

INTEGRATING THE ENVIRONMENT IN URBAN DEVELOPMENT: GOOD PRACTICE IN SINGAPORE*

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BACKGROUND

Singapore is a highly industrialized and urbanized city-state of three million people located in Southeast Asia. The city-state is located on an island of 647 km², nearly half of which is built-up; road infrastructure covers another 11% of the island's land mass. Singapore's economy developed rapidly, growing from a GNP per capita of \$1972 in 1971 to \$22,541 in 1995. During the past 30 years, the population has doubled, the urbanized area of the island has doubled, housing units trebled, and industrial land grew six-fold (Tan, 1995).

This rapid growth is largely attributed to Singapore's interventionist development strategy. With the loss of the Malaysian domestic market, stagnation of the *entrepot* trade and withdrawal of the British military at independence in 1965, the Government focused on labor-intensive manufacturing for export. Multinationals were drawn in with investment incentives as the local private sector had little industrial experience. By the early 1970s, the city had become the regional service and refining center for the petroleum industry and a regional finance center. Gradually, capital intensive production such as the electronics industry began to replace labor-intensive manufacturing (Murray and Perera, 1996).

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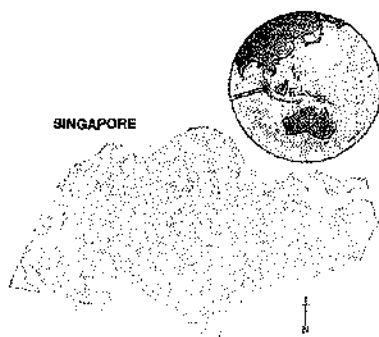


Figure 1. Location of Singapore



Figure 2. A panoramic view of downtown Singapore (ENV, 1997d, 4).

Part of Singapore's environmental profile can be attributed to changes in its economic structure. In 1961, the natural resource-intensive and polluting sectors of food, printing and publishing, and wood products accounted for 40% of industrial employment. By 1991, these sectors had dropped to only 8% while electronics and electrical appliances had risen to 40% (Chiu, *et al.*, 1997). However, much of Singapore's environmental success is due to its activist approaches to environmental planning and management.

Singapore became a republic in 1965. Since then, it has had a stable democratic government dominated by strong leadership. The leadership has consistently been devoted to economic development planning in order to raise the standard of living of its citizens. This approach eventually included the environment as part of a strategy of improving overall quality of life. The city-state is also multi-ethnic so care has been taken to ensure that all groups benefit from economic growth and environmental quality.

STYLES OF ENVIRONMENTAL PLANNING

Environmental planning in Singapore can be divided into three phases:

- before the Ministry of the Environment (ENV) - from colonial times until 1972;
- the formative years of the Ministry of the Environment - from 1972 to 1992; and
- the 'Green Plan' period - 1992 to the present.

Before the Ministry of the Environment

Prior to creation of the Ministry, a diverse set of actors focused primarily on environmental health and infrastructure issues. A body of Municipal Commissioners was created in 1856 which gradually took responsibility for health and sanitation problems. A Municipal Health Department was created in 1887 with a focus on controlling infectious diseases and inspecting food. The first water-borne sewerage network was completed in 1917. Efforts were initiated in the 1920s to manage solid waste and maintain drains. The net result of these activities was a visible improvement in public health by the 1950s.

Following self-government in 1959, many environmental services were combined. A Public Health Division in the Ministry of Health was given responsibility for all aspects of environmental health. Sewerage and drainage were carried out by the Ministry of National Development. Water supply was the responsibility of the Public Utilities Board.

In the early 1960s, these services participated in two projects that were keys to Singapore's future: the Jurong Industrial Estate (for promotion of industrial growth) and the Toa Payoh Satellite Town (the first of Singapore's widespread public housing estates). Environmental health staff helped formulate approaches for controlling industrial waste from Jurong. The Ministry of National Development ensured that sewerage and sewage treatment were developed as part of the new satellite town.

After independence in 1965, environmental planning for the remainder of the decade focused on:

- public cleansing, especially of drains and street vendor sites;
- licensing and control of street vendors;
- control of key disease vectors, especially for malaria and dengue fever;
- flood control; and
- expansion of the sewer network.

Despite these initiatives, Singapore at the end of the 1960s was faced with a number of environmental problems linked to urbanization and economic growth: air and water pollution, industrial hazards, dust, and noise.

In the early 1970s, environmental legislation and regulations became important tools for environmental planning. Laws were passed prohibiting smoking in specified public places, limiting emissions of air pollutants and making it easier to control food quality. Regulations were passed to allow for controlled discharge of industrial and commercial effluents into public sewers after necessary treatment. These were backed up by enforcement measures. For example, the Public Works Department's Sewerage Branch was made responsible for identifying sources of industrial pollution and ensuring that industrial wastes were properly discharged into sewers. Air quality was monitored by an Anti-Pollution Unit in the Prime Minister's Office and applications to build new factories were evaluated to determine whether they complied with anti-pollution requirements.

Overall, Singapore's early environmental planning style had the following characteristics:

- an early and sustained focus on themes of environmental health;
- attempts to integrate environmental features in major development initiatives such as industrial projects and public housing;
- relatively clear, but changing, lines of responsibility for environmental management;
- a relatively high level of priority attached to environmental protection, though less so to natural resource management;
- an increasing emphasis on regulatory and other command-and-control measures to deal with environmental issues;
- very little island-wide integrated environmental planning; and
- government-driven policy and implementation that involved relatively few stakeholders in decision-making.

Ministry of the Environment Era

Despite these efforts, the Government felt that a centralized organization was needed to deal with problems of pollution and environmental health. So, the Ministry of the Environment was created in September 1972. The new Ministry was composed of two divisions: Environmental Public Health (food inspection, epidemiology, quarantine, street vendors, vector control, cemeteries, research) and Environmental Engineering (sewerage, solid waste disposal, drainage, public health engineering). During its first year of operation, the Ministry focused on enforcing industrial pollution control, mechanizing solid waste collection, combating an outbreak of cholera through upgrading hygiene food handlers, and planning a waste incineration plant.

Over the next twenty years, the ENV refined its approach to pollution control. Numerous examples of developments during this period are provided in the section on 'Innovative Programs' below. Key characteristics of environmental planning during this period were:

- Use of campaigns to focus resources and public attention on priority problems. The most significant of these was the ten-year clean-up campaign for the Singapore River and Kallang Basin (see the Water Resources Management section below);
- Using land use planning as a means of preventing pollution. Only new developments that are environmentally compatible with surrounding land uses were approved;
- Employing pollution monitoring as an important device for enforcing regulations. Monitoring also allows for early detection of deteriorating air or water quality;
- Inspection is also an essential element of enforcement. Pollution control equipment is regularly inspected to ensure that it is properly maintained and operated;
- Public education, beyond major campaigns, is an important management tool to create awareness and ensure compliance. Targeted programs were developed for schoolchildren, the private sector and NGOs on environmental protection and management;
- Political will was critical for supporting major environmental initiatives, e.g. it was the Prime Minister who challenged the Ministry to achieve full river clean-up within ten years; and
- The predominant planning style continued to be top-down, with central decision-making and relatively little public consultation.

The Green Plan

During 1991, the ENV led development of a 'Green Plan' intended to guide the city's environmental planning and management through the year 2000 and beyond (until the time, after 2020, when the city achieves a steady-state population of four million). In preparing the plan, the Ministry actively sought views of public and private organizations. Public fora were organized to get citizen ideas as well as feedback on a draft plan. The resulting plan contains an environmental vision for the city (Box 1) and a set of objectives for environmental management and infrastructure, environmental education, international environmental programs, and environmental technology (ENV, 1992). The Plan was intentionally readied for and presented at the 1992 Earth Summit in Rio de Janeiro.

