Kedah is the “rice bowl of Malaysia” and water has always been essential to the state. The rivers have been used for irrigation, communication linkages between villages and to transport rice grown in the vast area of paddy fields. The relatively gentle flow from Kuala Kedah made navigation easy and Alor Star was established at the confluence of the Sungai Kedah and Sungai Anak Bukit as a port for the rice trade. The customs office at Tanjung Chali collected taxes for the government and Indian moneylenders provided the finance via the Chettiar houses along the Pekan Cina.

To facilitate the transport of padi from the Southern hinterland to Sungai Kedah by sampans, the first canal was constructed from the foothill of Gunong Jerai in Gurun to Alor Star in 1885 by the famous Menteri Besar, Wan Muhammad Saman. The building of this 42 km long canal was an engineering feat and the canal played an important role in the rice trade and for irrigation.

In modern times, the Muda Agricultural Development scheme was established in the 70’s to harness the waters of Muda and Pedu rivers and enable double cropping. The MADA area now produces about 40% of the rice grown in the country.

Rice cultivation has had a profound influence on the language, culture, customs and way of life of the Kedah people and it continues to play an important economic role in the state.

KEDAH LAUNCHES A New Model for IRBM

YB Dato’ Syed Umar Mashri bin Syed Abdullah - Kedah State Secretary

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INCREASING DEMAND

Paddy uses a lot of water, and in spite of the reservoirs of Muda, Pedu and Ahning, water remains a scarce resource. MADA has therefore introduced water saving methods, including recycling of drainage water. Irrigation is still by far the largest consumer of water, but industrial demand is growing and the rising standard of living also means increasing domestic demand. Tourism also consumes a lot of water. Finally, Kedah supplies water to Perlis and shares Sungai Muda with Penang. The economic development thus increases the demand for a limited resource.

WATER QUALITY

Water quality is also a concern. While the rivers are pristine in the upstream areas, they become increasing polluted downstream due to discharge of urban wastewater and agricultural run-off. All too often solid waste often also ends up in the river and this is especially a problem in urban areas. As a result, most storm water drains are very polluted and smelly, especially in the dry season.

A NEW APPROACH

Kedah realises that to deal with these problems, and with other issues such as sand mining and flood mitigation, the traditional sector-based approach is inadequate. While each agency has its own mandate, priorities and expertise and need to play their roles in addressing the problems, it is necessary to use a holistic approach and bring all the stakeholders together.

After a review of experiences from other countries and from other Malaysian states, the Kedah State Government is studying the possibilities to establish a Water Resources Board and has asked the IRBM project to assist in preparing a new water resources enactment. The Water Resources Board will be a small organisation drawing on the existing agencies, who will maintain their current roles, for instance in permitting and enforcement. The Board will have a coordinating role and it will formulate action plans. It will also draft guidelines and regulations to fill identified gaps. It will be chaired by the State Secretary. The Board will appoint a Water Resources Director and the UPEN Director will assume the role as Coordinating Director. Implementation will mostly be delegated to relevant authorities such as MADA, DID or the local authorities.

This model draws on the experiences from elsewhere. We find that it is suited for the situation in Kedah and hope it will be proved to be not only efficient, but also effective in addressing the issues. We look forward to the process of drafting the enactment.

By YB Dato’ Syed Unan Mashri bin Syed Abdullah
Kedah State Secretary
The view from the top of the newly constructed Tower at Tanjong Chali at the confluence between Sungai Kedah and Sungai Anak Bukit in Alor Star is magnificent: to the west Sungai Kedah flows towards the coastal town of Kuala Kedah, to the north the Sungai Anak Bukit bring out a grand view of the Zahir Mosque, and to the East the twin bridges are straddling across Sungai Kedah. One can easily imagine the glorious by-gone days of Alor Star some two hundreds ago at the exactly the same spot: sailing junks and trading ships from India, Middle East, China and far off places moored along the banks to take our rice, spices and other produce, sampans criss-crossing the rivers, workers loading and unloading goods from the ships, and the buzzing activities along Pekan Melayu and Pekan Cina. Could this history be made into one of the main attractions for tourists and visitors to Alor Star?

