are also of interest, where tilapia consumption has moved beyond these three niche markets and become more mainstream. This secondary data analysis will be followed up with interviews and focus groups of consumers and producers in the next few months, developing a detailed understanding of consumer perceptions and attitudes towards seafood products, food and organic aquatic food products. Health, welfare, environmental and sustainability impact analyses are also underway, developing an evidence base of current knowledge in respective areas which will be further developed when combined with evidence from technical trials.

The first round of technical trials (Phase 1) are underway, assessing tilapia growth rates and water quality with various stocking densities and feeds in a sustainable dark-water system (as opposed to the conventional energy-intensive, fish meal based, clear water recirculation system). Trials with our commercial partners will be based on the outcomes of these and are scheduled to commence later this year. Tilapia welfare and microbiological trials are scheduled for early 2006. Phase 2 laboratory and commercial trials are scheduled for late 2006 using results from all previous trials to refine the technology and assess the practicality of sustainable tilapia farming in a commercial base.

The health, environmental and sustainability impact analyses will be on-going throughout the three year duration. Marketing efforts will continue to focus on consumers and organic potential, examining tilapia acceptability and appropriate market positioning through tasting sessions and interviews with producers and retailers. Year 3 will focus mainly on dissemination, and tilapia production trials with interested farmers may be undertaken.

Our RELU project web page, http://www.aquaculture.stir.ac.uk/Systems/TilapiaProject.htm, has further details of the project and team members. Further questions on our research programme are welcome through the above website or f.j.murray@stir.ac.uk or Kathleen.grady@stir.ac.uk The RELU Programme web page, which details the programme rationale as well as information about other RELU projects, can be accessed at www.relu.ac.uk. Our commercial partners in Stirling can be found at http://www.pisces-aqua.co.uk/ while Fresh Water Fish Farms Ltd in Devon is currently undergoing website development.

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High dykes in the Mekong Delta in Vietnam bring social gains and environmental pains

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Changes to agricultural technology and an increase in population over the past thirty year have led to significant changes in water and land management in the Mekong Delta, Vietnam. Parts of the delta are now completely protected from the annual flood by systems of high dykes and farmers living inside them are able to cultivate three or more crops per year, as well as raising cattle and aquaproducts. High dykes have brought some economic gains, some environmental disbenefits but also some so-far unrecorded social gains. This short article reports preliminary findings from fieldwork carried out with staff from An Giang University (AGU) between 2002-04. It begins by setting out the changes that have taken place in the delta in the past 30-35 years. It describes some of the advantages and disadvantages of high dykes and suggests how the gains might be maintained while some of the disadvantages might be reduced.

