

RIVER POLLUTION AND RESTORATION TOWARDS SUSTAINABLE WATER RESOURCES MANAGEMENT IN MALAYSIA

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ABSTRACT

Malaysian settlements have historically sprung up along river banks and river estuaries. In many ways, rivers are sources of life, providing water supply for the people, irrigation for agriculture, as a means of transportation, a source of food in fisheries, hydro-electric power, and water use for industries. Rivers are also the habitats for riverine and aquatic flora and fauna and the river environment supports a rich biodiversity of life forms. Unfortunately, however, rivers also provide an easy conduits for the discharge of varying domestic, commercial, industrial and agricultural effluents via their natural function as drainage channels for flood mitigation. Malaysia has developed very rapidly over the last three decades, with urbanisation increasing many folds in all the major cities and towns. Coupled with this, agriculture expansion and industrialisation have also rapidly changed the land use from one of mainly forest and food crops to one of estates (cash crops), urban, commercial and industrial centres. All these developments have overstressed river systems. As a result, many river basins have reached their limits of water supply and are now susceptible to water stress and droughts. The occurrence of low flows is exacerbated when rapid development has produced great amounts of human wastes as well as wastes from all of man's activities, including agriculture, industrial, commercial and transportation wastes. This has resulted in a large number of polluted rivers, some to the extent of being not rehabilitable. Yet, many rivers can be restored and rehabilitated given the right kind of efforts. Deforestation has also led to the opening up of large tracts of land within river basins and this has resulted in not only increased sediment loading in the river systems but also in the aggravation of floods which further pollute the waters.

Currently, there have been some fragmented efforts from the authorities and the public for river restoration and rehabilitation. The Drainage and Irrigation Department has initiated a program to clean up the Kelang River, i.e. to clean the river of solid waste and silt, to improve water quality to Class III (recreational purposes without body contact) and to beautify strategic stretches of the river for recreational purposes. So far, it has had mixed results. Some stretches in the cities are showing good results as more attention has been focussed there but elsewhere the river is as dirty as ever. It is also a top-down approach that did not involve much participation from the local communities. Hence, they were often met with scepticism and resistance. Some river cleaning works were stalled mainly due to the resistance of riverine squatters who refuse to cooperate. Consequently, the whole approach to river restoration has changed. More and more, the public and water NGOs are playing a more important role. This is especially so when the community involved is the one that lives besides the river. This study demonstrates that river restoration and rehabilitation can only be successful with a combined effort between government, NGOs and the local communities working together to ensure the cleanliness of the rivers.

INTRODUCTION

Malaysia consists of two parts, Peninsular Malaysia and East Malaysia, which are drained by 150 river systems. About 100 of these are in Peninsular Malaysia and 50 in East Malaysia Sabah and Sarawak (Figure 1). Within these river systems is an estimated 1,800 rivers and major tributaries, with a total length exceeding 38,000 km. The largest river in Malaysia is Sg. Rajang with a catchment area of 51,000 sq. km while in the Peninsular, it is Sg. Pahang with a catchment of 29,000 sq. km. By world standards, Malaysian rivers are short and steep (Hj Keizrul bin Abdullah, 2002).

During historical times, rivers were the hub of life with not only the major settlements lining the banks but rivers also play an important role in the economic and social life of the people. Since independence in 1957, however, Malaysia has developed steadily changing from a rural economy based on agriculture and tin mining to an export based manufacturing economy. Over the last three decades, the transformation has been unprecedented with very rapid urbanisation and industrialisation. The change from rubber estates to oil palm and the opening up of extensive tracts of land by the Federal Land Development Agency (FELDA) coupled with uncontrolled logging transformed the land use from one of mainly forest and food crops to one of estates (cash crops) and townships (Ooi,