"The vision is of a Singapore as a model Green City by the year 2000. It will be a city with high standards of public health and a quality environment. One which is conducive to gracious living with clean air, clean land, clean water and a quiet living environment. A city with people who are concerned for and take personal interest in the care of not just their immediate environment but of the global environment as well. A city which will also be a regional centre for environmental technology.

The role of the public in achieving this vision is crucial. We will have to educate the people and to instil in every Singaporean a national commitment to protect and preserve the environment at home and globally. To be successful we need active support. We will seek strong support, commitment and participation from the corporate sector, the media and non-governmental groups to develop a culture of proactive environmental awareness.

We will support international efforts to protect the global environment and will play an active role in international conferences and seminars on environmental concerns. We will share acquired skills and expertise in environmental management and protection. We will make Singapore a regional centre for environmental technology from which environmental engineering services can be provided to the Asia-Pacific region and beyond."

Box 1. The Green Plan's Vision (Env, 1992).

The long-term goals and environmental strategies of the Green Plan were then translated into specific recommendations. Work groups were formed to develop action programs in the priority areas of environmental education, environmental technology, resource conservation, clean technologies, nature conservation, and noise pollution. The groups were primarily made up of representatives from government ministries and statutory boards, with some participation from the private sector and non-governmental organizations. There were feedback sessions chaired by the Minister of the Environment and senior ENV staff, and draft documents were made available to the public for comment. For the action programs, the work groups identified implementing agencies and recommended target dates for the completion of each activity through the year 2000. Then, public comment was incorporated before the action programs were finalized.

The following action programs were developed out of this process:

- **Building Environmental Consciousness** (actions to create an environmentally pro-active society, create an information network, encourage green consumerism, provide awards and recognition, and create a National Council on the Environment)
- **Corporate Responsibility and the Environment** (actions to change private sector attitudes, implement environmental auditing and involve the corporate sector in promoting public awareness);
- **Conserving Resources** (actions to contain CO₂ emissions, promote energy efficiency, support waste minimization and recycling, and reduce household as well as commercial and industrial waste);
- **Environmental Management and Infrastructure** (actions to improve environmental public health, prevent pollution and reduce environmental noise);
- **Nature Conservation** (actions to create an interconnected park network, develop nature appreciation, conserve coral areas, and selectively promote eco-tourism);
- **Encouraging Clean Technologies** (technical solutions for controlling sulfur oxide emissions, improving air quality, developing cleaner modes of transportation, introducing cleaner industrial processes, phasing out ozone-depleting substances, and encouraging R & D for clean technologies);
- **Environmental Technology** (actions to make Singapore a regional environmental business hub through incentives for foreign and local companies, human resource development and R & D);
- **International and Regional Cooperation** (actions to maintain a global and regional environmental profile for Singapore) (ENV, 1993).

These actions, developed in 1993, were approved by the Cabinet as a national plan covering all concerned agencies. Progress is reviewed annually and a stock-taking will be held in 1998/99.

The formulation of the Green Plan and subsequent action programs marks an important change in the style of environmental planning in Singapore. Previously, environmental problems were addressed on an issue-by-issue basis by government agencies without a strategic vision or much public participation. In contrast, the Green Plan addressed a broad range of environmental issues, involved government actors beyond the Ministry of the Environment as well as a limited set of other stakeholders, set out long-term goals (beyond the year 2020), and specified medium-term actions (through the year 2000). The Green Plan also encouraged a broader definition of environmental management beyond what had been the ENV's classic focus on environmental health, infrastructure and pollution control.

Figure 3a. The telemetry system for air monitoring network in Singapore (ENV, 1997d, 10).

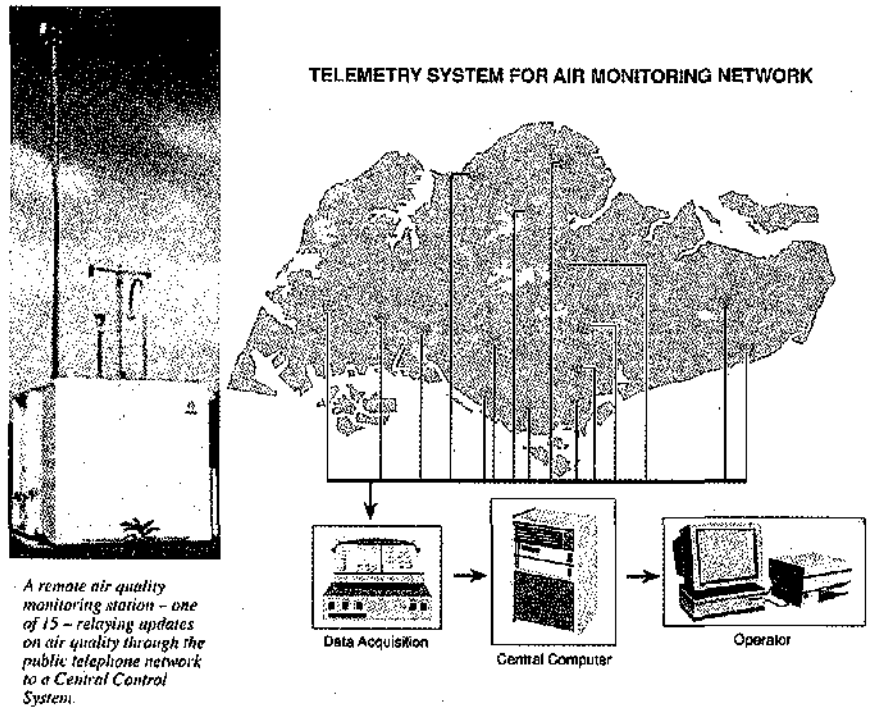


Figure 3b. Water monitoring points according to the Green Plan of Singapore (ENV, 1997d, 9).

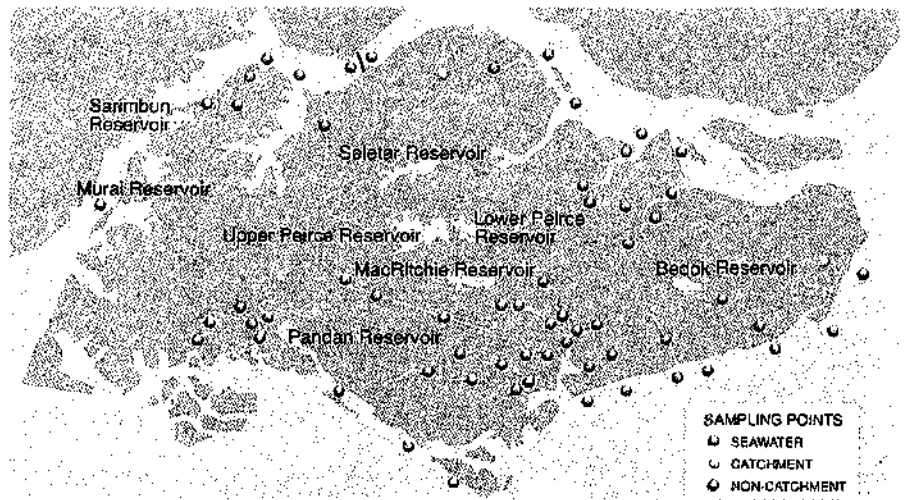


Figure 3c. Sewage treatment works and the deep tunnel sewerage system in Singapore (ENV, 1997d, 12).

