explored the wide variety of Latin American marine species, with leading presentations by Dr Daniel Bennetti of the University of Miami, Dr Andrei Sampaio of the Universidade do Rio Grande do Sul, Brasil, and Dr Luis Lajonchere, CIAD, Mazatlan, Mexico.

The second half of the meeting focused principally on freshwater species, with leading presentations by Dr Phil Scott of Universidade Santa Ursula, Rio de Janeiro, Dr Carlos Strussman of the University of Fisheries, Tokyo, Dr Gustavo Somoza of IINTECH Argentina, Dr Roberto Mendoza of Universidad de Nuevo Leon Mexico, Dr Alfonso Mardones of Universidad de Temuco Chile and Dr Carlos Martinez of INIRENA Mexico.

Dr Alfonso Mardones gave a superb summary of the developmental work behind culture of Puye (*Galaxias*) in Chile, a small fish which commands a massive price in the international market (\$600/kg), leading on to a wide ranging consideration of other native species in the region.

Prizes were award for the best student posters, judged by four of our invited speakers. The first prize was divided between Lidia Ambriz Cervantes (INIRENA-UMSNH) and F.Ribeiro (UFSC-Brazil).

Day four brought the meeting to a close with a relaxing field visit to our pilot farm and demonstration site at Ichupio, Tzintzuntzan, where a trial netting assured us that our fish were doing well. To everyone's delight, the family prepared a huge lunch of fried charales (small Atherinids) with fresh hand-made tortillas accompanied by fresh salsas and chillies.

The future

Staging this conference has had the major effect of focusing the interest of many key people on the issues of the Convention on Biodiversity (CBD), use of native species in aquaculture development as well as use of aquaculture as a powerful tool to maintain biodiversity and livelihoods. The pressure on nations to comply with CBD is also giving a strong impulsion to indigenous species development, even extending to changes in the law regarding importations. There could be many species currently under threat, even extending to extinction, and a reconsideration of the effects and future role of aquaculture linked to conservation is timely. The approach of the present Darwin Initiative project has given a lead to many workers who need to contend with this new situation.

The event has already spawned further meetings on native fish species for aquaculture in Brazil, Argentina and Chile as well as the strong prospect of a series of biennial pan-Latin American meetings to follow up this one. This is a very significant measure of success for the DI project and the timeliness of our original concept.

The conference website has been transformed into a reporting and linking point for all interested in this vital topic; see: <http://www.aqua.stir.ac.uk/GISAP/Conference/> where you will also find a full list of our sponsors.