

Cleaning of the Singapore River and Kallang Basin in Singapore: Economic, Social, and Environmental Dimensions

YUGAL KISHORE JOSHI*, CECILIA TORTAJADA** & ASIT K. BISWAS[†]

*Indian Railways, New Delhi, and formerly Lee Kuan Yew School of Public Policy, Singapore; **Third World Centre for Water Management, Mexico, and formerly Lee Kuan Yew School of Public Policy, National University of Singapore; [†]Lee Kuan Yew School of Public Policy, National University of Singapore

ABSTRACT *By 1977, decades of development and inadequate long-term planning in Singapore had resulted in heavy pollution in the waterways of the city-state, threatening its very survival. This paper analyzes the strategies for cleaning the Singapore River and Kallang Basin as part of an overall development plan which aimed at sustained growth. It also analyzes the economic, social, and environmental dimensions of these strategies not only to improve the conditions of the rivers and their surroundings, but also to develop the city-state, provide its population with an improved quality of life, including a clean environment, and most importantly, propel Singapore towards the path to sustainability and economic prosperity.*

Introduction

For decades, discussions on development and the environment in the international arena have mainly focused on a type of economic growth that is efficient in terms of use of natural resources and less harmful to the physical environment. During the years of discussions on the importance of environment in the development process, the focus of the dialogues has changed, terminology and concepts have evolved, discourses on specific issues have ebbed and flowed, and new and modified paradigms have been proposed. The net result, regrettably, has been that overall development practices have had limited impacts on poverty alleviation and that environmental conditions in many parts of the world continue deteriorating (Tortajada, 2005).

For nearly half a century, while most developed and developing countries have focused on the theory behind the development paradigms, Singapore has aimed at their implementation. From the time of its independence in 1965, aware of the fundamental importance of its limited natural resources, the city-state has implemented sound environmental policies to conserve its natural resources while concurrently planning for economic growth and development (Ooi, 2005). Along the years, its overall long-term planning, pragmatic

Corresponding Address: C. Tortajada, Third World Center for Water Management, Avenida Manantial Oriente 27, Los Clubes, Atizapán, Estado de México, 52958, México. Email: cecilia.tortajada@gmail.com

0790-0627 Print/1360-0648 Online/12/040647-12 © 2012 Taylor & Francis
<http://dx.doi.org/10.1080/07900627.2012.669034>

policies, clear visions, forward-looking strategies, and political will have continuously improved its foundations for sustainable development.

One of the main activities Singapore implemented as part of its strategy for sustainable development was the clean-up of its several river systems, which were grossly polluted when the city-state became independent in 1965. Fortunately, it had a visionary and dynamic prime minister, Lee Kuan Yew, who by any account was well ahead of his time. In 1969, he asked the relevant government departments to draw up and implement a plan which would clean up the rivers of the city-state. In 1977, disappointed with the progress of the departments, whose main concern was the cost of implementation of the plan, he gave them 10 years to complete the operations. True to Singapore style, the strategy for cleaning up the Singapore River (historically the most important trade artery) and the Kallang Basin was implemented within this time. A cursory analysis of the benefits of the clean-up, including the phenomenal increase in commercial and industrial activities and land values around the banks of the rivers, in addition to the significant health, social, and environmental benefits, indicates the vision of Prime Minister Lee.

This paper analyzes the strategies that were adopted to clean its river systems and how these were successfully implemented. It also analyzes the economic, social, and environmental dimensions of these strategies, whose objectives were to develop the city-state, provide its population with an improved quality of life and a cleaner environment, and most importantly, propel Singapore towards the right path to sustainability and economic prosperity.

River Systems

The Singapore River has a maximum navigable length of 2.95 km from where it starts at Kim Seng Bridge to its mouth at Marina Basin. Its width varies from 160 m at Boat Quay to 20 m at Kim Seng Bridge. The Kallang River, the longest river in Singapore, flows for 10 km from the Lower Peirce Reservoir to the sea. The Kallang Basin drains five main rivers: Bukit Timah/Rochor, Sungei Whampoa, Sungei Kallang, Pelton, and Geylang. The Singapore River drains a catchment area of about 1,500 ha, and the total drainage area of the Rochor, Kallang, and Geylang is 7,800 ha (Yap, 1986). The Singapore River joins with the five rivers from the Kallang Basin at the city front, and together they flow out to the sea through Marina Bay. Although they are not large rivers, their economic importance and social and environmental relevance to Singapore is akin to that of the great rivers of the world in the countries through which they flow (see Figure 1).