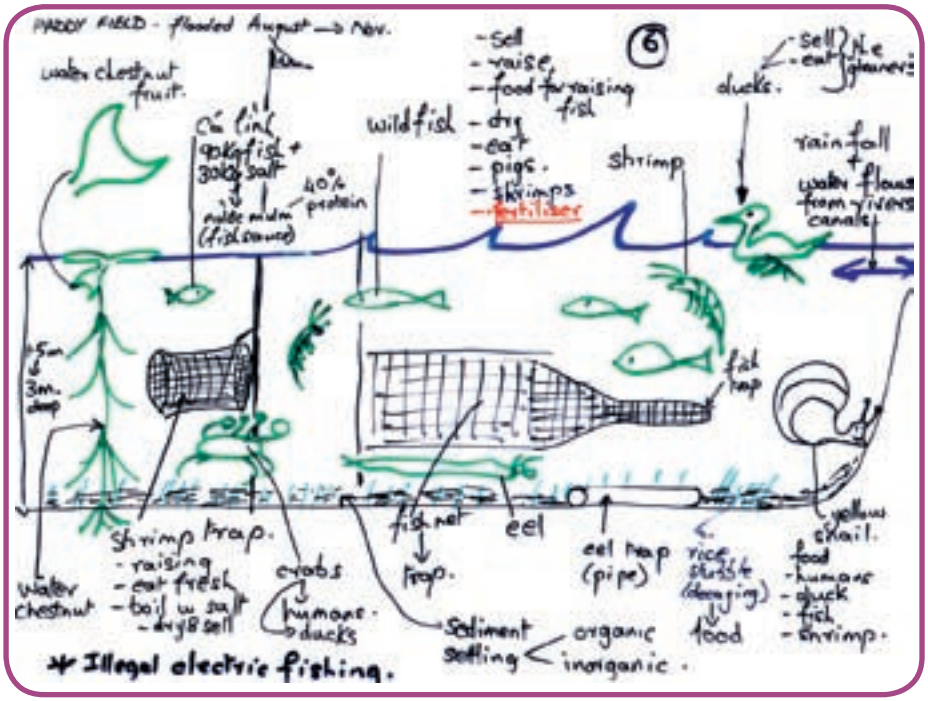

Figure 1. What a flooded paddy field provides.

The Mekong Delta lies in the tropical monsoon belt. It has an area of some 6 million hectares, two thirds of which lie in Vietnam, the remainder in Cambodia. The monsoon rain occurs between June and December and for part of this time much of the delta is covered with flood water. At the back of the delta, near the border with Cambodia, this rainwater is added to by water flowing out of rivers and canals and over the land. In some places in An Giang province at the back of the delta, low-lying areas of land are inundated by 2-3 metres of water for three or four months from August onwards. Each cubic meter of river water contains up to half a kilogram of sediment, silt and organic matter. This natural fertiliser and soil has built the delta

and made its soil fertile. However, in many places in the delta the soils are potential or actual acid sulphate and at the coast saline water intrudes into the delta with each tide. Both of these factors have a negative effect on the cultivation of rice.

Since the 1980s Vietnam has moved from being a net importer of rice to become the world's second largest exporter of rice. Today the Mekong Delta is Vietnam's rice basket. It produces more than half of the country's rice, as well as large quantities of fruit, vegetables and cultivated and wild aquaproducts. This has happened at a time when consumption at home has increased as well. The population is still rising but people have more rice to eat. How did this happen? Up until the late 1960s Vietnam relied on many varieties of flooding rice. Here the farmer sows seeds by broadcasting them onto the ground near the beginning of the rainy season, the seeds germinate and the plants grow upwards, keeping pace with the rising level of the flood water. Later the plants flower, seeds form and when the floods go down the plants are harvested off the ground. This produces one or two tonnes per hectare, it takes six months to grow and only one crop of rice is harvested each year. However, there are few inputs and farmer's costs are low.

Since the late 1960s Vietnam has undergone an agricultural revolution. In the 1960s rice breeders at the International Rice Research Institute (IRRI) in the Philippines began to produce the 'IR' strains of rice, such as IR5 and IR8. Research scientists in Vietnam adapted these for local conditions and they were available in Vietnam from the year 1966[i]. These plants are short stemmed, take ninety to one hundred days from sowing to harvesting and are high yielding (5 tonnes per hectare is normal, 8 tonnes is not unusual). The big difference is that these rice plants are grown by irrigation during the dry season. To do this dykes have been raised around the fields. Originally this was done to keep irrigation water inside the fields, but it served a second purpose as well: at the start of the flood season in July and August the dykes delayed the entry of flood water into the fields, thus extending the end of the growing season. In 2004 a group of farmers in Cho Moi, a district of An Giang

Figure 2a. Fisherwoman with traps for eels in flooded land

Province, told me how in 1978 their rice crop had been under threat from the exceptionally early and severe floods that occurred that year. They were instructed to harvest the unripe crop, but instead of doing that they had torn up a section of an adjacent bank and piled it up onto the dyke. They raised their dyke not once, but twice, they saved that crop, but the long term effect was to be dramatic. Farmers refer to these dykes as 'August dykes'. From here the next step was to pump flood water out of the fields in December and then sow the first crop earlier. This enabled farmers to move from growing one crop of long duration, low yielding rice to two crops of short duration, high yielding rice in one year, or one of rice and a second crop of another kind. The banks of the dyke also provided a location for planting trees and building houses. Today (2005) there are probably less than 1,000 hectares of flooding rice left in An Giang Province[ii], where formerly it was the only technology available.