1979). This was followed by expansion of urban, commercial and industrial centres. All these developments have overstressed river systems. As a result, many river basins have reached their limits of water supply and are now susceptible to water stress and droughts. The occurrence of low flows is exacerbated when rapid development has produced great amounts of human wastes as well as wastes from all of man's activities, including agriculture, industrial, commercial and transportation wastes. This has resulted in a great number of rivers that are very polluted, some to the extent of being not rehabilitable. Yet, many rivers can be restored and rehabilitated given the right kind of efforts. Deforestation has also led to the opening up of large tracts of land within river basins and this has resulted in not only increased sediment loading in the river systems but also in the aggravation of floods which further pollute the waters. Related to deforestation and development of hill land is the incidence of accelerated erosion leading to landslides (Chan et al., 2000). These events lead to sediment pollution of rivers. Further downstream, the excess runoff from the heavy tropical rainstorms inundate large tracts of land, causing damage and economic losses with significant loss of life (Chan, 1995). Low water levels during periods of drought result in water shortages leading to rationing of supply, interruptions to commercial and industrial activities, and losses to agricultural production. The rapid pace of development of the past three decades have exacerbated the situation and brought with it problems of flash floods, reduced base flows, river water pollution and siltation.

RIVER POLLUTION

Notwithstanding its important ecological functions, rivers are Malaysia's major source of fresh water, contributing some 97 % of total water supply. Malaysia is well endowed with copious rainfall and abundant water resources. With an average annual rainfall of 3,000 mm, there is an estimated 566 billion m³ of water running off into the river systems each year (Hj Keizrul bin Abdullah, 2002). Yet, many parts of the country are still experiencing water stress. Presently, 25 river basins have been

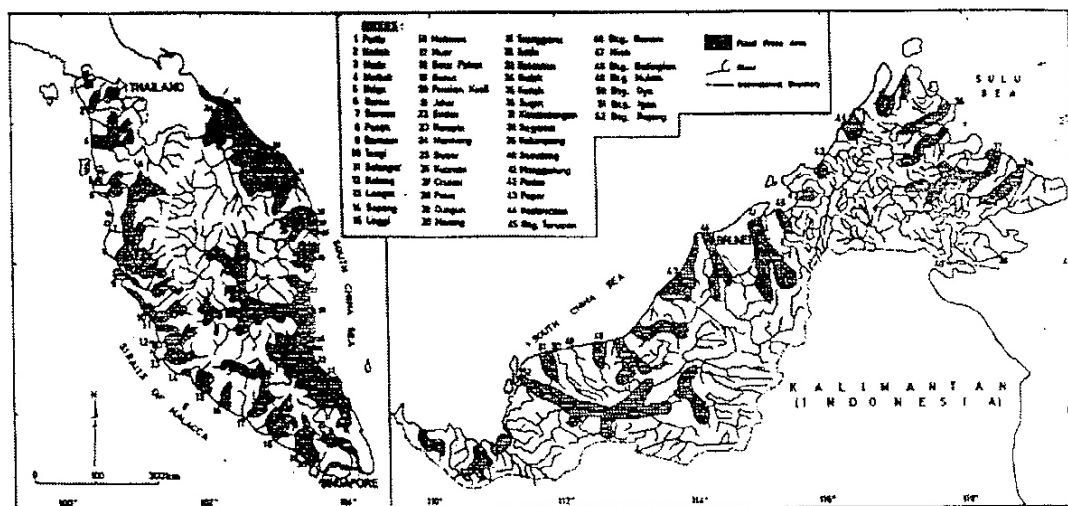


Figure 1: Distribution of rivers in Malaysia.

identified as areas experiencing water stress. In its natural state, rivers have built-in self-purification abilities, i.e. they can absorb and cleanse themselves of wastes and impurities. Hence, they can maintain a level of river water quality that is able to enrich the natural beauty and to support humans as well as the diversity of riverine flora and fauna. However, rivers have their limits. Disruptions to the natural river basins via opening up of catchment areas for polluting human activities have resulted in adverse changes to the hydrology of rivers, including deteriorating river water quantity as well as quality. As a result, the river's role as an important life support system has greatly diminished in importance, and its ability to support the eco-system is greatly threatened. In Malaysia today, as in

many other developing countries, the state of rivers is appalling and in many urban areas, rivers have been literally turned into open sewers, some to the extent of being non-rehabilitatable.