Increasing trade and the related urban and industrial growth from the 19th century onwards contributed very quickly to serious pollution of the Singapore River. As early as 1822, Sir Stamford Raffles, who founded Singapore in 1819, established a committee to look into the state of the river and found that a considerable amount of sand had been aggregated around its mouth because of the construction of jetties on the North Boat Quay side of the river. Throughout the years, several committees and commissions were established to investigate ways of cleaning and deepening the river to try to solve the serious problems resulting from both heavy sedimentation and serious pollution. Nonetheless, the different recommendations that were made by the various bodies were not implemented, mostly due to financial constraints, because they involved land acquisition and replacement or construction of bridges across the river (National Archives, 1953, 1955; Dobbs, 2003; Tan, 2009).

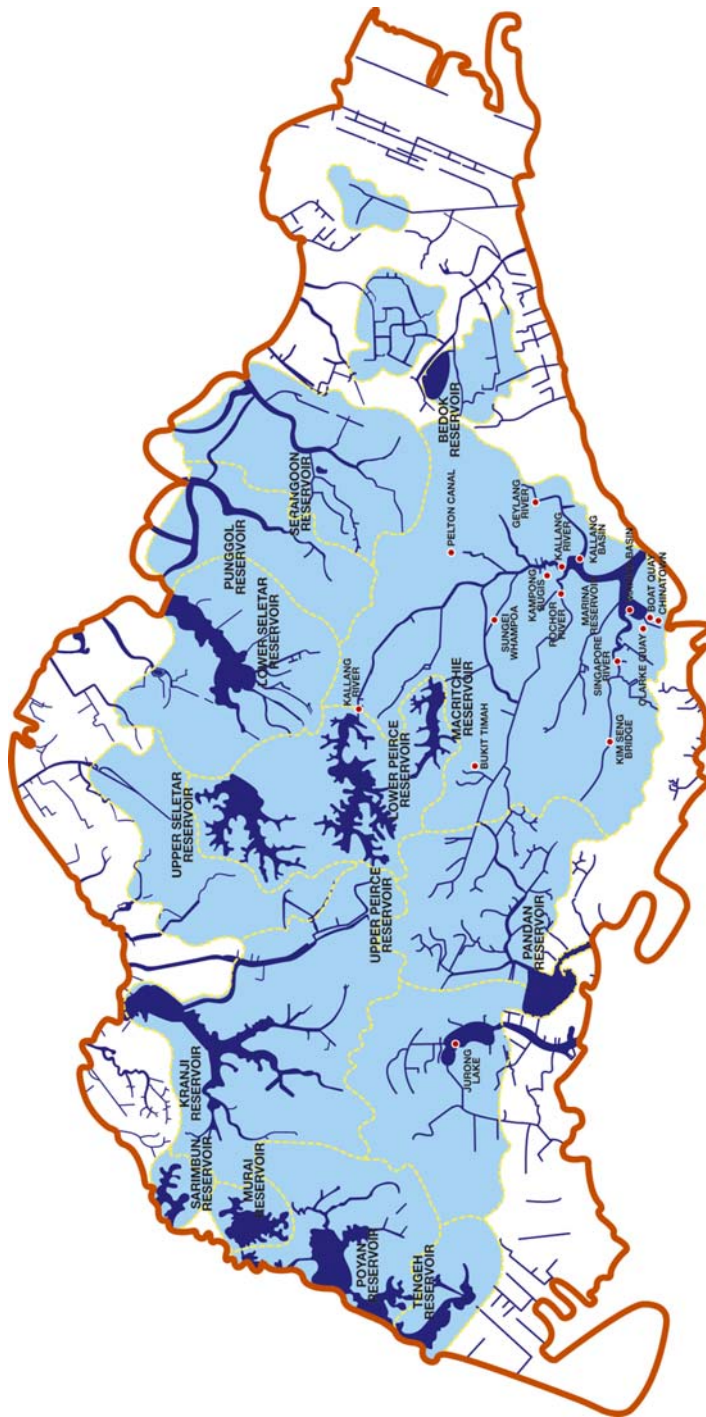


Figure 1. Map showing the catchment areas of the Singapore River and Kallang Basin.

With the passage of time, the Singapore River became increasingly polluted, with rubbish perennially floating in its waters (National Archives, 1967). Stench pervaded the area surrounding the rivers from discharges of organic and inorganic wastes. Pig and duck farms, squatters, backyard trades, cottage industries, latrines, street hawkers, vegetable vendors, boat repair and other riverside activities, sullage water from houses, refuse from unsewered houses dumped directly into the streams, and so on, had made not only the Singapore River, but all rivers in the city-state, grossly polluted and with no sign of aquatic life (Ministry of Environment, 1987). Prime Minister Lee noted that a blind clerk who worked for his wife could discern when his bus neared the Singapore River because of the stench (personal communication, 2010).