The problem for the farmer was that sometimes the second crop would be destroyed because flood waters would rise early and come into the fields before the crop could be harvested. In some parts of An Giang province this still happens today, but since 1996 the dykes have been raised further. These high dykes keep out all flood waters and allow a system of continuous cropping: three crops of rice per year, even seven crops in two years. Not only continuous rice, but other changes as well: fish can be cultivated without the need for the ponds to be given raised net walls to keep fish inside them during the floods; fruit trees can be grown in the fields with no risk of drowning

Figure 2b. Farmer with two-crop rice field within an August dyke

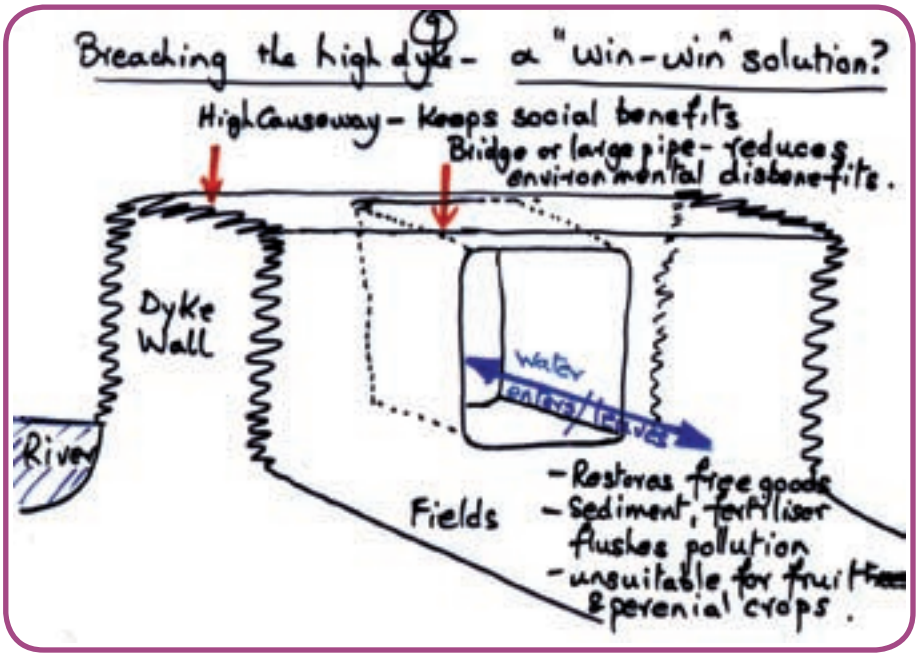

Figure 3. How farmers imagine an improved dyke would work.

in the flood season; cattle can be raised in the fields, thus reducing pressure for space on the banks. Most of all, farmers have year round crops and a steady income and landless people have paid employment as well.

A team of teachers from the Agriculture Faculty of An Giang University worked with me in 2004 to investigate the social effects of raising the dykes. Working with the People's Committee and using PRA methods, we carried out some group meetings to hear people's views about the high dykes. We asked the groups to use wealth ranking to help us to identify where people of different levels of wealth, different conditions of health and different levels of school attendance could be found. Afterwards we interviewed householders and heard their views, also the views of some health and school officials, although this part of the work is incomplete. We did this in one commune in Cho Moi district and in two other communes elsewhere in the province, one commune which had recently enclosed a small area behind a high dyke, the other where the building of a high dyke was under discussion.