Various sources of pollution occur in Malaysia, mainly from agriculture (fertilisers, pesticides and sediments from soil erosion), livestock farming (animal wastes), domestic homes (human wastes), urban areas (greywaters and untreated wastewaters) and industries (industrial effluent). Pollution already adversely affects river water as well as the river environment. This renders river water unfit for any use. First there is organic wastes, the main sources being from domestic, agro-based industries and livestock farming (mostly pig farming). In many urban and industrial areas, organic pollution of water from both point and non-point sources have resulted in environmental problems and adversely affected river water quality and the habitats of aquatic flora and fauna. According to Hj Keizrul bin Abdullah (2002), the worse cases of pollution are when rivers flow through urban areas as they are subjected to heavy solid and liquid waste disposal from squatter settlements, drainage effluents from commercial area, food centres and wet markets, residual hydrocarbon from urban traffic and workshops, and excessive silt loads from land clearings. In the Klang Valley alone, an estimated 80 tons of solid wastes end up in the Sg. Kelang alone daily.

Squatters are another major source of river pollution. Most of the towns and cities in Malaysia (including the Federal Capital of Kuala Lumpur) grew from squatter settlements. Currently, squatter settlements line the banks of all the major rivers in the urban areas, with many such as along the Melaka River are built over the river itself (Plate 1 Left). Since river banks are flood-prone, the land is seldom developed. Hence, these areas provide a cheap/free and convenient locale for the poor. In recent years, immigrants from neighbouring countries have literally "flooded" these squatter settlements, just as the settlements themselves are flooded ever so often. Squatter settlements are not provided with sanitation facilities or rubbish disposal facilities. Hence, the squatters use the rivers both as a source of water as well as a means of waste disposal. It is not uncommon to find toilets constructed on stilts in the river. Squatters are also guilty of dumping all sorts of rubbish into rivers, including old furniture and broken down motor-cycles and cars. Along the Sg. Kelang alone, it is estimated that about 40,000 families live in squatter settlements. Hence the amount of pollution generated is enormous.

Deforestation and rapid land use change due to accelerated economic growth have destroyed the natural forest cover replacing it with exposed or partly exposed surfaces (Plate 1 Right). Other activities that have had a similar effect on the land use are mining operations, construction of housing, logging and clearing of forests, highway construction, agriculture estates, quarrying and urbanisation (Chan, 1999a). All these have caused high concentrations of suspended sediment in downstream stretches of rivers. Typically, the lower stretches of Malaysian rivers are characterised by heavy silt loads especially after heavy rains. For urban areas, Hj Keizrul bin Abdullah (2002) demonstrates that 90 % of sediment load in rivers are derived from land cleared for construction. For example, in the Klang Valley alone, it has been estimated that erosion averages 2,950 tons/sq. km/yr for the whole catchment, equivalent to about 3 mm of soil loss a year. In many upstream areas where forest clearance has been rapid, erosion rates of more than 50,000 tons/sq. km/yr are not uncommon (Wan Ruslan Ismail, 1995; Chan et al., 2000). In comparison, the rates of erosion for undisturbed forest catchments are only of the magnitude between 10 to 100 ton/sq. km/yr. Hence, pollution via sedimentation is a serious problem for Malaysia rivers and a major river management issue (Douglas, 2002).



Plate 1: Left - Squatter houses along the Melaka River, Malaysia. Right - Deforestation caused by land development in the Penang Hill in Penang State, Malaysia.