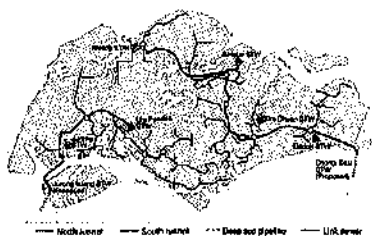
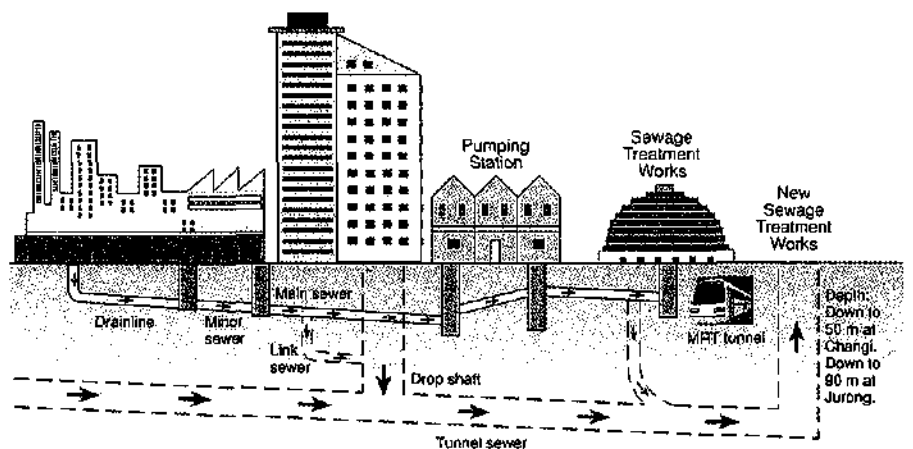


Figure 3d. Layout of deep tunnel sewerage system in Singapore (ENV, 1997d, 12).



CURRENT APPROACHES TO ENVIRONMENTAL MANAGEMENT

Singapore currently uses four sets of instruments to manage environmental problems: regulatory measures; planning controls; economic incentives; and encouragement of public awareness and participation. Each set is briefly described below along with examples of their application. These stem from a post-independence philosophy of active government involvement in many sectors of the economy and society. As former Prime Minister Lee Kuan Yew put it:

I am accused often enough of interfering in the private lives of citizens. If I did not, had I not done that, we wouldn't be here today (Murray and Perera, 1996, 20).

Regulatory Measures

Singapore employs a range of regulatory instruments to protect and manage the city's environment. There are approximately forty environmental laws covering the following subjects: cattle, clean air, destruction of disease-bearing insects, environmental public health, food, hydrogen cyanide, infectious diseases, poison, smoking, and water pollution control and drainage. Emissions standards have been set for 17 types of air pollutants covering a wide range of stationary sources. Allowable limits have also been set for liquid effluent discharge to sewers and waterways; these include temperature, BOD, COD, total suspended solids, total dissolved solids, pH value, and 28 different chemicals. Maximum limits have been set for transport of hazardous materials beyond which authorization must be obtained. 26 categories of toxic industrial wastes are also subject to specific legislated controls (ENV, 1997a).

Singapore is known as a 'fine' city partly because of its rigorous application of fines to enforce regulatory measures. Examples of fines that are applied to enforce environmental regulations include:

- Air pollution - violators of the Clean Air Act are subject to a maximum fine of S\$10,000 (US\$6666) plus S\$500 (US\$333) per day for continued non-compliance. Vehicles emitting smoke or visible vapor can be fined up to S\$500 as well.
- Water pollution - the maximum fine for violating the acceptable effluent limits is S\$5,000 (US\$3,333) per violation. Discharging oil into Singaporean coastal waters is subject to a maximum penalty of S\$500,000 (US\$333,333) or two years' imprisonment.
- Solid waste - littering is punishable by fines up to S\$1,000 (US\$666) per incidence. Serious and repeat offenders may also have to carry out public cleaning activities for up to three hours.
- Noise pollution - a range of fines have been set for vehicles, construction and other activities that exceed acceptable limits.

This fine structure has yielded revenues that range from S\$3.3 million (US\$2 million) to S\$4.5 million (US\$2.8 million) annually during the 1990s (Foo, 1996). The ability to enforce regulations also depends on the existence of an effective monitoring system. Air pollution is measured through 12 monitoring stations and mobile sources must pass an emissions inspection before they can be registered. Water quality is measured on a monthly basis in 47 streams within watersheds and in 17 rivers in non-water catchment areas. Coastal water quality is measured regularly at nine sample points in the Straits of Johore and ten points in the Straits of Singapore. The Pollution Control Department of the ENV monitors individual sites by conducting over 50,000 inspections per year. Finally, the ENV responds to citizen monitoring by investigating several hundred complaints about air and water pollution each year (ENV, 1997c; Foo, 1996) (Figures 3a-d).

Planning Controls

Singapore's long-term development and land-use strategies are embodied in a Concept Plan. The most recent version was prepared in 1991 and is based on a time frame to the year X (beyond 2020) when the population will stabilize at four million. Spatially, the plan seeks to deconcentrate the existing central business district to four new regional centers. Environmentally, the Plan seeks to:

- identify development constraints and land uses that affect the environment;
- project land needs for environmental infrastructure;
- identify areas for siting pollution-prone services and infrastructure;
- locate areas for nature conservation; and
- continue protection of water catchment areas.

Overall, the Plan states that 'Singapore will be cloaked in greenery, both manicured by man and by protected tracts of natural growth, with water bodies woven into the landscape' (Foo, 1996, 13). Administratively, the Plan is implemented by an Urban Redevelopment Authority (URA). The URA has further subdivided the island into 55 planning areas, each with a local plan called a Development Guide Plan (DGP), to manage the development potential of each area (Hin, *et al.*, 1997). Some of the environmental outcomes of the URA's enforcement of the Plan and DGPs are:

- industries are located primarily in proper industrial parks;
- a minimum of 0.8 ha. of parks and gardens is required per 1,000 people; and
- tree cutting is controlled in designated areas.

All land development proposals need to be submitted to the URA for approval before implementation. For construction, the Public Works Department approves building permits and considers technical requirements for environmental health, drainage, sewerage, and pollution control; post-construction inspections are carried out to ensure compliance. Several thousand planning consultations are held each year on land use and factory siting that include a review of environmental impacts. Finally, while environmental impact assessment is not legislated, it is a mandatory administrative requirement for developers seeking to undertake large projects that are likely to have a major environmental effect (Foo, 1996).

Economic Incentives

The key economic instruments used for environmental management in Singapore are user fees, licensing, fiscal measures, and auctions. User charges are levied for:

- wastewater collection and treatment (households pay S\$0.15 and other users pay S\$0.32 per m³ of potable water consumed plus S\$3 annually per sanitary fitting);
- solid waste (businesses are charged according to the volume of refuse they generate while households and street vendors pay a flat monthly rate); and
- street vendors, restaurants and port facilities pay fees to cover inspection costs.

Revenue from these fees collected by the ENV can amount to nearly half of the Ministry's total annual expenditure (ENV 1997a). Licensing is used especially to limit traffic congestion in the central area of the city (see section below on Traffic Management). Tax differentiation is used between leaded and unleaded fuel so

that unleaded is sold at a lower price in order to encourage its use. There are also tax incentives to encourage the use of cleaner technologies. Finally, a Vehicle Quota System was introduced in 1990 that capped annual vehicle population growth at 3%. Vehicle purchasers must bid for Certificates of Entitlement (COE) that are issued in limited numbers for different categories of vehicles. The COE component of a car's final price can range from 30-40% for medium-sized cars and 15-25% for larger vehicles (Foo, 1997b).