Some years ago, there was talk of turning Alor Star into the “Venice of the East” and this idea has always been at the back of the minds of planners and some entrepreneurs in the tourism industry. Located in the largest rice bowl of Malaysia, Alor Star has a rich history and is the original founding spot of the oldest Malay sultanate. Together with the beautiful Zahir Mosque and the old palace complex right in the city square, the many old world quaint shop houses, the immense green carpet of paddy fields, an intriguing and interesting story of a kingdom and a city build on the trade of the humble rice grain could certainly be woven into an interesting story, not just for locals but also foreign tourists!

In addition, there are interesting natural riparian flora and fauna along Sungai Kedah and Sungai Anak Bukit that are unique to the tropics. Take for example the nipah palms that are still found on some stretches. A nice cool drink called nira nipah can be extracted from the cut inflorescence, and a natural sweetener called “gula melaka” can also be made from the same exudates. Some berembang trees where fireflies congregate are still growing in some part of the riverbanks. The mangroves and natural vegetation along the banks from the tidal barrage to Kuala Kedah have rich bird life where some 50 species of birds and hundreds of migratory egrets roost in the trees. Could these be developed to form a river cruise package for nature lovers and eco-tourists?

Sungai Pedu is a beautiful clean tributary to Sungai Kedah
BAMBOO RAFTING

Upstream, nearer to the source of Sungai Pedu, the twin water spouts at the base of the Pedu Dam spew out a large volume of clear water for about one third of the year to irrigate the paddy fields in the Muda Scheme. The Sungai Pedu is scenic and ideal for bamboo rafting and in the past many bamboo rafting races from here down to the coast have been organised. This could easily be revived as an annual sporting event.

POLLUTION PROBLEM

Like in so many parts of the world, rivers have been used as a conveyance route in the past. But with the advent of motor vehicles and the modern road systems, rivers are no longer used in this way and sadly land reserves on riverbanks are often occupied with unsightly squatter houses. People dump rubbish and all sorts of things into the rivers. Wastewater from the shops and houses in the city find their way into the rivers too. The construction of the tidal barrage on Sungai Kedah near MADA head office, built to prevent the intrusion of sea water into the rice fields, has aggravated the pollution problem because the daily flushing and cleaning of the river by the tidal cycles is now prevented. The end result is that Sungai Kedah and Sungai Anak Bukit are now not appealing to the eyes and also not attractive for water sports and other recreational activities.

The pre-requisite for river tourism is therefore improving the water quality by reducing and eradicating river pollution through several means: Control the flows of wastes and grease into the rivers, relocating the squatters along the river reserves, educating the public to love the rivers, etc. This requires a concerted effort by many government agencies.

URBAN PARKS AND RECREATION

Another approach is to create more linear parks along the riverbanks of the rivers in Alor Star and link up with the existing parks and paths along both Sungai Kedah and Sungai Anak Bukit to add on and enlarge the recreational and green lung areas for the city. Foot path and bicycle path could be added to link the linear parks and encourage local residents to use and enjoy the scenery along the rivers. The penny boat ferry service can also be revived and be given a new lease of life for residents to use to cross the rivers for leisure or for work. This would improve the quality of life of the residents of Alor Star and also enhance the city’s image.

Combined with the gradual improvement in water quality, water sports such as canoeing and kayaking currently promoted by the Youth and Sport Ministry could certainly flourish along with angling. This would compliment the boat races which is an annual event in the birthday celebration of HRH Sultan of Kedah. With increased utilisation of the rivers by local residents, river tourism will surely follow suit.

Turning Alor Star into the “Venice of Malaysia” is not an impossible dream after all!