The most serious kind of river pollution, however, is the pollution by heavy metals and hazardous chemicals discharged from the thousands of factories in industrial zones, especially those located upstream of rivers (Chan, 1999b). Privatisation of treatment of industrial wastes has made such treatment expensive, and there are a significant number of factories not treating their wastes. Some have even been caught dumping their wastes illegally. The economic slowdown in recent years has exacerbated this problem as there are more and more incidents of illegal dumping of toxic wastes and leakages of waste products from improperly constructed containers as well as accidental spillage. This has caused serious pollution, especially to the rivers. Based on the current large volume (which is increasing alarmingly) of pollutants of all sorts, rivers can no longer perform their self-purification function. Consequently, river pollution monitoring by the Department of Environment (DOE) has shown a drastic decline in water quality of rivers. For example, out of the 117 rivers monitored in 1997, 24 were rated as clean, 68 slightly polluted and 25 polluted (Table 1). The situation improved slightly in 1998 but the conditions of rivers deteriorated again in 2002. In terms of heavy metal contamination, 55 rivers have been found to exceed the maximum limit of 0.001 mg/l for cadmium, 44 rivers exceeded the iron limit of 1.00 mg/l, 36 rivers exceeded the lead limit of 0.01 mg/l and 24 rivers exceeded the mercury limit of 0.0001 mg/l (Hj Keizrul bin Abdullah, 2002).

RIVER RESTORATION

The term "Restoration" brings with it negative connotations as something ought to be in a poor/bad/degraded state to warrant restoration. Hence, river restoration broadly means bringing a degraded river back to where it used to belong, i.e. in its natural state. Although river restoration has been defined in a number of ways, depending on who is doing the restoration (engineers will give a completely different definition from environmentalists or biologists), it can be taken to mean the process of returning a degraded/damaged river ecosystem to its condition prior to disturbance. Although river restoration aims to restore a river back to its original natural state, whereby the river attains equilibrium (within itself as well as with its environment), the aims of restoration managers must be realistic and practical. Hence, practical river managers often define river restoration as "...the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the functions of the ecosystem are recreated...The goal is to emulate a natural, functioning, self-regulating system that is

Table 1 : Quality of River Waters, 1987 – 2002

Year	No. of Rivers Monitored	Clean	Slightly Polluted	Very polluted
1987	91	43	45	3
1988	91	48	40	3
1989	91	45	43	3
1990	90	48	35	7
1991	87	37	44	6
1992	87	25	55	7
1993	116	30	75	11
1994	116	38	64	14
1995	115	48	53	14
1996	116	42	61	13
1997	117	24	68	25
1998	117	33	68	13
2002	120	30	68	22

(Source: Department of Environment Malaysia)

integrated with the ecological landscape in which it occurs (Drainage and Irrigation Department et al., 2003). River restoration should involve all stakeholders – government, businesses, water departments, water companies, industries, NGOs, local communities, schools, and all who have an interest in the river. All stakeholders should work together in a joint effort to clean-up the river, control pollution and garbage dumping, de-silt and dredge out garbage, re-establish streamside habitat, bring back fish and bird life, and improve recreation facilities along the river. At the same time, they should also convert the river from a neglected flood hazard to an economic asset for the local communities.

THE KELANG RIVER CLEANUP PROGRAMME: A TOP-DOWN APPROACH

The Klang River is located in the Klang river basin, one of the most densely populated area of the country housing 3.6 million people (about 18 % of Malaysia's population) (Chop and Juhaimi Jusoh, 2002). The Klang River passes through major urban centers of Ampang, Kuala Lumpur, Klang, Shah Alam, Subang Jaya, Petaling Jaya, Kajang, Ampang Jaya and Selayang. Hence, it is not surprising that the Klang River has been notoriously known as the "Most polluted river in the country". The river flows through one of the most densely urbanized regions in the country, passing through the urban conurbation of the Federal Territory (Kuala Lumpur)-Petaling Jaya-Shah Alam-Klang (Plate 2). The proposal to clean up the river was first made in 1988 with the Department of Irrigation and Drainage (DID) heading a team of government agencies. However, due to bureaucracy, the program was not formalized until 1992 (Chop and Teh, 1993). The three main objectives were:

- (a) To clean up the Klang River and its major tributaries from rubbish and silt;
- (b) To improve the water quality of the Klang River and its major tributaries to a standard minimum of class III standards (WQI=60) (i.e. suitable for recreational purposes without body contact); and
- (c) To beautify the riverine areas with a view to provide and upgrade recreational facilities within the city.



