

Wastewater Reuse in Aquaculture: Socially and Environmentally Appropriate Wastewater Treatment for Vietnam

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Hanoi, the capital city of the Socialist Republic of Vietnam, has a population of more than 1 million people, 40% of whom live in the old city which is served by a central combined wastewater and stormwater drainage system. The wastewater flows southwards by gravity to low-lying Thanh Tri district where it is treated by a traditional system: the nutrients in the wastewater are reused to grow fish, rice, and land and aquatic vegetables, which form a significant part of the diet of the city's people. The system has been developed mainly by the farmers of Thanh Tri district through

experience accumulated over the past 30 years. In 1960, this district was a sparsely populated swamp where rice was grown but with low yields. The rice crop was also frequently destroyed by flooding. Farmers began to experiment with wastewater-fed fish culture but fish yields were low: there was only wild fish seed from the river to stock the fishponds and the flows of wastewater to and drainage water from the fishponds were inefficient. During the 1970s, the canals were deepened and pumps were installed to supply wastewater to fishponds and ricefields, leading to the evolution

of the large-scale system in operation today.

There are no large, conventional, wastewater treatment plants in Hanoi. The daily discharge of 320,000 m³ of wastewater flows by gravity to Thanh Tri district where it is treated by the agriculture-aquaculture reuse system. The area is dissected by the Kim Nguu and the To Lich Rivers which drain the wastewater from the city. The wastewater is pumped from these rivers into concrete channels which distribute it to fishponds and fields. As it flows through these farms it is treated and reused before being discharged into the Nhue

River. Analyses of biological oxygen demand (BOD₅) indicate significant reduction with distance along the Kim Nguu River from which wastewater is repeatedly withdrawn and discharged for reuse. In 1994, the BOD₅ fell from 90 mg/l at Lo Duc Sewer at the head of the system in municipal Hanoi to 8 mg/l at Phap Van near the Nhue river in the dry season. Visual observations have confirmed these scientific measurements, demonstrating a high wastewater treatment efficiency of the system.

Wastewater is reused and treated in four main types of farming: fish culture in 200 ha; rotation of rice and fish culture in 400 ha; land vegetables; and aquatic



Wastewater after treatment in fishponds.

PHOTOS BY PETER EDWARDS, AIT



Cultivation of land vegetables.



Employment of women in vegetable cultivation.

vegetables. The farmers have learned by experience to regulate the amount of wastewater pumped into their fishponds. The black, deoxygenated wastewater from the rivers mixes with and fertilizes pond water, which becomes green as it produces plankton upon which the fish feed. Green water is ideal as this indicates a productive and healthy environment for fish. If the pond water becomes clear, the farmers pump large volumes

of wastewater into their ponds but they avoid pumping too much wastewater which would lower the dissolved oxygen and raise the concentrations of ammonia, which would kill the fish. Yields of 5-8 t of fish (e.g., silver carp (*Hypophthalmichthys molitrix*), rohu (*Labeo rohita*) and tilapias are harvested annually per hectare.

Farmers rotate rice and fish in shallow ponds located at a distance from the rivers

where the supply of wastewater is insufficient to culture fish in the dry season. Fish yields of 4-5 t and rice harvests of about 3 t/ha/crop are harvested from these sites. Vegetables such as cabbage and kale, and aquatic macrophytes such as water spinach, are irrigated and fertilized with wastewater throughout the area.

The systems provide: employment for farmers in Thanh Tri district and for wholesalers and retailers of fish, rice and vegetables in municipal Hanoi; relatively cheap food for poor consumers in Hanoi (about 4 500 t of fish annually: 40-50% of the total fish supply for municipal Hanoi; a low-cost system to efficiently treat wastewater; and a healthy environment in the suburbs of Hanoi which acts as a 'lung' for the city.

A pamphlet on this system has been produced by the Hanoi Sewage Fish Group, a multidisciplinary group of researchers from:

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- Hanoi University, Department of Environmental Engineering;
- Hanoi University of Civil Engineering;
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