F.K. Phang
Monitoring for IRBM

Monitoring is important for good environmental management. Many agencies are monitoring the environment for various reasons, but there is little coordination and it is difficult to get a clear perspective. The working groups for water quality and water resources recognise this and the IRBM project therefore asked ERE Consult to help develop a strategy for the Sungai Kedah basin.

The main purpose of the strategy is to ensure that the right environmental information is obtained to support the implementation of IRBM. This has been translated into three main objectives, namely information on:

- environmentally sensitive areas, which has been identified as the six water intakes and the MADA area.
- the environmental state of the river basin as a whole. This includes the water quality index (WQI) and the pollution load (concentration x discharge).
- special issues which here has been identified as pesticide levels.

DEVELOPING THE STRATEGY

In developing the strategy, two main issues needed to be resolved as early as possible. The first was the amount and type of information needed for IRBM while the second issue dealt with how to divide the river basin into smaller management units or sub-basins.

The team soon realised that a lot of water-related information is collected in the basin, but the focus should be on information needed at the strategic policy-making level as opposed to detailed technical operational data. The principle the team adopted here was ‘less is more’ to ensure that the monitoring strategy

would not get drowned in data. It was necessary to sieve a large number water data which was important at the technical and operational level but not for the strategic level.

SUB-BASINS

Traditionally river basins are subdivided according to hydrological boundaries and homogenous land use. For hydrological modelling this can be quite detailed, but such a level is not needed here. Moreover the Sg Kedah basin does not quite conform to the traditional river basin in that it has been substantially modified. The basin receives water from the Muda reservoir, which is outside the natural basin and it supplies water to the MADA scheme which is a heavily modified drainage system.

The approach the team adopted was to consider the MADA area and the Muda reservoir catchment as part of the basin. This resulted in 7 sub-basins: 3 along the main river, 2 main tributaries plus the Ahning and Pebu reservoir catchments.

The team then reviewed the data sources and identified stations that were particularly relevant for the objectives and recommended how the gaps could be filled.
PROPOSED MONITORING NETWORK

At present there are 54 water quality stations, 26 water discharge (flow) stations, 95 rainfall stations and one groundwater station in the river basin. The agency with the most extensive water monitoring in this basin is MADA which operates more than 50% of the total stations.

The proposed monitoring network consists of only 26 stations and only one of these are new, namely a station has been proposed for the monitoring of pesticides.

One unique feature of the proposed monitoring strategy is that it incorporates monitoring pollution loads which would mean obtaining both water quantity and quality data. Traditionally water monitoring stations in Malaysia only monitor either quantity or quality data and not both at the same station. This approach to monitor pollution loads when used in combination with the existing WQI approach would result in more accurate monitoring of the river basin. Ultimately the pollution load approach also means that pollution loading targets can be set and monitored for each individual sub-basin.

To achieve this it is recommended to expand a number of stations so they collect both water discharge data and water quality data. In some locations it is possible to pair water quality stations with flow stations nearby.

The main parameters are the six parameters of the WQI which are DO, BOD, COD, SS, pH and AN as well as water discharge data.

OTHER RECOMMENDATIONS

The monitoring strategy has also provided other recommendations:

• telemetric online monitoring to enable a better protection of the water intakes in the event of acute pollution.
• coordinated training on water quality sampling procedures to ensure the quality of the data collected.
• In-situ DO measurement at MADA stations
• IRBM Unit to calculate the BOD and TSS loading at the monitoring stations (load (kg/day) = concentration x discharge) to get a more accurate picture of the state of the river basin
• ASMA to establish river flow (discharge) measurement by establishing rating curves for each station.

FLOW OF DATA

The study showed that there is an abundance of data, but the availability of information is poor so the data are not fully utilised. One of the main areas the IRBM monitoring strategy attempts to tackle is therefore the integration and flow of information between the various data sources and monitoring stations. It is proposed that the IRBM Unit facilitate integration of this information via a platform for data sharing that is easy to understand and readily accessible.