Plate 2: The Klang River runs right through the Federal Capital of Kuala Lumpur, one of the most urbanised and densely populated regions in the country.

A total of eight sub-programs were established, each to be carried by one or more agencies. The Sub-Programmes were construction, maintenance and desilting under the jurisdiction of the DID, beautification under the Kuala Lumpur City Council (DBKL), education, enforcement and water quality monitoring under the DOE, rehabilitation of aquatic life under the Fisheries Department, and the treatment of wastes from animal husbandry by the DOE (http://agrolink.moa.my/did/river/sgklang/klang_basin.html). Due to rapid development of upstream areas, siltation has reduced the drainage capacity of the Klang River considerably. Furthermore, greater urbanisation and denser built-up areas have increased the percentage of impervious surfaces, leading to greater runoffs and shorter lag times (Chan, 1996). This has resulted in greater incidence of flash floods. To reduce the flood risk for the city, desilting is necessary. Most of the desilting is currently carried out by DBKL and DID FT. The former is responsible for work within the Kuala Lumpur city while DID FT focuses on other areas outside the city. Rapid development has resulted in heavy siltation of the Klang River, with soil erosion rates at 18 tonnes/ha/year (i.e. about 2.3 million tonnes of annual soil loss). This produces a sediment yield of average 7.8 tonnes/ha/ year or about 1.0 million tonnes from the river. The major contribution to the overall erosion level is from urbanizing areas (62%) (Chop and Juhaimi Jusoh, 2002).

The beautification programme aims to enhance the natural beauty of the Klang River and its corridors. Once beautified and landscaped, the corridors provide suitable spaces for recreation such as jogging, walking, picnics, fishing, boating etc. The DBKL heads the beautification programme with representation from the various municipalities. Under this sub-program, an overall Beautification Masterplan was developed for the whole stretch of the Klang River up to the town of Klang (First phase - 1992-2002).

However, there are obstacles to the cleaning up and beautification of the Klang River. Squatting is a major problem as they not only contribute to pollution of the river but also impede clean-up work as they refuse to relocate or move. There have been many occasions when squatters have stopped either the

DID's or the contractors' heavy machinery from moving on to river banks. According to mass media reports (The Sun, 20 February 2002), squatting is a phenomenon reinforced by broader socio-economic and political forces. He found that politics and squatting are closely linked. Politicians capitalise on squatters to gain support by setting up local branches of their parties, supposedly to protect the squatters from being evicted from their houses. Thus, it is not surprising to find branches of political parties in squatter areas. Through the political system, squatting is reinforced to the extent of being "institutionalised". However, not all squatter settlements support the ruling government. Some support the opposition parties and these parties champion their cause by making the eviction of squatters into a political issue and often make it extremely difficult for the clean-up authorities to do their job.

Hence, there is another sub-programme aimed at relocating about 2,650 squatters' families which now live in colonies along the banks of the river. This job is headed by the Federal Territory and Klang Valley Development Division of the Prime Minister's Department. Unfortunately, relocation is a messy and expensive exercise (Chan, 1997). Up to 1999, only 310 squatter families had been relocated. The major reason for the limited success of the relocation programme is the inability of local authorities to provide alternative low cost housing to the squatters. Nevertheless, both the Selangor State Government and DBKL are committed to see a "Squatter free" Klang Valley by the year 2005. Whether or not this is realised remains to be seen.

The rehabilitation of aquatic flora and fauna is a sub-programme headed by the Department of Fisheries. Sensitive species such as the jelawat, baung, lampam as well as udang galah (prawn) were released in the relatively clean upper stretches of the Gombak, Batu and Klang rivers. However, further downstream where the water is slightly polluted, hardier species such as Tilapia were released. Since the stretches within Kuala Lumpur is heavily polluted, the waters are not likely to be able to support much aquatic life except for some species of catfish. The department has employed tagging to monitor the fish and indications are that this might work. If the restoration exercise is successful and the water becomes cleaner, more sensitive species such as the Kelah and Sebarau may yet make a return to the Klang River in the future.