Planning for Development

One of the most pressing problems that post-colonial Singapore faced was a serious shortage of housing. The ruling political party, the People's Action Party, developed a 5-year plan to improve the quality of life of the population, to give citizens a sense of ownership, and to solve the problems related to the economy, including lack of housing and overcrowding in the Central Area. The first and main piece of legislation to this effect was the Housing and Development Act of 1960, which gave the Ministry of National Development authority to administer a low-cost housing programme (Quah, 1983). This programme included the clearance of slums, construction, conversion, improvement, and extension of any building for sale, lease, rental, or other purposes. Institutions were established to develop public housing and also to promote economic growth. The Housing Development Board (HDB), established on 1 February 1960, was the first statutory board to tackle the serious housing shortages. This was followed by the creation of the People's Association on 1 July 1960 to deal with the communist and communal threats by controlling and coordinating the 28 community centres it inherited. The Economic Development Board was the other statutory board, established one and half years later to solve the growing unemployment problem by attracting foreign investments to Singapore (Quah, 2010).

Singapore achieved independence in 1965. Thereafter, its overall economic growth rate was unprecedented. Its gross domestic product (GDP) increased by a compounded annual rate of over 9% during the 1960s and its industrial production increased by more than 20%. In 1968, Singapore was made headquarters of the Asian Dollar Market, and in 1969 it became a gold market so important that it surpassed Hong Kong and Beirut (Turnbull, 2009). Singapore's ship building and repairing business almost doubled, from S\$64 million in 1966 to S\$120 million in 1968. In 1969, the city-state became the busiest port in the Commonwealth, surpassing London. Manufacturing activities increased in Jurong after the town was reorganized into the Jurong Town Corporation, which also managed 11 other industrial estates.

By 1970, Singapore achieved a state of near-full employment and needed to relax its immigration laws in order to attract more workers. By the end of the same year, Jurong had 264 production factories employing 32,000 workers and another 106 factories under construction (Turnbull, 1977). The government of Singapore decided very early that its economic growth should not be at the expense of its environment. On the contrary, it recognized that a clean and green environment was essential to attracting the investment and retaining the talent which would support further growth. Along the years, the city-state

has therefore invested in critical environmental infrastructure, despite competing demands for funding. Examples include S\$2,000 million spent on drainage development projects, S\$3,650 million earmarked for the Deep Tunnel Sewerage System, and some S\$300 million for the Singapore River clean-up.

Change Triggered by Political Will

Structural, institutional, and legal reforms were essential for the development of Singapore and also to achieve significant reductions in terms of sources of pollution that were going into the rivers. Prime Minister Lee Kuan Yew did not consider river pollution as an isolated problem: he rightly noted that it was the end result of all other pollution problems prevalent in the city-state. If the nation was to develop as a productive industrial society, and the population was to be provided with an improved quality of life, the solutions to the issues affecting the population of Singapore in general, and those living around the Singapore River in particular, had to be considered, planned, and implemented within an overall framework that would consider financial, legal, institutional, policy, and management issues.

In March 1969, Prime Minister Lee called on the drainage engineers in the Public Works Department and water engineers in the Public Utility Board to work together on a plan to solve the environmental problems associated with the rivers of Singapore. He laid stress on the necessity of controlling land-based pollutants and emphasized the need to restore the river banks (National Archives, 1969a). A flurry of activities took place as part of this initiative. Within two weeks, meetings between the principal agencies took place, pollution sources were identified, and solutions for reducing the river pollution levels were proposed. Unlike pre-independence administrations, the prime minister was interested in more than just discussions. This time, feedback to the prime minister was stressed in the correspondence between the government departments and ministries (National Archives, 1969b).

In fact, the prime minister had already expressed his interest in cleaning the Singapore River from 1968. It was during that year that his government passed a strict Environmental Health Act which called for the prosecution of anyone found to be polluting the rivers. At that time, the discussions and progress reports regularly referred back to the prime minister, and a sense of urgency and the expectation of rapid results were reflected in the activities undertaken (National Archives, 1969c). An Atmospheric and Effluent Pollution Study Group was formed to carry out detailed analyses of the Singapore River bed, water, and air, to determine what pollutants and gases were present in and around the river. As expected, the study concluded that the river was highly contaminated with organic matter.