Dennis Victor
Water plays an essential part in the entire growth cycle of the rice plant. Water ensures the healthy growth and eventually a bountiful harvest of the crop. In addition, water also plays another equally important function in ensuring that the paddy field is free of weeds.

The construction of the Muda and Pedu Dams to conserve water resources and the network of canals and drains has enabled double cropping in the entire Muda Scheme of 96,588 hectares in Kedah and Perlis. The Muda Scheme, aptly named the Rice Bowl of Malaysia, now produces about 40% of all the rice in Peninsular Malaysia.

Rice cultivation practices have changed since the scheme was established.

**TRANSPANTING**

Until the early eighties, transplanting was the main method to establish the crop. Here rice seedlings are raised in small nursery plots and later transplanted by hand to the main field. In this labour-intensive method water is retained in the fields. Since weed seeds cannot germinate under flooded conditions, weeds are not a major problem in the fields.

However, Malaysia’s rapid industrialisation in the eighties meant a massive out-migration of farm workers and this created a critical labour shortage. Rice farmers had to adopt mechanisation and employ other labour-saving techniques to replace the traditional labour-intensive ways. As a result, direct seeding rice culture took over as the crop establishment technique in the Muda Scheme.

**WET DIRECT SEEDING**

Wet direct seeding is now practised by the nearly all farmers in the MADA area. Wet seeding requires the rice field to be levelled, ploughed and puddled under flooded conditions. Water is led into the fields for pre-saturation of soils and to soften the soils for ploughing and subsequently seeding. However, just before seeding water has to be drained of again because rice seeds, like all other seeds, require oxygen for germination and growth. Only when the rice seeds have germinated and the young plants established themselves is water re-introduced in the field.

Wet direct seeding therefore not only uses more water, but also loses a fair amount of soils when the water is drained from the field. This pollutes the waterways and rivers. In addition, the exposed rice fields
enable weed seeds to germinate. Grassy weeds infestation is a serious problem arising out of this change from transplanting to direct seeding. Direct seeded rice crop therefore requires heavy usage of herbicides to control the grassy weeds, thus increasing costs and aggravating the water pollution problem.

More recently, direct seeding has caused the emergence of a new type of rice called weedy rice or padi angin which is early maturing and easy shattering. The origin of this new type of rice is still not completely known but it has become a major factor of yield loss in Malaysia and some neighbouring rice producing countries. As the name suggests, padi angin perpetuates and establishes itself very quickly in the rice field because the early ripened grains are shattered and blown by wind to the field. Once the padi angin is established in the fields, they are very difficult to eradicate as they cannot be killed by herbicides (they belong to the same genus and same species as rice). It is a big problem because they compete with the normal rice for fertiliser and farmers cannot harvest their grains!

**WATER SEEDING**

Recently a new innovative rice crop establishment method called water seeding has been developed to overcome the grassy weeds and paddy angin problem in the MADA area. With this method the seeds are first soaked in water with chemicals (mainly peroxide-based compounds) that will supply enough oxygen to enable the seeds to germinate in a flooded field.

There are many advantages of this new technique. Firstly, water introduced for pre-saturation of the field and for subsequent ploughings is retained in the field during seeding, thus saving vital water resources and reducing pollution to the waterways.

Secondly, standing water in rice field will prevent the germination of weeds and padi angin seeds, thus reducing the infestation of these two groups of unwanted plants. Water seeding technique has high potential in saving water and costs of production.

**DEMONSTRATION PROJECT**

Realising the importance of this water seeding crop establishment technique, MADA has initiated a demonstration project with the support of the IRBM project to fine-tune the technique in their Research and Training Centre in Alor Serdang, Kota Sarang Semut, Kedah. Initially, MADA is seeking the optimum water level for good crop establishment and determining the required water consumption.