The sub-programme of "Public awareness and education" is headed by the Selangor Information Department. The programme is aimed at educating the general public and raising awareness with respect to preservation and conservation of rivers and its environment (Hj Keizrul bin Abdullah and Mohd Fadhilah bin Hj. Mahmood, 1998). Special attention is given to those living in the vicinity of the rivers, especially the thousands of squatters. The many activities under this programme are gotong royong (community self-help), talks and lectures, exhibitions, camping and kayaking on the river. Overall, these activities have been successful but the number of people involved was not as high as expected.

Often, despite the presence of many laws which protect rivers in one way or another, enforcement is a problem (Meenakshi Raman and Mageswari Sangaralingam, 2002). Hence, another sub-programme is that of enforcement headed by the Department of Environment Malaysia (DOE). The DOE is supported by all Local Authorities and state Department of Environment offices. It is responsible for monitoring water quality and inspecting factories for their wastewater discharges. It is also responsible for charging the polluters. The DOE has also set up a GIS database for the Klang River basin. However, while the GIS database expedites the work of the DOE, monitoring and enforcement have always been problems. Lack of staff and "problematic" factories have reduced the effectiveness of this sub-programme.

THE SG PINANG AND SG ARA RIVER CONSERVATION AND RESTORATION PROGRAMMES: A BOTTOM-UP APPROACH

River conservation and restoration is not the sole responsibility of government. In order for rivers be conserved and managed effectively, the role of NGOs and ordinary citizens are becoming increasingly important (Rasagam and Chan, 2002). The work of Water Watch Penang (WWP), the only water NGO in Malaysia, is a good example. One of WWP's river conservation activities is the "*Sg Pinang River Walk - Caring For Our Rivers Campaign*". This is targeted at the general public. For example, on 13 March 1999, a clinic on the importance of looking after our rivers was conducted. The objective is to instill awareness and love for our rivers. The event was well received as about 20

participants with ages ranging from 3 to 60 took part. The president led the group in the "River Walk" along the banks of the Sg Air Terjun (a tributary of the Sg Pinang) (Plate 3).



Plate 3: Teaching the local community to monitor and love their rivers – case of the Sg Air Terjun in Penang, Malaysia.

The group was instructed on the importance of water conservation and hence the need to keep our rivers clean. They were then treated to some basic water monitoring exercises where participants conducted themselves in the river. The kids as well as adults enjoyed this exercise tremendously. The objective is to get the residents living in the vicinity to adopt that section of the river and monitor its "Health" via simple indicators such as the physical characteristics (velocity and discharge, cross-section area of river channel, temperature, colour, turbidity, presence of rubbish, smell/odour, flowing or stagnant water), the biological characteristics (presence of aquatic weeds, fish, and other aquatic wildlife) and the chemical characteristics (pH, Dissolved Oxygen and Conductivity). Because participants actually get into the river to perform various tasks, they really enjoyed themselves. Hence there is potential in this sort of activity. This activity was repeated in several other localities with different communities. On all occasions, it was well received. It appears that WWP's message on loving rivers was passed on.

The use of *forums and publications* by WWP has also been effective in instilling greater public awareness in loving and restoring our rivers. People need to be constantly reminded about the fragility of our water resources. In order to do so, WWP creates greater awareness for water conservation by giving public talks, takes part in forums of discussion and publishes water related articles in newspapers. The occurrence of severe water crises in the 1990s in Malaysia, particularly in 1997 and 1998, made everyone take notice of the importance of water conservation. Many forums and workshops were held of which WWP were a part of them. The drought in 1997 and 1998 caused severe sufferings amongst a great percentage of the population. In the wake of this episode, many water workshops and seminars were organised. WWP presented the keynote and concluding papers in EPSM's water workshop, an indoor talk for the Malaysian Nature Society, a paper in the Academy of Sciences Malaysia's seminar, a paper in the Global Environment Centre's water forum, many presentations in the Socio-Economic and Environmental Research Institute (SERI) series of lectures under the Sustainable Penang Initiative (SPI) for Penang, and this USM/JPS national conference on rivers. Many similar talks and lectures are lined up in the near future.