Public Awareness and Participation

Public awareness about environmental matters is developed in Singapore through three major avenues: specialized campaigns, the education system and the 'Clean and Green Week.' The first campaign, 'Keep Singapore Clean', was initiated in 1968. Since then, there have been focused campaigns to build public awareness about pollution, food hygiene, infectious diseases, waste management, sanitation, anti-spitting, anti-littering, river clean-up, and global environmental issues. Often, a campaign will preclude introduction of an environmental or public health law; public education is then followed up with strict enforcement. Schools are important conveyors of environmental information: they participate in the national campaigns, environmental material is included in the curriculum and students are encouraged to participate in environmental clubs and projects such as beach clean-ups. Since 1990, Singapore has held a Clean and Green Week with a different theme each year. Activities include giving environmental awards to youths, other individuals and organizations, clean-up of specific areas, special seminars, school competitions, public exhibits, dissemination of new publications. NGOs and the private sector are increasingly involved as sponsors of activities during the week (ENV, 1997a). The private sector is also promoting awareness about clean production technologies, waste minimization, environmentally-friendly products, energy and water conservation, and implementation of ISO 14000 standards (ENV, 1997d).

Increased environmental awareness led to the development of environmental NGOs in Singapore in the 1980s and growing pressure for public participation in environmental decision-making. By 1990, an umbrella National Council on the Environment (now called the Singapore Environment Council) was established by the private sector to promote environmental awareness. The Council facilitates networking of environmental NGOs, encourages public environmental responsibility and develops environmental protection and management measures for both public and private implementation. As a non-profit organization, it can receive tax-exempt donations from the public (ENV, 1997d). However, neither the Council nor other environmental NGOs are regularly consulted on environmental policy. Public participation in developing the Green Plan and action programs was also relatively limited.

The DGP planning process is perhaps the most structured opportunity for the public to take environmental factors into account, though the process is not set up for the sole purpose of incorporating environmental comments. An initial Outline Plan that covers broad strategies must be made available for public comment before the DGP is further developed and adopted. The draft DGP itself must also be available for public review over a period of two weeks before it can be finalized. During this exhibition period, the public can give their feedback and suggestions on the plans, including environmental issues. These are seen as wedges that may eventually open up the governmental process to more institutionalized stakeholder involvement (Mallone-Lee, *et al.*, 1998). A form of unstructured public participation has been the involvement of citizens and local

environmental organizations who complain about particular incidents of air, water and land pollution; these have been important sources of information for the ENV.

INNOVATIVE ACTIVITIES

During its experience with environmental planning and management, Singapore has developed a number of examples of 'good practice' in the fields of land use, transportation, water resource management, waste management, environmental health, air pollution control, nature conservation, noise control, and support for environmental businesses and regional cooperation.

Land Use

Land use controls, described generally above, are a major means of environmental management in Singapore. The URA is Singapore's land use planning authority. The ENV advises the URA on specific environmental measures that are needed in land use planning to protect watersheds, manage facilities for waste collection, treatment and disposal, and ensure that new developments are both properly sited and compatible with surrounding land uses. One way that this is done is by providing advice in the development of DGPs so that these local plans use environmental factors to guide development activities. The URA also takes many other factors into consideration in the planning of DGPs in addition to the environment. Other public and private sector land developers also consult the ENV on needed environmental controls.

At the planning and building phases of new developments, the ENV checks development proposals and building plans to ensure the sufficiency of waste management, make sure that pollution control requirements are incorporated into designs and that measures are undertaken to mitigate negative environmental impacts. New developments must obtain occupation permits and completion certificates that are cleared by ENV's Sewerage, Drainage, Environmental Health, and Pollution Control Departments (ENV, 1997c). This is done through the Central Building Plan Unit of ENV's Pollution Control Department. The Unit is a 'one-stop' service that is regularly consulted by private and public sector agencies with development proposals such as new housing estates and industrial facilities as well as alterations and additions to existing sites (Foo, in Briffett and Lee, 1993).

Particular attention is paid to developments in water catchment areas and to industrial siting. Industries are classified as clean, light, general, and special (high pollution potential), and separate land use rules are applied to each category. This integration of environmental features into land use planning has resulted in: proper siting of industries (separation of residential and industrial areas); rational provision of environmental infrastructure; encouragement of industries to use cleaner technologies; and effective protection of watersheds (ENV, 1997b).

One of the largest developers in Singapore has been the government's Housing and Development Board. It has constructed over 600,000 units which house an impressive 86% of the city-state's population. The HDB, guided by an earlier Concept Plan, helped to build 20 new or satellite towns around the central city to channel new development to areas that were both economically and environmentally appropriate, improve infrastructure planning and reduce congestion.

The center of each new town is also the terminal point for public transportation and most residents are within five minutes' walking distance from their neighborhood center. Finally, the industrial development in each new town, accounting for about 20% of land area, was restricted to light, non-polluting facilities (Field, 1992).

Transportation

The goal of transportation planning in Singapore is to provide an efficient and reliable system for the mobility of people and goods. According to Singapore's Land Transport Authority, this should be achieved through the following strategies:

- integrated and coordinated land use and transportation planning;
- increasing the capacity of Singapore's roads;
- improving the public transport system;
- effective travel demand management; and
- improving traffic management (Foo, 1997a).

To implement these strategies, it employs three innovative approaches that help minimize the environmental side-effects of traffic congestion: the Area Licensing Scheme; the Park-and-Ride System; and imposing high costs on vehicle ownership. These innovations are reinforced by the existence of an affordable, efficient and integrated public transportation system consisting of mass rapid transit, local buses and trans-island buses.

The Area Licensing Scheme (ALS) is a system of road pricing to manage demand for road space that is highly congested during peak hours. In 1975, the Government designated an area of 725 ha. comprising the central business district plus the most important commercial and shopping corridor (Orchard Road) for intensified traffic management. Currently, there are 33 entry points into the area; these are marked with signs and lights and are policed during restricted periods. Motorists must purchase a special license and display it on their windshields if they want to enter the restricted area during peak periods. Peak times are 07:30-19:00 Mondays-Fridays and 07:30-14:00 on Saturdays. Fees are progressively higher for motorcycles; private cars and company vehicles, and licenses can be purchased for monthly, daily or part-day use. At present, charges range from S\$1-6 for a daily license and S\$14-120 for a monthly license. Ambulances, fire engines, police vehicles, and public buses are exempted from licensing (Foo, 1997a). In 1998, an Electronic Road Pricing system was introduced using in-vehicle smart cards and road sensors to automatically charge users entering the restricted area. Electronic surveillance cameras photograph the license plates of vehicles without cards or with insufficient funds and violators are fined by mail (McNulty and Parker, 1998). Road pricing has also been extended to three expressways during peak morning commute hours (ENV, 1997d).

The ALS has played an important role in reducing central-city congestion during peak hours. For example, the number of vehicles entering the morning peak period (07:30-10:15) averaged 46,000 in May 1991 compared to 74,000 in March 1975 (before the scheme was implemented); this is even more remarkable considering that Singapore's vehicle population doubled during the same period. There was also an important shift in modal split after implementation of the ALS. In the pre-ALS period, 56% of trips to the CBD were by car and 33% by bus; by 1983, this had reversed and 69% of trips were by bus and only 23% by car. Environmentally, accidents in the restricted area dropped from 4,405 in 1978 to 3,382 in 1982 while there were average decreases in total acidity (-11%), smoke (-32%) and NO_x (-8%) in the same period (Foo, 1997a). Most recently, the Land

Transport Authority estimates that traffic volume has dropped a further 17% in the CBD since introduction of the electronic road pricing system. The average speed during peak hours has increased from 50 to 61 kph; this compares favorably with London where the average speed is 16 kph, or slightly slower than horse-drawn vehicles at the turn of the century (McNulty and Parker, 1998). As with the ALS, the goal of the Park-and-Ride Scheme (PRS) is to alleviate congestion in the CBD during peak hours. Since it was first introduced in 1975, the PRS has gone through several incarnations. It began as a series of peripheral parking lots where drivers could leave their vehicles and board buses into the CBD. Following completion of Singapore's Mass Rapid Transit network in 1987, it evolved into a system where the lots were linked to rapid transit stations. In the current enhanced PRS system, there are 19 parking lots: eight are located near both MRT stations and bus stops, another eight are only near MRT stations and three are only near bus stops. Drivers purchase monthly tickets for S\$72 that enable them to park at a specified lot and use mass transit or a bus to commute to the CBD (Foo, 1997b).