Data from the first trial in season 1/2005 are very encouraging - both in terms of water saving and in control of grassy weeds and padi angin. Once this method is proven to be practical and effective, MADA will continue to search for more answers to field problems that may arise out this new water saving technique. Wide adoption of this technique will not only benefit farmers but will also contribute towards the conservation of the precious water resources.

F.K. Phang
Y.B. Dato' Ahmad Bashah Md. Hanipah, the EXCO member responsible for Housing, Local Government and Environment, officiated a seminar on "Treatment of wastewater from markets, restaurants and food stalls" held in Langkawi on 29 March 2005.

A total of 40 representatives from local authorities, government agencies and representatives from the Hawkers Association participated. An exhibition on river water pollution was held in conjunction with the seminar.

Among the papers presented were:

- Water quality of Sg. Kedah: pollution sources and mitigation measures (DoE)
- Management of grey water from restaurants, food stalls and wet markets: DID's perspective (DID)
- Experiences of grey water management in Kuching, Sarawak (Natural Resources and Environment Board)
- Demonstration projects in Selangor for water quality improvement (Lembaga Urus Air Selangor)
- Experiences in water quality improvement (Majlis Perbandaran Petaling Jaya)
- Grey water management in urban areas (Universiti Teknologi Malaysia)
- Ideas for demonstration projects for IRBM Sungai Kedah (Chemsain Konsultant)

The Singapore Public Utilities Board hosted a technical visit for Malaysian officials from 28-29 September 2005. The 22 participants came from some of the partners the project works with, mainly from Selangor and Kedah.

In Singapore the participants exchanged experiences with the Public Utilities Board on the handling of oil and grease from restaurants and food stalls. This is immediately relevant to the problems in Malaysia and the demonstration projects now being designed by the project.

The participants learned about the approach used to clean-up the Singapore River, including the involvement and coordination of all the key agencies concerned, as well as the planned Marina Bay project and the associated clean-up of the urban watershed that will discharge into the future reservoir. The Singapore River clean-up and Marina Bay projects provided inspiration to the participants as case studies in IRBM in an urban setting. The group also learned about Singapore's water reclamation activities including wastewater treatment and NEWater.
Malaysian food is rich in oil and grease and much of this ends up in the wastewater when plates and utensils are washed. All too often the washing in restaurants and food stalls ends up in the storm water drains. The drains become smelly and attract rodents and vermin, and sooner or later the dirty water finds its way to the river. While this is not the main source of water pollution - that is usually domestic wastewater - it is a significant source.

And even if the wastewater from the kitchen is led to a wastewater treatment plant, as it should be, the high content of oil and grease means that the sewer often clogs.

The answer is to let the wastewater pass an oil-and-grease trap before it is discharged. But how should this be done?

SIZE MATTERS

In this case, size matters. The reason is that a big trap has a higher retention time, which means that the wastewater spends sufficient time in the trap to allow the small drops of oil and fat to rise to the surface where they accumulate. If the trap is too small, much of the oil will simply pass through the trap and it will not be effective.

A big trap also has another advantage: you don't need to empty it so often. If the trap is small, even a small food stall will need to empty it once or twice a day. That is a messy, unpractical and unhygienic operation. Some time after installation, many of these units are no longer in use. The small units are relatively cheap, but they are not effective and often only used for a short time.

Singapore uses two standard designs, both are concrete tanks installed in the ground outside the restaurants. The smaller trap has a diameter of 1.0 meter and caters for up to 7 stalls with a total seating capacity of 100 chairs, while the larger unit has a diameter of 1.8 meter and can be used by up to 20 stalls with a total of 300 chairs.

MAINTENANCE

In Singapore there are 6,000 oil-and-grease traps. All shops which prepare food have to be connected to a trap before they can get a business licence, and they also need to have a service contract with one of the 24 licensed contractors. The units are normally emptied once a month and it is more economical in installation and operation if the stall owners, who pay the costs, can agree to share a bigger unit.