An immediate technical solution was to spread several tonnes of sodium hypochlorite at specific locations of the river to mitigate the situation. However, it was quickly realized that this was not a practical way to solve the pollution problem (National Archives, 1969d). The interim reports produced during 1969 identified that the main sources of pollution were domestic and industrial discharges as well as trash thrown into the river (National Archives, 1969e). The reasons behind these sources were identified. For example, much of the domestic waste was from people living along the rivers or in the river catchment areas, with old settlements like Chinatown representing a source of considerable water pollution. It was subsequently decided that hawkers, squatters, makeshift industries (with the exception of the lighterage industry), storehouses, and others who made their living alongside the river, would have to be relocated to other areas as soon as possible.

In August 1969, the boat-builders were among the first to be informed that they would have to be relocated away from the river, along with the firewood and the charcoal dealers, who were also important sources of pollution. Notices were served to businesses and individual premises all along the river. Provisions were also made through the HDB for affected individuals and businesses to receive housing and commercial premises on a priority basis (Dobbs, 2003; National Archives, 1970).

Relocation campaigns received broad media coverage. Nevertheless, the people who were to be relocated were reluctant to move, even after receiving offers of compensation and allocation of new housing and/or business premises. Some of the members of Parliament expressed their concern over the actions that were to be taken against unauthorized facilities located along the banks of the Singapore River (National Archives, 1971a). Since the government was very keen to carry out the operation with as little confrontation and bad press as possible, the resettlement of unauthorized hawkers (National Archives, 1971b) and squatters continued, but the speed of the removal proceedings remained slow.

The Cleaning Operation, 1977–1986

By early 1977, much of the environmental work and control activities of the river-polluting sources had already been planned or were under consideration by the appropriate authorities. The cleaning of the various rivers had progressed close to the mouth of the basin, but the mouth itself and the catchment areas still represented a major challenge in ensuring significant improvement in water quality. This is because some 44,000 squatters were still living in unsanitary conditions in the vicinity of the rivers, and liquid and solid wastes from the hawkers, vegetable vendors and markets, and unsewered premises continued to represent various sources of pollution. In addition, 610 pig farms and 500 duck farms were still draining untreated wastes into the rivers, especially into the Kallang Basin (Dobbs, 2003).

In 1977, despite the HDB's rapid pace of construction of flats, there were still 46,187 premises with squatters, the majority of which used night-soil buckets or pit latrines. Some had overhanging latrines that discharged wastes directly into the water bodies (Chou, 1998). The Kallang Basin had the largest number of squatters (42,228), followed by the Singapore River (with a total number of 3,959). The wastes generated by 4,926 hawkers and wholesale vegetable vendors who worked along the roads ended up putrefying in the drains and eventually polluting the rivers. The industries on the banks of the rivers, such as trading, lighterage, cargo handling, and boat building and repairing were housed in old and congested buildings. Due to the absence of pollution control facilities, oil, sullage water, and solid wastes were discharged to the river, which further contributed to its already severe pollution.

Meanwhile, the importance of the Singapore River in terms of entrepot trade had changed. By the 1970s, the Port of Singapore Authority was handling most of the cargo moving through Singapore. Port facilities developed exponentially throughout the 1970s, as a result of which the port became one of the busiest harbours in the world, with technological improvements in cargo handling playing a major role in this rapid transformation. By mid-1972, Singapore was already opening the first container port in the region, with two more under construction and due for completion in 1978. This meant that the Singapore River, once vital in terms of trade, rapidly became insignificant, becoming a "graveyard for derelict lighters" (Dobbs, 2003, p. 110). Once it was evident that the river no longer played

the fundamental role in Singapore's trade that it had earlier, it became easier for the government to proceed with the cleaning operations.

On 27 February 1977, during the opening ceremony of the Upper Peirce Reservoir, Prime Minister Lee gave a definite target to the Ministry of Environment to clean the Singapore River and Kallang Basin (Hon, 1990, p. 41). The urgency and seriousness shown by the prime minister were clear to every government agency. This was evident from the fact that the requests sent by the Ministry of Environment for funds for proposed tasks to clean up the rivers were agreed to by the Finance Ministry immediately (Hon, 1990). The Ministry of Environment became the coordinator of the action plan that was formulated jointly with the Drainage Department, after identifying major sources of pollution. The Master Plan for the Cleaning of the Singapore River and Kallang Basin was drafted after eight months of study (Chou, 1998). The plan recognized the complexity of the problem and the need to involve various ministries and government agencies. As the catchments represented approximately 30% of Singapore's land area, it was a challenge for the planners to decide how to prevent polluting activities of very varied nature which were also located far from the rivers (Tan, 2009).