Average sales of monthly tickets have risen from 15 in 1991 to 572 in 1996. However, there are over 2,900 spaces available in the 19 parking lots, indicating that only about a fifth of capacity is being used. In 1996, just over 1% of motorists who regularly drive into the CBD were diverted into the PRS system. User surveys indicate the following problems: parking hours are too restrictive; parking lots are not available at all MRT stations; lots are too far from the stations; monthly tickets are restricted to only one lot; and monthly tickets are too expensive (Foo, 1997b). Thus, the PRS is an innovative approach to traffic demand management that has not yet achieved its potential due to a number of operational constraints.

The cost of vehicle ownership in Singapore is intentionally high in order to limit the overall vehicle population and to raise revenues to cover the social costs of motorization. The final price of a private car in Singapore consists of: OMV (the manufacturer's price, insurance and freight costs), ARF (additional registration fee, currently set at 150% of the OMV), import duty (currently 45% of the OMV), a S\$1,000 (US\$666) registration fee, an annual road tax (ranging from S\$0.70-1.75 per cc of engine capacity) and other costs (e.g. retailer's costs and profits). In addition, since 1990, vehicle owners must bid to purchase a Certificate of Entitlement (COE) through the Government's Vehicle Quota System before the vehicle can be used on the road. COE costs typically range from 10-30% of total vehicle cost (Foo, 1997a). Thus, a 2,000 cc vehicle with an OMV of US\$20,000 might end up costing a Singaporean over US\$75,000. This and other measures to discourage car use have resulted in a relatively low level of car ownership in Singapore (85 cars per thousand people) (ICLEI, 1995).

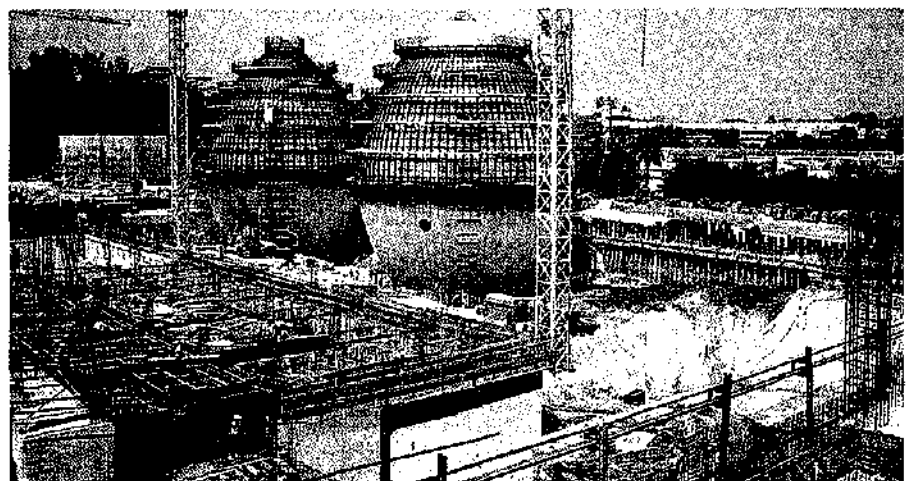


Figure 4. The construction of a pair of egg-shaped digesters at the Kranji Sewage Treatment Works is part of a five-year programme to upgrade sewage treatment works by using compact, space-saving designs and reducing the emission of offensive odours (ENV, 1997d, 11).

All of these transport innovations are bolstered by the existence of one of the world's cleanest and most efficient public transportation systems. Singapore has an integrated system consisting of city buses, suburban-city center express buses and the Mass Rapid Transit railway. The MRT is a 67 km system that carries more than 560,000 passengers a day. Transit Link, a public corporation, was established in 1987 to operate and integrate all modes of public transport. Commuters can travel between trains, subways and buses using one pass. Buses carry half of all road passenger traffic and 65% of commuter trips are by public transit (ICLEI, 1995).

Water Resource Management

As an island, water management is critical for Singapore. The city-state has been an innovator in drinking water resource management, wastewater and water pollution control, river clean-up, and flood control. Each of these areas is more fully described below. Singapore's water catchment areas meet less than half of residential, commercial and industrial demand for clean water. The remainder must be imported from Malaysia. Thus, drinking water management has been not only an economic and environmental issue for Singapore but has also been perceived as a national security issue. Some of the innovative measures to conserve and manage drinking water include:

- protection of water catchment areas through the land use planning measures described above as well as nature conservation activities described below;
- collection and treatment of urban stormwater as a source of raw water;
- water audits and technical assistance for industries and commercial users to help them conserve on water use, re-use wastewater and substitute non-potable for potable water where feasible;
- mandatory installation of water-saving devices in private commercial establishments and new public apartment buildings;
- metering of all water consumption and setting of water charges to recover costs and discourage excessive levels of consumption;
- use of a sophisticated monitoring system to measure and model water distribution, pressure and leakage;
- an apprentice plumber program whereby people seeking to become plumbers must apprentice in an apartment building, conduct regular inspections and seek to minimize leaks and water wastage within the building; and
- imposition of high standards for waterworks as well as residential and commercial plumbing in order to ensure efficient functioning of the water delivery system and reduce maintenance costs.

These measures are primarily administered by the Water Department of the Public Utilities Board. In many low-income Asian cities, half of the water in the municipal system is unaccounted for. In Singapore, largely because of these measures, the city has increasingly achieved a level of unaccounted-for water approaching the theoretical minimum loss of 5% (PUB, 1996). Water pollution is controlled through several different measures. Polluting industries are generally sited in industrial estates that are located outside of water catchment areas and are served by public sewers. Industries must install pre-treatment facilities to handle their liquid effluents which exceed discharge limits. Pre-treatment plants must be installed prior to commissioning of new factories (ENV, 1997c). For household effluents, most of the island is sewered. There are now 2,500 km. of sewer pipeline, six large sewage treatment plants serving an equal number of catchment areas and 130 pumping installations. A deep tunnel sewerage system is planned that will require only two centralized treatment facilities, less land as buffer zones and eventually no pumping stations (ENV, 1997c) (Figure 4).

In 1977, the Singapore River and Kallang Basin catchments, covering a fifth of the island, were heavily polluted by organic and inorganic discharges, stench pervaded the watercourses and the rivers supported little or no marine life. Prime Minister Lee Kuan Yew challenged ENV to improve the watercourses and ENV responded with a report the same year outlining priority problems and options. Over the next ten years, an action plan was implemented that involved:

- development of housing, industrial workshops, sewerage, and food centers; massive resettlement of squatters, cottage and other industries, and farmers out of sensitive areas;
- re-siting of street vendors into food centers;
- phasing out of polluting activities; and turfing and landscaping of riverbanks.

Work was implemented by various departments and agencies under five Government ministries, all of which were coordinated by ENV. Financing came from central government revenues at a cost of S\$200 million (US\$125 million), not including the costs of public housing, food centers, industrial workshops, and sewerage. These measures resulted in cleaner water, a return of aquatic life to the River and Basin, and an aesthetically pleasanter waterfront (ENV, 1987).