The outlets of the vacuum trucks that service the traps are provided with numbered seals by the Public Utilities Board (PUB) to ensure that the contractors always deliver the sludge to the sludge treatment plant. Here the sludge is condensed and eventually deposited at landfills with other sewage sludge.

DEMONSTRATION PROJECT

The IRBM project is installing oil-and-grease traps in Selangor as well as in Kedah in order to gain experience from Malaysia and to demonstrate how this can be done. At present it has been decided to install traps in Bukit Sentosa in Selangor and in two locations in Alor Star.
The Sand Mining Working Group held a workshop on 5-6 January 2005 in Sik to discuss the problems associated with the industry. The participants were sand-mining operators, politicians, administrative and enforcement agencies.

The workshop discussed the technical aspects, the problems faced by the various stakeholders and reviewed the responsibilities of the various agencies in planning, regulating, monitoring and enforcement of sand mining activities. This included existing regulations and guidelines as well as monitoring and enforcement.

Several background papers were presented by DID and JMG. Case studies in Sungai Muda were used as basis for discussing the issues. It was concluded that there was a need to conduct monitoring and enforcement in an integrated manner; that sand mining operators, land owners and permit holders need to play an active role to ensure that guidelines and conditions are adhered to; that awareness campaigns to educate stakeholders and implementing agencies are important; that it is necessary to establish Sand Mining Working Groups at district level to enhance management of the activities; and that a policy paper should be submitted to Majlis Mesyuarat Kemajuan Negeri Kedah.

As a follow-up, a Sand-mining Policy Formulation Workshop was conducted from 2-3 August 2005 in Cameron Highlands. Background papers were presented by the Department of Land and Mines, Department of Irrigation and Drainage and the Chief Technical Adviser of the IRBM Project. The participants discussed a draft state policy for sand mining. It is planned to finalise the draft policy at another workshop soon.
ENVIRONMENTAL ASSESSMENT OF ANIMAL HUSBANDRY

Animal husbandry can be a significant source of water pollution and the Sg. Selangor Basin Management Committee therefore established a working group with representatives from Department of Veterinary Services, DOE and LUAS to assess the situation in the basin and propose appropriate measures.

Animal husbandry is not a major industry in the basin. There are over 400 farms, but most of them are small. The 47 commercial and semi-commercial farms account for the bulk of the production. The total annual production (ex-farm value) is RM 74 million.

To supplement the available statistical data, a team visited 60 farms, including all commercial and semi-commercial farms, and took water samples at 14 farms.

It was found that the total generation of animal waste is about 228 ton per day of which 41% from poultry, 36% from cattle and 19% from swine. This is a lot of waste, but fortunately direct discharge from animal farms to water courses is not common. It is difficult to measure the actual pollution as the discharge is irregular and often flows over land. The team was therefore not able to quantify the total pollution load from animal husbandry to the river.

**POULTRY**

Poultry farming is the main activity. Chicken manure is bagged and sold as fertiliser for vegetable farming. Poultry farming generates only little wastewater, but some is produced in connection with cleaning of cages and sheds, and from splashing of rain on manure. On some farms such water is channelled to ponds, on others to streams. Much seeps into the soil and may pollute the groundwater. The report recommends that wash water is collected and that storm water management is improved.

**CATTLE**

Cattle farming accounts for only 3% of the value of animal husbandry, but pollution from cattle farming is a cause of concern. Most cattle graze on public land or in oil palm estates. Grazing itself is not considered a source of pollution as the animal density is low, but there are problems with stables and more intensive forms of production. Most cattle and buffalo farms do not have any form of proper waste management, and liquid waste is often channelled directly to streams or seep into the ground. During rain stored manure also washes into water courses. The two feedlots in the basin are the only cattle farms with waste management. The waste from these is channelled to unlined, 3-stage earth ponds. Some of the solid waste is pressed into pellets for use as fertiliser, while the liquid fraction is spread on grassland. It is recommended that proper waste management be introduced on all cattle and buffalo farms in a systematic manner.