By the time the plan for cleaning the rivers was implemented and the corresponding programmes were started in 1978, some 21,002 unsewered premises had been identified in other parts of the city-state (Chiang, 1986). These unsewered areas were densely populated with squatters, and the difficulty of accessing them made the cleaning operation almost impossible. Most of these unsewered premises were served by night-soil buckets, pits, and overhanging buckets, which were unsanitary, a source of smell, and a serious source of water pollution. At the beginning of the programme, 11,847 night-soil bucket latrines were identified. All of them were phased out, except for 533 which were sewerred. The last night-soil bucket was phased out in 1987. Similarly, all 621 overhanging latrines were also phased out. The 3,961 unsewered premises which discharged sullage water into the water bodies in 1977 were reduced to 36, and the 710 premises without refuse-removal services were reduced to 129 by September 1981 (National Archives, 1981). Sand-washing was controlled by phasing out private sand quarries and by centralizing such activities under a public holding company so that they could be properly managed.

The main objective of the action plan was to restore the water quality of the Singapore River and the Kallang Basin so that aquatic life could thrive in them. The objective was expected to be achieved basically in terms of five major activities: removal or relocation of polluting sources and phasing out of polluting industries; development of suitable infrastructure for those affected by relocation; awareness about the overall development programme; strict law enforcement; and cleaning and dredging of the waterway (for the overall strategies of water-related development of Singapore, see Tortajada *et al.*, Forthcoming).

One of the main challenges that both the Government of Singapore and the population faced together during the implementation of the cleaning operation was the resettlement of the population and the relocation or phasing out of industrial and commercial activities.

Resettlement, Relocation, and Phasing-Out Activities

The Resettlement Department, under the HDB, was the main authority in terms of land clearance and resettlement of the squatters. Within the clean-up programme, high priority was given to the clearance of the squatter colonies and run-down urban areas in order to

proceed with redevelopment. An 8-year target was established for the completion of this programme (Tan, 1986).

Squatters were resettled under a resettlement policy which was first introduced during 1960s. Under the policy, which was applicable to Singapore nationals only, all persons and business establishments affected by resettlement were to be offered housing and compensation (Tan, 2009). In 1978, about half of the 46,187 squatters were on privately-owned land. According to the resettlement plan, the land would first be acquired by the land acquisition authorities before it could be cleared. Timely construction of suitable infrastructure at new places to relocate large numbers of shops and backyard industries represented a major challenge for the authorities.

The Resettlement Department divided the squatters into three categories based on the amount and type of pollution they generated. The serious sources of pollution, such as pig farms, were cleared on an urgent basis. Some 675 pig farms were scheduled for complete clearance by 1981 as a top priority. The second priority was the squatter colonies in the catchment areas that were planned for relocation to housing estates in new towns. Finally, the pockets of land which would become open spaces, greenery, or future development, were left to the last stage of the clearance process (Loy, 1986).

Clearance and relocation programmes were based on census surveys of the affected squatters. Eviction notices were given by the Land Office, Resettlement Department, HDB, or Jurong Town Corporation, depending upon who owned the land. Squatters were given eviction notices several times, including repeated warnings, to convince them to relocate; severe actions were taken against non-compliant squatters as well as against those persons who delayed their departure without valid reasons.

In general, all persons and business establishments affected by resettlement were offered compensation, as well as housing that was of much better quality than they had before. They also benefited from concessions in rents or waivers of down-payments on their facilities. Squatters were compensated at fixed, government-approved rates, which were *ex gratia* in nature. For example, farmers were paid approximately S\$205/m² for their houses, while squatters were compensated at a rate of S\$105/m² of housing. Grants in cash were given to farmers in lieu of alternative farm lands. Residential families and business establishments living in the central urban areas who preferred to arrange for their own accommodation were also given cash compensations (Tan, 1986). Table 1 shows the numbers of squatters in the Singapore River and the Kallang Basin that were relocated.

Table 1. Squatters cleared in the Singapore River and Kallang Basin.

Catchment area	Target number of squatters to be cleared	By 1979		By 1981		By 1983		By 1985 (September)	
		Squatters cleared	%	Squatters cleared	%	Squatters cleared	%	Squatters cleared	%
Singapore River	3,959	1,097	27.7	1,921	48.5	3,213	81.2	3,744	94.5
Kallang Basin	42,228	9,657	22.9	24,781	58.7	34,596	86.9	40,830	96.7
Total	46,187	10,754	23.3	26,702	57.8	37,809	81.9	44,574	96.5

Source: Tan (1986).