WWP's Education Programme for School Children and Website - WWP's main aim is to educate the young to love and monitor the health of our rivers. Hence, a Sungai Pinang "experience" was held for school children on 15th May 1999. This is one of WWP's major thrust towards instilling love for our rivers amongst our future generations. The idea is to target school children and educate them about river cleanliness. School children are taught about the cleanliness of rivers, water resources of rivers, flora and fauna depending on rivers, river pollution, factories pouring untreated effluents into rivers and bad habits of humans dumping rubbish into rivers etc. The students are taught some basic water monitoring tests and allowed to do it hands on in the river itself. About 30 students from Tanjong Bungah School took part. Students were briefed on the importance of water conservation and hence the need to keep our rivers clean. The group was then taught some basic water monitoring exercises in which they conducted the exercises themselves in the river. WWP hopes that this school will adopt this section of the Sg Air Terjun so that the students will monitor its "Health" by testing simple indicators such as the physical characteristics (velocity and discharge, cross-section area of river channel, temperature, colour, turbidity, presence of rubbish, smell/odour, flowing or stagnant water), the biological characteristics (presence of aquatic weeds, fish, and other aquatic wildlife) and the chemical characteristics (pH, Dissolved Oxygen and Conductivity).

When the students had finished their exercises at this location, they were then taken by bus to downstream Sg Pinang (at the Patani Road Bridge). Here, they conducted the same exercises and to their disgust, they found the huge contrast in river cleanliness between the two sites. Many refused to get into the river at the second site! The results of the exercises confirmed the vast difference in the quality of the river at the two different locations. The president then rounded up with a discussion as to the reasons for the change in water quality and cleanliness. Students were asked to recommend ways and means of cleaning up the second site. WWP will then help the school adopt the Sg Pinang as the school's "River". From then on, the school children will continue to monitor the cleanliness of the river. They then enter the data into their school's internet site (which is linked to WWP's internet site at <http://www.greenfield.fortunecity.com/leo/184>) via computer. WWP will do the same for other schools and all the students from the participating schools will be able to log on to their computers and view each other's data, talk to one another about river conservation, have discussion groups linked to their school subjects, ask WWP questions, plan further river projects, etc.).

WWP is a member based NGO. It depends on the voluntary service offered by members as well as from the public. Hence WWP has a programme called *Public Collaboration in Restoration of Rivers*. Since people are the end users, whether it be water supply or river use, it is vitally important that people are consulted and involved in programmes in which they are the target. There can be no success even with the best planned and best funded programmes if people do not participate or co-operate. The role of individuals should never be under-estimated. The combined effect of all individuals can be great. Individuals can save water, reuse water and reduce water use through a multitude of ways both at home and at work. Unless all three levels play their parts, the frequency and severity of water woes are set to become major problems in the coming millennium rapid development, urbanisation and population growth put additional demands on the country's water resources. WWP expects to involve as many people as possible in its programmes, whether directly or indirectly. WWP also acts as the mediator between people, water companies and government.

As a good example of a model for community participation in the management of rivers, WWP is currently carrying out "The Sg Kluang Neighbourhood Park". The Sg. Kluang is an important river which passes through the residential areas of Bayan Baru and Bukit Gedong as well as the Bayan Lepas Industrial Zone before it drains into the Western Channel near Pulau Jerejak. WWP is going into partnership with the Department of Irrigation and Drainage (DID), the Penang Development Corporation (PDC) and the local residents to develop a riverside park that will cater for the recreational needs of the Bayan Baru population as well as provide a mechanism for community participation in river management. The project consists of providing minimum landscaping, basic recreational amenities and a cycle track within an approximately 4 km stretch of the drainage reserve of the river. An administrative mechanism for community support and management of the park is also proposed which requires the support of the JPS and PDC. Benefits expected from this project are much needed park and recreational facilities in Bayan Baru, considerable enhancement of the river landscape and improved access for river maintenance and a reduction in the amount of waste thrown into the river along this stretch. Other benefits include a cycle and jogging track linking Sg. Ara to the coastal sea front which