**PIGS**

There are now only five pig farms in the basin with a total population of 10,660 pigs. All pig farms treat the waste in a series of ponds and samples indicated this was rather effective. The treated water was led to large ex-mining pools with no visible outlets. All farms thus practise “zero-discharge”. Since the farms are surrounded by ex-mining ponds and are located only slightly above the groundwater level, there is little risk of groundwater contamination except for wells at the farms themselves. With the relatively small number of pigs and the large ponds, the current pig farming operations do not pollute the river in any significant way.

**LEGAL FRAMEWORK**

With the exception of the pig enactment, the existing legislation does not address environmental issues. DVS advocates good animal husbandry practices, but at present these are voluntary schemes and they may not be sufficiently detailed to be readily enforceable if made mandatory.

**MITIGATION MEASURES**

DVS will follow-up on the findings and examine ways to implement the various recommendations made in the report. The issue will also be taken up during the preparation of the IRBM Action Plan and it is expected that it will include a list of mitigation measures.
FRESHWATER AQUACULTURE IN THE SG. SELANGOR BASIN

Freshwater aquaculture is a significant activity in the Sungai Selangor basin, which not only provides a livelihood for the operators, but also fish for the tables, recreation and ornamental fish. Freshwater obviously requires water of good quality, but the industry also impacts on the quality of water in the river.

There is a concern over possible pollution caused by the discharge of used water from the ponds and the IRBM project therefore asked WWF to study assess the environmental impact of freshwater aquaculture in the Sungai Selangor basin. The study was supervised by the Fisheries Working Group and carried out in close collaboration with Department of Fisheries, DOE and LUAS. It recommends measures to ensure the sustainable development of the industry, including zoning.

MANY TYPES OF CULTURE

Aquaculture activities in the basin are quite diverse. More than 20 species are cultured at 28 aquaculture farms, mainly in excavated ponds and cement tanks. The two most important species are hybrid catfish (keli) and tilapia.

WATER USE

Most of them use rivers as their main water source. The river water quality was mostly sufficient for aquaculture, but due to sand mining, silt is a problem and some areas (especially Sg. Sembah which drains the Rawang sub-basin) are affected by high levels of BOD and ammonium.

DISCHARGE OF USED WATER

The amounts and the quality of the discharged water also varied considerably. Only 13 of the 28 farms were found to discharge used water, and some only in small amounts.

The most polluting farms were rearing catfish, but other catfish farms had only very limited discharge and the wide variation in farm types and culture practices made it difficult to relate the effluent discharges in relation to farm type.

Effluent concentration in itself was not a good indicator of the pollution. About 80% of pollution load (in kg/day) was actually due to a single...
farm practising very high stocking density of more than 50kg/m², which discharged a high volume of effluent with a modest organic load concentration. When regulating the industry, it is therefore important not to look at concentration alone.

The total discharge of phosphate from aquaculture operations is estimated at 125 t/yr. Compared to the total transport of the river this is insignificant. The discharge of nitrate and sediment is also small compared to other sources. Discharges in connection with harvesting and emptying of ponds are not considered as there are no data to indicate the extent of this.

Although the regular discharge from aquaculture operations in most cases is relatively small, appropriate mitigation measures should be taken to encourage farmers to employ water reuse strategies and wastewater treatment. At present many aquaculture farms in the Sg. Selangor basin employ basic production technologies that do not include sustainable husbandry techniques, water reuse strategies and wastewater treatment infrastructure.