In Cho Moi people reported some social benefits, but voiced concern about other effects, particularly on the environment, when all flood water is excluded from the fields:

- Education. Children's education gets a real boost, with school attendance improving; children stay in school longer and reach higher standards. In the flood season it is easier to get to school by road rather than by boat. Parents spend less time ferrying their children to school (a discouragement to attendance) and some parents reduce or stop seasonal migration to follow work, so their children's education is less broken. Parents' attitude to schooling is said to improve and the local government gives it a higher priority; and teachers are more willing to go and work there.
- Health. Formerly, diarrhoea was an issue in the flood season, but this has now reduced. However, sot xuat huyet (mosquito borne dengue fever) still remains a problem. Access to health facilities is easier along the top of the high dykes and more consistent family planning may be possible; parents can take babies to be vaccinated, whereas formerly health teams went to visit homes. However, there was widespread and general concern about exhaustion and a rise in the occurrence of high blood pressure, particularly among older people. One respondent stated that 40% of women and 60% of men over 60 years old suffered from high blood pressure. The rise in blood pressure is attributed by some to the increased use of pesticides. Nowadays farming is possible all year round, but this has taken away the traditional 'resting time' in the flood season and farmers report more stress and exhaustion. As the return from rice has dropped so the pressure to work harder has increased.
- Economic. There is more work available, but the family tends to get the benefit, rather than hiring in labourers. Farmers have diversified and have a wider range of produce to sell than before. Incomes have generally increased. However, yields have dropped and the need for fertilisers to maintain them has increased, pushing up costs. The margin between the cost of inputs and the return from selling the produce has narrowed and farmers need to work even harder and longer to maintain their income. However, transport is much better and they have better access to the market. Where formerly they might have had little choice of middlemen to sell their crops to, now they do. Poor and landless people may be worse off. Formerly, during the flood season they would go into the fields and catch wild fish to eat and sell, this no longer happens; the return from a day's labour is less than from a day's fishing. Fishing was their one opportunity to create a saving, but that has gone.
- Environment. The major change is that flood waters no longer flow into the fields from rivers and canals. This denies the ground its annual layer of silt and organic matter. There is an impression that the ground is now drier than before and 'exhausted'. Yields have gone down and to maintain them fertiliser use has doubled over recent years, e.g. in some cases from 25 kg/công[iii] to 50 kg//công. This is true for a wide range of crops, not just for rice. With the loss of flood waters the supply of wild fish and other 'free goods' into the fields has ceased. For example, formerly a small fish called ca linh was reasonably abundant in flood waters. It would be netted in large quantities and fermented with salt in large jars to produce a protein rich liquor called nước mắm, or fish sauce. Poor households would take this with rice, vegetables and a few small fish as their main meal. Richer farmers may not have made much use of this, but for poorer farmers and households without land this has been a serious loss. People are said to be eating less fish in their diet.

Further field work and analysis will be needed before definite conclusions can be drawn. However, there is a strong impression at this stage that there are gains in health and education from raising the level of the dykes and evidence that the initial economic gains are not sustainable. People are concerned about the greater use of chemicals than before and their impact on the soil, water and themselves. Among some people, including officials however, there was talk of the need to breach the dykes and allow floodwaters to return onto the land. Carrying this out would be challenging and would need to reconcile the needs of different interest groups. Rice farmers might benefit, but fruit tree growers would experience a loss. What is needed is some system that could retain the social benefits to health and education, while reducing the environmental disbenefits. A partial solution might be to breach the dykes in some places, but keep a series of causeways intact above the flood level. The benefits to education, health and transport could be maintained, while flood waters could restore soil fertility and provide access to free goods for poor people, as suggested in Figure 3.

Charles Howie formerly taught biology in Central Scotland. Since 1998 he has developed a second career in agriculture and rural development. He worked as a volunteer for periods of time over three years with staff at An Giang University, Vietnam, to develop a new kind of curriculum for integrated rural development. In return An Giang University helped him to undertake research into farmer decision making. At present he is a full time ESRC/NERC funded PhD student in the Geography Department of Royal Holloway, University of London [*c.a.howie@rhul.ac.uk*]. He is also a research associate at the Royal Agricultural College, Cirencester.

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[ii] Vo-Tong Anh, personal communication with the author, April 2005

[iii] one công is a tenth of a hectare or 1,000m^2