can also be connected to the new residential areas in the north such as Bayan Bay and the Gold Coast development. Future phases can include extending the proposal upstream to improve the water quality of the river through a catchment management programme. So far, all parties appear enthusiastic about the project as it is probably the first time such a project is jointly undertaken by government, statutory body, NGO and the public.

CONCLUSION

There is no doubt that water will be the issue of the next millennium as this vital resource gets depleted and more polluted. As such, rivers which are the major suppliers of freshwater for human consumption (including for industries and agriculture), will become central to water availability. As the majority of rivers and their basins are already badly polluted, it is projected that water supply will fall short of demand. This will then put the brakes on future development, especially Malaysia's Vision 2020 to becoming a fully developed nation. Against this background of depleting water resources is the ever looming threat of population increase. All these will lead to more water crises. We must take stock of this.

More importantly, we must start taking proactive actions, even sacrifices, to protect, conserve and restore our rivers so that their waters can be sustained for future use. This is where people from all levels ranging from politicians, policy makers, private companies, NGOs to individuals can play an important part. River conservancy and restoration are currently tackled by the authorities. The example of the Sg Klang clean-up programme is encouraging but much needs to be done. For example, Even though the programme had gone through seven years of implementation, there has not been any significant change in water quality in the Klang River as the water for the river is still in class IV. This is where solid waste disposal and rubbish disposal have continued due to poor public response. The government has not really reached the people effectively. The beautification program appears quite successful and is well underway in meeting its targeted objective. Restoration of aquatic life in the river is not encouraging as large stretches remain poor in aquatic life. The authorities have also not tackled the squatter problem effectively although there is this vision by the Selangor State Government and DBKL of not having any more squatters within the basin by the year 2005. Because in-migration from other States as well as from neighbouring countries is expected to increase, squatters are expected to increase rather than decrease in the coming millennium. If we do not tackle the squatter problem and make people more responsible, there is little hope that any clean-up programme will be successful. To restore the Klang River to its once natural state with its full potential, the Government must not work alone. They need to involve NGOs and the people. River pollution and related water problems happens at the local level. Hence, decision making regarding solutions should be carried out at the lowest appropriate level, ideally involving all stakeholders ranging from government to the private sector, NOGs, the local community and schools. People should be the focus both in decision making as well as active "workers" involved with restoration work. If the people are not involved, they may not co-operate, not because of spite but because they are not aware. The motto of "Malaysia Boleh" (Malaysia Can) is not necessarily limited to the role of government alone.

Finally, more efforts and funding need to be injected to sustain the river clean-up programme. Some loose ends also need to be tightened. More importantly, the programme needs to be extended to all other rivers in the country. Government should also explore the option of working together with NGOs and the people in the cleaning and restoration of rivers. WWP and other NGOs offer an option, an extra tool in which authorities can use effectively to curb water demand. Authorities and water companies must get out of their accustomed role of being the sole-provider to being partners with NGOs and people for the benefit of the country. They can continue to play their pivotal role in water supply management but must increasingly employ a significant portion of their strategies on managing the demand side. While the authorities and water companies can build upon their expertise in the fields of basin-wide planning (especially when basins cut across borders), integrated catchment management, inter-state co-operation and water transfers, legislation on water conservation, enforcement of activities that threaten water resources, more effective pricing that encourages water saving and recycling, greater interaction and co-operation of government agencies in addressing water issues, and wider coverage of awareness

through educational programmes in the mass media, they must collaborate and involve the available NGOs with a view to greater effectiveness in sustainable management of our water resources.

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