The unpleasant experience of resettlement from a familiar location to a fairly new environment was mostly offset by a wide range of resettlement benefits that covered the needs of the affected population in order to minimize the related inconveniences. The political stability and fast economic growth during this period further helped in making resettlement less painful to the affected people and enterprises.

Close and effective coordination between the Resettlement and Planning Departments ensured that alternative housing was constructed before the squatters were moved. Nonetheless, resettlement proved difficult for businesses; most owners continued to reject the sites proposed for their new facilities. Eventually, population and businesses settled down to the new places offered. This, in turn, proved beneficial for all the population in the long run (Hon, 1990). For example, Kampong Bugis, located within the catchment of the Kallang Basin, was considered a fire hazard, a death trap, and a slum close to the city, in addition to being one of the main sources of pollution for the catchment of the basin. There were 3,000 people living in wooden houses squeezed into every inch of land without proper sanitation. In 1982 it had 151 industries of some sort, 5 large warehouses, 12 boatyards, 50 shops, 12 Chinese temples, and 1,137 families. After more than two decades of the cleaning of this area, it is now one of the most urbanized landscapes in Singapore (Mak, 1986) (see Figure 1).

By 1986, all the squatters had been resettled, meeting the 8-year deadline for clearing the catchment area. These areas were then successfully developed by the HDB into housing estates, new towns, and industrial parks.

Initially, resettlement was very slow, mainly because of a shortage of alternative accommodations for the squatters and their shops, as well as for the industries. With the objective to expedite the process, the Jurong Town Corporation requested that the HDB provide support through the construction of more flats. It was then announced that more units for relocation would be available in 1984 and 1985. For the local industries, special-purpose workshops were built, and some of the industrial units were also relocated to factories in rentable, modular units of 100 m² to suit their needs (Mak, 1986).

Boat-builders and boat-repairers were also relocated in suitable places. Within two years after locations were identified, roads, drains, bridges, and sewers were completed and the resettlement process was started. Finally, by December 1985, all of them had been relocated.

Lessons Learnt

The massive operations faced numerous difficulties and challenges but also innumerable successes and achievements.

In terms of construction of public housing, the HDB decided to build housing estates within a radius of five miles from the city centre. The activities of most of the people were in the Central Area; they were not prepared to move to housing estates away from their jobs if transportation costs were high (HDB, 1963; Waller, 2001). This provided an opportunity to relocate the population from slums to high-rise public housing, and in the process upgrade the level of services provided in terms of water supply (from community standpipes to direct water supply for all households), gas, and electricity. To give an idea of the extent of the public housing that was necessary, it has been estimated that the demolition of each shop-house in the central area required the construction of a minimum of 5 to 8 units of public housing flats to relocate the affected population (Chew, 1973).

In terms of direct impacts on the affected population, more than 26,000 families were resettled. Most of them moved into public housing built by the HDB, improving their

quality of life as well as living conditions very significantly. All 4,926 hawkers were relocated into food centres built by the HDB, the Urban Redevelopment Authority, and the Ministry of the Environment. By 1986, there were no unlicensed hawkers in Singapore.

In January 1984, the vegetable wholesalers were relocated to a new wholesale market built by the HDB at a cost of S\$27.6 million (Ministry of Environment, 1987). More than 2,800 industrial cases of backyard trades and cottage industries were relocated, and most of them moved into the industrial estates built by the HDB and Jurong Town Corporation.

Regarding farming activities, by March 1982, the Primary Production Department had phased out all pig and duck farms from the catchment areas.

By September 1983, lighterage activities involving some 800 lighters were relocated to a new area where mooring and upgraded facilities were provided by the Port of Singapore Authority at a cost of S\$25 million. The task of physically cleaning up the rivers became easier after the relocation of the lighters. From 1982 to 1984, 2,000 tonnes of refuse were removed from the Singapore, Kallang, Geylang, and Rochor rivers (Poon, 1986). The Drainage Department dredged approximately 40,000 m³ of sediments from the Singapore River and about 600,000 m³ from the Rochor and Kallang rivers (Yap, 1986). In December 1986, the charcoal trade was relocated from Geylang River to a location where appropriate facilities had been constructed by the HDB at a cost of S\$5.66 million.

The public housing development programme had a huge impact on the provision of water supply. The number of HDB units had increased exponentially, from 19,879 in 1960 to 118,544 in 1970. Each flat was provided with direct piped water supply, which was metered. The number of metered connections increased from 102,819 in 1960 to 264,314 in 1970. In fact, more than 90% of the increase in the number of meters was due to the increase in public flats.