Singapore is a small island with one of the highest rainfall rates in the world yet flooding is a thing of the past. Innovation in the field of drainage for water management has included:

- using pre-cast box culverts to cut drains on busy roads overnight in order to minimize construction time and traffic disruption;
- using computer modeling to optimize canal design;
- incorporating special engineering and landscaping features to retain a river's natural features as well as its flood control role; and
- using jet grouting to stabilize riverbanks while limiting disturbance to surrounding areas.

These innovations have reduced the size of floodprone areas in Singapore from 3,000 ha in the 1970s to 300 ha at present (ENV, 1997e).

Waste Management

Limited land area combined with rapid economic growth and industrialization have led Singapore to adopt several novel approaches to solid and hazardous waste management. These include:

- adopting incineration as the main method for disposing combustible wastes;
- preparing an offshore landfill for disposal of non-incinerable wastes and incineration ash residues;
- increasing efforts to minimize waste generation; and
- strict management of hazardous wastes.

As existing dump sites began to fill up in the 1970s, Singapore decided to opt for incineration as a means of reducing the volume of final waste that required disposal. Three incineration plants have been constructed since 1978, located in the central, northern and western part of the island. Much of the city's solid waste is generated in the east, centralized at a transfer station, compacted into containers, and then hauled to incineration plants in the north and west. Of the 7,600 tons of solid waste generated per day, 70% is incinerated. The remainder of the waste is disposed at a landfill site. Incinerators have pollution control equipment



Figure 5. Fly ash from municipal incinerators is used to make these bricks (ENV, 1997d, 26).

and emissions are monitored on a regular basis (ENV, 1997e). A fourth plant is scheduled for completion in 2,000; it will be one of the world's largest with a capacity of 3,000 tons per day at a cost of S\$1 billion (US\$666 million) (ENV, 1997c).

The present landfill site is expected to be full by 1999 and no additional sites are available on the main island. Thus, an offshore landfill is being constructed adjacent to the island of Pulau Semakau. This will be a 350 ha. site that is anticipated to meet landfill needs beyond the year 2030. A marine transfer station is also being built that will receive and process non-combustible waste and incineration ash before it is barged to the offshore landfill. Works will cost an estimated S\$840 million (US\$525 million) and should be completed by 1999 (ENV, 1997c).

The magnitude of investments for new landfill and incineration facilities has convinced the Singapore government of the need to minimize the generation of waste before it requires disposal. ENV undertakes the following waste reduction activities:

- sets aside land for the private sector to operate recycling activities;
- creates in-house recycling centers in hotels, apartments buildings, factories, and other large establishments (1,255 centers set up by 1995);
- establishes public recycling centers in partnership with a private sector sponsor (58 created by 1995);
- encourages Government agencies to use recycled products, issues a 'Green Label' to inform consumers about products that are less damaging to the environment; and
- provides free waste audits for promote better waste management (Foo, 1997c).

In 1996, 1.76 million tons or 39% of the 4.52 million tons of solid waste generated in the country were recovered for re-use. The highest recovery rates are for ferrous metals (92%), non-ferrous metals (84%) and construction debris (71%); the lowest rates are for food waste (1%), wood/timber (12%), glass (14%), and plastic (14%) (ENV, 1997c) (Figure 5).

ENV controls the collection, treatment and disposal of hazardous wastes in Singapore. Private companies are licensed to establish treatment and disposal facilities in industrial estates. As of 1996, 110 such companies were operating. That year, they collected 63,870 m³ of toxic industrial wastes such as used oil, waste solvents, spent etchants, and chemical wastes. 80% of this was recovered for re-use and the remainder was treated and rendered safe for landfill disposal. Hospital and clinic waste is separated into color-coded plastic bags and placed in special containers. Two licensed companies then collect the biohazardous material for disposal in special high temperature incinerators (ENV, 1997c).

Environmental Health

There has been a historical focus on improving environmental health in Singapore for over a century. Beyond proper solid waste management, the main innovative features of the city's approach to environmental health include:

- Food hygiene - over a period of fifteen years (1972-1986), street vendors were relocated to over 150 markets and food centers in order to improve sanitary conditions as well as facilitate inspection. All food handlers are registered with ENV, inoculated against typhoid, given X-ray exams if they are older than 45, and must pass a basic food hygiene course. Finally, all food establishments are regularly inspected and hygiene standards are strictly enforced;

- Vector control - mosquitoes, rats and other disease-bearing pests are kept in check through public education campaigns, vector control programs and engineering measures like an anti-malarial drainage system; and
- Infectious disease control - ENV integrates services like Quarantine and Environmental Epidemiology in order to both control entry of infectious diseases into the island and effectively trace outbreaks if they occur.

Results are that Singapore has one of the lowest food poisoning rates in the world (despite its tropical climate) and the island was declared malaria-free by the World Health Organization in 1982 (ENV, 1997a,e).

Air Pollution Control

The key principles of air pollution control in Singapore are to minimize emissions at source and to reduce emissions exposure through careful siting of industries. Efforts to minimize the emission of air pollutants include:

- control of fuels used by industries and commercial enterprises;
- requirements that industries install air pollution control equipment to comply with emissions standards;
- regular inspection of stationary sources to ensure that control equipment is properly maintained and operated (nearly 50,000 in 1996);
- promotion of unleaded fuel for vehicles;
- gradual tightening of emissions standards for vehicles;
- regular mandatory emissions inspections for vehicles;
- prohibitions on the open burning of wastes;
- ban on the importation of CFCs;
- use of auctionable permits for the consumption of ozone-depleting substances;
- regular monitoring of air pollutants throughout the island; and
- rapid response to citizen complaints about stationary and mobile sources of air pollution.

Overall results are that measured levels of pollutants are almost always within the WHO long-term goals and USEPA standards and unleaded fuel now accounts for 70% of petrol sales since its introduction in 1991 (ENV, 1997a,c). Standards may not be met at all times, such as the regional haze that affected the area in 1997 and 1998 from fires in Kalimantan and Borneo in Indonesia.

Nature Conservation

Proposals for the protection of the natural environment initially stemmed from an NGO. The Nature Society of Singapore, in its 1990 Master Plan for the Conservation of Nature in Singapore, identified 28 sites that had sufficient nature conservation to warrant permanent protection. These included the Bukit Timah primary forest and the Central Catchment mature secondary forest. Tidal mudflats and mangroves, freshwater marshes and wetlands, and some undeveloped offshore islands were also listed (Briffett, 1990; Wee, in Briffett and Lee, 1993).

Singapore's nature conservation policy has a goal of setting aside 5% of its land mass for preservation. Currently, nineteen areas, comprising 3,130 ha., have been designated as natural sites and are managed by a Natural Parks Board. They include a wide range of habitats such as primary and secondary forests, marshlands and mangrove swamps. Sites were selected because of their ecological value, for watershed protection, or because of their potential for recreation,

education and scientific research. The DGPs are being drawn up for these sites and they will serve as management tools for the future. A 360 km. Park Connectors Network is being implemented so that flora and fauna corridors will link many of the sites (ENV, 1997d). Urban greening has also been actively promoted: over one million trees have been planted since independence and all public areas as well as new private developments must meet high standards for landscaping (Hin, *et al.*, 1997).