RECOMMENDATIONS

The team recommended that:
- All farms should either (a) practise zero-discharge or (b) treat the wastewater in sedimentation / oxidation ponds with a retention time of at least 24 hours to ensure that the effluent meets Standard A.
- Hatcheries should be equipped with a two-stage discharge treatment system. The first stage including disinfection to destroy pathogens and feral releases, while the second stage is an oxidation pond with minimum 24 hours retention time.
- Where pond sediments are removed after harvest, they should be stored within the farm before being properly disposed of. Where pond sediments are not removed, they must be dried out and tilled to facilitate aeration and then compacted to prevent erosion.
- The discharge outlets should have double screened gates to trap feral organisms.

ZONING

It is also recommended to gazette aquaculture zones (aquaculture development areas). Such zones could give the industry better protection and perhaps allow the establishment of common treatment facilities for used water.

REGULATION

The team found that the draft Inland Fisheries Rules (Aquaculture) provides a good framework for the industry and should be enacted. Alternatively regulations may be developed using the LUAS Enactment. It was also recommended to develop guidelines for the appropriate freshwater aquaculture systems.

IN MEMORIAM

Allahyarham Ir. Hj. Rahmat bin Hj. Mohd. Sharif passed away on 7 February 2005. The late Ir. Hj. Rahmat was the Director of Luas, seconded from DID since the establishment of Luas. Hj. Rahmat was very dedicated to improving the environment and to the organisation he served. He was very supportive of the IRBM project, and though we did not always agree, we enjoyed a very good working relationship. I wish to thank him for all the help. Our thoughts go to his family.

Bo Christensen

Aquatic insects and other small freshwater organisms depend on their environment. The presence of certain groups of animals therefore indicates whether the water is clean or polluted. It is actually possible to calculate a biological water quality index from samples of macro-invertebrates and this can even be done by school children as an environmental education activity.

**COURSE IN PENANG**

The project held a training course on this during 2-3 February 2005 in Penang. Here Dr Salmah Rawi from the School of Biological Sciences, Universiti Sains Malaysia, taught the participants how to use the “Freshwater name trail”, which was adapted by the project for use in Malaysia. The participants came from DID, DOE, Natural Resources and Environment Board (Sarawak), Environment Protection Department (Sabah), Kedah Education Department, Majlis Perbandaran Petaling Jaya and NGOs and their response was very encouraging.

The training familiarised the 42 participants with the common freshwater macro-invertebrates and their habitats, taught them how to take samples, how to use the guide to assess water quality and how to teach school children these skills.

**OTHER TRAININGS**

A similar training was conducted in Alor Star during 1-2 June 2005 in collaboration with the Kedah Education Department. 40 secondary school teachers from the districts of Pasir Terap, Baling, Langkawi and Sik who are involved with ‘Kelab Alam Sekitar’ participated in the training course.

Subsequently, the Kedah Education Department collaborated with DID on a subsequent course in Sg Sedim for a school in Kulim.

In July 2005, DID conducted another session on bio-indicators in FRIM as part of an MNS environmental education awareness course.

In addition, DID gave a talk on IRBM and gave demonstration of bio-indicators during a state-level meeting organised by Kedah Education Department in November 2005.
The IRBM training gives an introduction to the technical aspects of water and land management as well as the institutional and legal framework and it provides an overview of the roles of the various parties involved. The training consists of two modules of 3 days each and includes field visits.

The target group is quite wide and includes all agencies throughout Peninsular Malaysia as well as NGOs and private sectors that deal with some aspect of water resources and river basin management. The structure and contents of the course was developed by the DID and the IRBM Project and refined through several rounds of discussion with relevant government agencies and NGOs.

The IRBM training courses were conducted in 2004 and comprised four 3-day courses for about 230 participants. Following positive feedback from the courses in 2004, the EPU proposed that the training be extended to all states in Peninsular Malaysia.

In 2005 DID therefore organised a series of 8 IRBM workshops with a total of 430 participants from all states. Overall, the workshops were well received by the participants. Feedback obtained from participants and lecturers will be used to fine tune future workshops. It is envisioned that similar workshops in 2006 will be targeted specifically at the local authorities in the states the project works in.