The length of water distribution and supply main also increased, from about 1,200 km and 80 km in 1960, to 1,840 km and 104 km, respectively, in 1970. More than 65% of the increase in the length of the distribution mains was to serve villages and HDB estates outside the city area. During the same period, the number of standpipes decreased, from 2,224 in 1960 to 528 in 1970. Thus, the HDB development programme played an important role, not only in increasing the number and quality of housing units but also in increasing the coverage of water supply. It is important to note that this extraordinary improvement was made before the creation of long-term plans such as the 1971 Concept Plan and the 1972 Water Master Plan. Thus, even without these plans, the institutional coordination between the HDB and the Public Utilities Board allowed the Public Utilities Board to develop the necessary infrastructure for water supply to ensure that the new housing developments were not only available on time but also had better services compared to where the people had lived before.

Overall, in terms of investments, Chou (1998) estimates the total costs incurred at S\$200 million. He also cites some of the specific expenditures, such as S\$21 million to form beaches in the Kallang Basin, S\$13 million for removing mud and other structures, and expenditures incurred by the Port of Singapore Authority, the HDB, and other government agencies as discussed earlier. Leitmann (2000) also puts the cleaning cost at S\$200 million, excluding the costs of public housing, food centres, industrial workshops, and sewerage. According to Tan (2009), however, the clean-up cost the government nearly S\$300 million, excluding resettlement compensations. It is not clear whether this figure includes costs incurred directly and indirectly in manpower, time, education programmes in schools and for the public, and so on.

The figures given by Tan (2009) are the most recent. Therefore, one can conclude that the Singapore government had to pay roughly ten times the original estimated price because of the delay in cleaning its rivers. An important lesson for any governments trying to control pollution in their water courses is that delay, or insufficient action, increases the total costs exponentially.

When the costs of the river cleaning programme are compared with the benefits, it is clear that it was an excellent investment. The river cleaning programme had numerous direct and indirect benefits, since it unleashed many development-related activities which transformed the face of Singapore and enhanced its image as a model city in terms of urban planning and development. The value of land and its demand along the waterways and catchments increased many-fold and very large investments were made to attract tourism, recreation, and business-related activities by both the government and the private sector. For example, the Boat Quay and Clark Quay areas were developed as two main entertainment areas. Overall, the programme left a valuable legacy for future generations and gave the present one a refreshing sense of achievement.

Similarly, Kallang Basin's new sandy beaches and parks transformed it into a location for water sports and other recreational activities, promenades, and numerous commercial activities. In addition to these, the river clean-up supported other long-term development plans. Economic development along the banks of the Singapore River, for example, or construction of a mass rapid-transit tunnel under the Singapore River, would have been impossible if the river and its surroundings had remained severely congested and polluted.

The most important lesson, however, is the exemplary political will of the leadership in Singapore, who envisioned and encouraged a sustained process of social and economic development through which the quality of life of the population could be improved, sustainable development could be achieved, the environment could be protected, and the city-state could place itself in the right track of sustainability. Lee, the visionary prime minister, realized in the 1960s that holistic long-term policies that promote coordination among the different agencies and different sectors in the city-state were worth pursuing, in spite of their complexity. This is the only way to achieve economic, social, and environmental gains for the people of Singapore, not only at present but also in the future. This is a lesson that the rest of the countries of the world should learn and then emulate as a very salutary example.

Acknowledgements

This paper is part of a broader research project on urban water management in Singapore sponsored by the Lee Kuan Yew School of Public Policy, NUS, Singapore, and the Third World Centre for Water Management, Mexico.

References

- Chew, C. S. (1973) Key elements in the urban renewal of Singapore, in: Chuan Peng Chye (Ed.). *Planning in Singapore, Selected Aspects and Issues*, pp. 32–44 (Singapore: Chopmen Enterprises).
- Chiang, K. M. (1986) The cleaning up of Singapore River and the Kallang Basin catchments. Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).
- Chou, L. M. (1998) The cleaning of Singapore River and the Kallang Basin: approaches, methods, investments and benefits, *Ocean and Coastal Management*, 38, pp. 133–145.
- Dobbs, S. (2003) *The Singapore River: A Social History 1819–2002* (Singapore: Singapore University Press).