Noise Control

Singapore is tackling noise problems through government actions. An Environmental Noise Management Unit was established in 1994. The Unit is supported by an Environmental Noise Advisory Committee consisting of industry, professional, academic, and government representatives. Together, they have developed noise action programs for: monitoring; control of road traffic and MRT train noise; indoor noise for future residential buildings; control of noise from indoor and outdoor entertainment; boundary noise limits for factories; promotion of good management practices for noise reduction at construction sites; and planning guidelines for noise control. An environmental noise monitoring system has been set up which conducts twice-yearly, week-long measurements at 21 representative sites around the island (ENV, 1997a,c).

Environmental Business and Regional Cooperation

Singapore is actively seeking to use its experience and comparative advantages to both attract environmental businesses and to develop itself as a regional center for environmental cooperation. Over 100 environmental technology companies are currently located on the island. New local, foreign and joint-venture environmental enterprises are being encouraged through tax incentives and by touting Singapore's role in the regional market, its existing stock of human resources, research and development facilities, manufacturing support, and the island's quality of life (ENV, 1997f).

Singapore is seeking to become a regional center through project activities, institutional development and agreements. Environmental firms provide technical assistance and equipment for investments in other countries in the region. For example, consortia involving Singaporean firms have helped develop four industrial parks, including environmental controls, in Indonesia and China. Institutionally, the Government and the EU have established a Regional Institute of Environmental Technology to facilitate the transfer of technical expertise from the EU to the region, ENV has a Center for Environmental Training which serves as a regional training agency for environmental engineering and public health, and the ENV's Institute of Environmental Epidemiology as provides regional assistance (ENV, 1997f). Finally, Singapore has concluded a regional environmental cooperation agreement with ASEAN and bilateral agreements with Indonesia, Malaysia and Vietnam (ENV, 1997c).

CHALLENGES AND LESSONS FOR THE FUTURE

Singapore has enjoyed many successes in urban environmental planning and management. All the same, there are several areas for improvement. Critics have noted the following:

- Environmental impact assessment of projects is not required in Singapore and it would be advantageous to do so (Briffett, 1992);
- Public participation in planning decisions is nascent and greater involvement would improve the quality and outcome of planning decisions (Mallone-Lee, *et al.*, 1998); and
- The recycling rate is well below that of a similarly land-constrained, densely populated country (Japan's rate is over 50%) and a number of additional approaches are warranted (Foo, 1997c).

In addition, the predominant style of environmental planning and management has been top-down and more reliant on regulatory instruments. Environmental protection could be more efficient and effective through participation, some decentralization and greater use of economic incentives in combination with command-and-control approaches. Finally, ENV may not always have sufficient knowledge, commitment or clout to fully protect the environment in planning and investment decisions.

In the eyes of the Government, Singapore faces the following environmental challenges:

- Meeting rising expectations about air and water quality, cleaner surroundings and public health that come with economic development;
- Continuing to reconcile environmental needs with the demands of economic growth and competitiveness;
- Ensuring the cooperation of an environmentally-conscious population;
- Accelerating the introduction of clean technologies; and
- Fulfilling international and regional environmental commitments (ENV, 1997e).

In conclusion, several lessons can be drawn from Singapore's impressive experience with addressing and resolving environmental issues. Lessons for urban environmental planning include:

- Start with the basics – Singapore pursued a phased approach to tackling problems, beginning with environmental health issues (sanitation, vector control, food hygiene) and highly visible problems such as river and basin pollution;
- Coordinate planning in key sectors – the integration of land use, public transportation and motorization plans and policies has allowed Singapore to reduce the environmental impact of the private automobile;
- Integrate environmental considerations in standard procedures – environmental protection is an integral part of land use planning, industrial siting and building controls, largely negating the need for an environmental impact assessment process; and
- Get the politicians on board – political will has been an essential force behind successful planning and implementation of environmental measures, *e.g.* the Prime Minister's support for river clean-up and the Cabinet's endorsement of the Green Plan.

Singapore teaches the following lessons about urban environmental management:

- Educate, monitor and enforce – environmental regulation has been so successful in Singapore because public awareness of new environmental measures is followed monitoring and inspection with strict and consistent enforcement of serious penalties;
- Manage through institutions with clout – the ENV provides strong environmental management because it integrates important functions like infrastructure and environmental health, and because it has real enforcement powers;

- Try and try again – a willingness to experiment, learn and evolve have benefited both institutions such as the ENV and programs such as the various incarnations of the Park-and-Ride program;
- Combine economic instruments with regulatory measures – traffic management, one of Singapore’s biggest successes, is a good example of how rules can be complemented by economic incentives such as road pricing, the high cost of vehicle ownership and, of course, fines; and
- Involve the private sector – Singapore has made effective use of the private sector for implementing environmental policies such as partnerships to sponsor recycling centers and licensing for hazardous waste collection and treatment.

Similar lessons can be found from another ‘eco-city’, Curitiba in Brazil; these are summarized in **Box 2**.

Overall, Singapore has had a strong government that exercised power in a pragmatic and forceful way. Its small size, concentrated economic development and compact state government have assisted in achieving tight controls. The compliant population has generally learned to accept government leadership as it is responsible, largely uncorrupt and sincere in attempting to meet the needs of the community. A committed top-down approach has combined flexible responses with rapid action for environmental management. The main challenge now, with increasing education, higher aspirations for environmental quality and a desire for more public involvement, is that new strategies for planning and management are in order.

Curitiba, capital of Parana state, is also known as the ecological capital of Brazil. By the late 1960s, metropolitan Curitiba with a population of 800,000 (now 2.2 million) was on its way to becoming another automobile-dominated city plagued by traffic congestion, air pollution, urban sprawl, and inadequate infrastructure. Instead, the city took a different course by giving preference to public transportation over the private car, working with nature instead of against it, using appropriate rather than high-technology solutions, and innovating with citizen participation instead of master planning.

A number of measures, sustained and improved over the last 25 years, have produced impressive results:

<u>Measures</u>	<u>Results</u>
Integration of transport & land use policies: land use legislation enforces higher densities around major transportation corridors	Curitiba has one of the lowest rates of ambient air pollution in Brazil; gasoline use per vehicle is 25% less than in other Brazilian cities
Emphasis on efficient public transportation: main corridors have express bus lanes; each line is integrated for rapid transfers; the system is faster and cheaper than those in other Brazilian cities	Bus system serves 1.3 million passengers per day or 75% of all commuters despite the fact that the city has the 2 nd highest car ownership in Brazil; people spend about 10% of their income on transport which is low for Brazil
Controlling flooding: protection of natural drainage systems; conversion of riverbanks to parks; construction of artificial lakes to contain floodwaters	Damage from flooding is a thing of the past; green space increased from 0.5 to 50 m ² per capita during a period of rapid population growth
Managing solid waste: curbside collection of recyclables & central separation facility; use of informal sector; purchase of garbage from poor neighborhoods	70% participation rate in recycling program; waste collection extended to marginal areas; life of landfill extended; resources conserved
Developing institutional capacity: city has own urban planning institute; incentives for private sector involvement in management; public participation & transparency	99% of citizens polled would not want to live anywhere else; most innovative mayor had average 70% approval rating

Box 2. Challenging Conventional Wisdom in Curitiba (Rabinovitch with Leitmann, 1993; Rabinovitch and Leitmann, 1996).