- Hon, J. (1990) *Tidal Fortunes: A Story of Change. The Singapore River and the Kallang Basin* (Singapore: Landmark Books).
- Housing and Development Board (HDB)(1993) *Housing and Development Report. Annual Report 1960* (Singapore: Government Printing Office).
- Leitmann, J. (2000) *Integrating the Environment in Urban Development: Singapore as a Model of Good Practice*, Urban Waste Management Working Paper No. 7 (Washington, DC: Urban Development Division, World Bank). Available at http://www.ucl.ac.uk/dpu-projects/drivers_urb_change/urb_environment/pdf_Planning/World%20Bank_Leitmann_Josef_Integrating_Environment_Singapore.pdf (accessed 26 October 2011).
- Loy, W. S. (1986) Phasing out of pig and open range duck farms in water catchments, Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).
- Mak, K. C. (1986) Jurong Town Corporation: a case study on resettlement of squatters and backyard industries in Kampong Bugis, Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).
- Ministry of Environment (1987) *Clean Rivers: The Cleaning Up of Singapore River and Kallang Basin* (Singapore: Ministry of Environment).
- National Archives (1953) Government Order, CSO, 1163/53/21, PWD 223/53 Vol. I, 9 September, Singapore.
- National Archives (1955) SEE (C&M) 198/53, p. 143, 28 September, Singapore.
- National Archives (1967) Letter from Sim Ki Boon (a member of advisory board to the government) to Permanent Secretary, Ministry of National Development, PWD 223/53, Vol. IV, p. 44.
- National Archives (1969a) Prime Minister's memorandum to Wong Chooi Sen, PWD 223/53, Vol. V, p. 100A, 26 March, Singapore.
- National Archives (1969b) Lionel de Rosario's letter, PWD/223/53, Vol. IV, p. 167, 10 October, Singapore.
- National Archives (1969c) Various communications and interim reports, available in File no. PWD/223/53, Vol. IV.
- National Archives (1969d) Letter from Director of Public Works to Chief Chemist, PWD/223/53, Vol. IV, p. 121, 2 June, Singapore.
- National Archives (1969e) Interim Report on Improvement to Rivers and Canals in Singapore, draft submitted by Ling Teck Luke, Ag. SEE (D&M), PWD/223/53, Vol. IV, p. 181A, Singapore.
- National Archives (1970) Various communications and interim reports, available in File no. PWD/223/53, Vol. V, Singapore.
- National Archives (1971a) Letter from Hon Sui Sen, M.P. for Havelock, to Director, PWD/223/53, Vol. V, p. 117, 24 May, Singapore.
- National Archives (1971b) (D&M)/PWD's letters to Supdt. Hawker Branch, Ministry of Health, PWD (D&M)/450/6, No. 223/53, Vol. V, pp. 112 and 118, 14 April and 25 May, Singapore.
- National Archives (1981) *Progress Report on Cleaning Up of Singapore River/Kallang Basin and all Water Catchments (1977–September 1981)*, Ministry of Environment, PWD 223/53, Vol. VI, p. 15A, Singapore.
- Ooi, G. L. (2005) *Sustainability and Cities: Concepts and Assessments* (Singapore: World Scientific).
- Poon, I. H. (1986) PSA's role in the cleaning up programme, Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).
- Quah, J. S. T. (2010) *Public Administration Singapore Style* (Bingley: Emerald Group).
- Quah, S. R. (1983) Social discipline in Singapore: an alternative for the resolution of social problems, *Journal of Southeast Asian Studies*, 14(2), pp. 266–289.
- Tan, W. T. (1986) The HDB Resettlement Department and its role in the cleaning up programme of Singapore River and the Kallang Basin catchments, Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).
- Tan, Y. S. (2009) *Clean, Green and Blue* (Singapore: Institute of Southeast Asian Studies).
- Tortajada, C. (2005) Sustainable development: a critical assessment of past and present views, in: A. K. Biswas & C. Tortajada (Eds) *Appraising Sustainable Development: Water Management and Environmental Challenges*, pp. 1–17 (New Delhi: Oxford University Press).
- Tortajada, C., Biswas, A. K. & Joshi, Y. K. (Forthcoming) *Singapore Water Story* (Singapore: Routledge).
- Turnbull, C. M. (1977) *A History of Singapore 1819–1975* (Singapore: Oxford University Press).
- Turnbull, C. M. (2009) *A History of Singapore 1819–2005* (Singapore: NUS Press).
- Waller, E. (2001) *Landscape Planning in Singapore* (Singapore: Singapore University Press).
- Yap, K. G. (1986) Physical improvement works to the Singapore River and the Kallang Basin, Paper presented at *COBSEA Workshop on Cleaning-up of Urban River*, 14–16 January, Singapore (Ministry of the Environment of Singapore and UNEP).