KENTSEL GELİŞMEDE ÇEVRE KAYGISI: SİNGAPUR ÖRNEĞİNDE BAŞARILANLAR

ÖZET

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Güneydoğu Asya'da 647 km² yüzölçümlü ve üç milyon nüfuslu Singapur, ileri düzeyde bir sanayi 'ada-kent'i ve çok sayıda etnik toplumdaki oluşmuş bir ülkedir. İngiliz askeri yönetiminden 1965'te kurtulan ada, 1970'lerde bölgenin petrol arıtma ve finans merkezi oldu. Zamanla işgücü-yoğun üretim yerine sermaye-yoğun elektronik sanayii gelişti. Singapur'un çevre konularına duyarlı bir toplum oluşturmasının bir nedeni sanayiindeki bu dönüşümdür. Çevre kirlüten sektörler 1960'lı yıllarda sanayiinin %40'ını oluşturmaktayken 1991'de bu oran %8'e düşmüş bulunuyor. Ancak Singapur'un çevreye ilişkin başarıları, edilgen olmayan bir yaklaşıma sarılmış olmasındandır. Demokratik bir yönetime sahip olan adada hükümetler 1965'ten bu yana 'çevre'yi yaşam düzeyinin yükseltilmesinde başlıca etkenlerden biri olarak görmüşlerdir.

Çevre planlama, Singapur'da farklı evrelerden geçmiştir. Çevre Bakanlığı kurulmasından önce (1972) su baskını, pis su şebekesinin geliştirilmesi ve benzeri işler bağımsız birimler marifetiyle yürütülmüştür. Çıkarılan yasalarla 1970'li yıllarda topluluk ortamlarında sigara içilmesi yasaklanmış, ticari ve sanayi atıkları ile yiyecek hazırlama süreçleri denetim altına alınmış, hava kirliliği düzenli olarak izlenmeye başlanmıştır.

1972'de kurulan Çevre Bakanlığı, iki ayrı bölümden oluşmaktaydı: Çevresel Toplum Sağlığı (yiyecekler, salgınlar, karantina hizmetleri, sokak satıcıları, mezarlıklar, vb.) ve Çevre Mühendisliği (pis su, katı atıklar, drenaj, vb.). Bakanlık ilk yıllarda topluluk ortamlarında çöp toplama, kolera önleme, sağlıklı yiyecek, merkezi atık öğütme projelerine ağırlık vermiş, izleyen yirmi yıl süresince de kirlilikle mücadele, Singapur Nehri'nin temizlenmesi, toplum eğitimi gibi kampanyaları yürütmüştür.

1991'de Çevre Bakanlığı, 2020 yılına kadar olan dönem için bir 'Yeşil Plan' hazırladı. Kapsamlı bir vizyon getiren Yeşil Plan'ın kamu desteği kazanması amacıyla çok sayıda halk toplantıları düzenlendi. Çevre teknolojisi tercihleri, çevre eğitimi, uluslararası çevre programlarına katılma, çevresel altyapı ve işletme hedefleri içeren Yeşil Plan, 1992 Rio de Janeiro Zirvesi'nde sunuldu. Daha sonra, öncelikli uygulama alanlarında çalışma grupları oluşturuldu.

Singapur'da çevre sorunlarının yönetiminde yasa ve yönetmelikler, planlama, ekonomik özendiriciler ve halk bilgilendirme ve katılımı olmak üzere günümüzde dört farklı kurumsal araç takımı kullanılmaktadır. Hava ve su kirliliği, hastalık taşıyan haşarların yok edilmesi, halk sağlığı, yiyecek içecek maddeleri, kimyasallar ve zehirler, bulaşıcı hastalıklar, sigara, vb. konuları kapsayan, kırk kadar doğrudan çevreyi ilgilendiren yasa bulunmaktadır. Hava kirliliği konusunda 17 ayrı tip kirletici belirlenmiş, çok sayıda istasyon aracılığıyla izlemeye alınmıştır. Pis su sistemine atılanlar konusunda da ısı, katı oranları, pH değeri ve 28 ayrı kimyasal kapsamak üzere izin verilebilecek sınırlar belirlenmiştir. Sanayi atıklarından 26'sının taşınması, devri ve yok edilmesi yasal denetim altındadır. Singapur bu yasaların uygulanmasında ve parasal cezaların tahsilinde güçlü bir disiplin sağlamıştır. Hava kirlenme suçlarında 7 000 ABD Doları (ayrıca her geçen gün için 300 Dolar), su kirlenme suçlarında 3 000 ABD Doları üzerinde cezalar uygulanmaktadır. Cezalar, 1990'lı yıllarda 2-3 milyon ABD Doları düzeyinde bütçe gelirleri oluşturmuştur. Bu uygulamalar öncelikle yeterli bir izleme ağına varlığına bağlıdır.

Singapur'da genel 'Kavram Planı' (1991), uzun dönemli (2020 ve ilerisi) arazi kullanım stratejisini belirler. Nüfusun 4 milyon düzeyinde durağanlaşacağını öngören bu Plan, mevcut merkezin dört ayrı yeni merkezde yeniden yapılanmasını sağlamak üzere kullanım kısıtlamaları getirmekte, çevresel altyapı için yer ve güzergahlar önermekte, kirliliğe duyarlı kullanımların toplanacağı alanları tanımlamakta, doğa koruma alanlarını belirlemekte, koruma amaçlı su havzalarının eşik sınırlarını çizmektedir. İdari açıdan Plan, Kentsel Gelişim Otoritesi (URA) tarafından uygulanmakta ve ada 55 alt bölgeye ayrılmaktadır. Her bölgede Gelişme Kılavuz Planı adı verilen planlar ise sanayiye uygun sanayi parklarına yerleşimini, kişi başına 80 m² park ve bahçe alanının sağlanmasını, ve belirlenen alanlarda ağaç kesiminin yasaklanmasını denetler. Arazi geliştirme işlerini ilgilendiren tüm izinler URA'dan alınır. Yapılaşma izinleri ise bu yönetimin bayındırlık işlerine bakan bölümü tarafından verilir. Bu aşamada, kirlilik standartlarına uygunluk, teknik gereklerin yerine getirilmesi konuları denetlendiği gibi, kullanım süresince de bu birim tarafından izlenir. Fabrika yer seçimi ve çevresel etkileri konularında yapılan değerlendirmeler, yılda birkaç yüz bin toplantı gerektirmektedir. Büyük projelerde çevre etki değerlendirmesi yapılması yasal zorunluluktur.

Çevre yönetimi konusundaki ekonomik araçlar ise harçlar, ruhsatlar, mali kısıtlar ve açık artırma ve satım yöntemlerini kapsar. Konutlarda 0.15\$/m³, diğer kullanımlarda 0.32\$/m³, ayrıca her lavabo ve klozet için 3\$ kullanıma harcı alınmaktadır. Çöp toplama konusunda işyerlerinde hacme göre, sokak satıcılarından ise aylık olarak harç alınır. Ayrıca, sokak satıcıları, lokantalar ve benzeri yerler denetim maliyetlerini de karşılamak zorundadırlar. Harçlardan elde edilen kamu geliri, Çevre Bakanlığı'nın yıllık harcamalarının yarısı kadardır. Ruhsat verilmesi, özellikle trafik sıkışıklığı yaşanan merkezi alanlarda uygulanan bir yöntemdir. Ayrıca, kurşunsuz benzin daha ucuza satılarak kullanımı özendirilmektedir. Temiz teknoloji kullananlara vergi indirimleri tanınmakta, araç sayısındaki artışları %3'te tutmak üzere kısıtlamalar uygulanmaktadır.

Çevre konularında halkın uyarılması ve katılımın sağlanması başlı başına bir etkinlik alanıdır. Özel kampanyalar, genel eğitim sistemi içine entegre edilen programlar, 'Yeşil Hafta' ve 1968'den bu yana sürdürülen ve her yıl bir farklı temaya sahip olan 'Singapur'u Temiz Tutalım' kampanyaları, kirlilik, yiyecek denetimi, hem küresel sorunlarla ilgili başarılı çalışmaların yapılmasında, hem de ilgili yasaların çıkarılmasına yönelik baskı grupları ve kamu oyu oluşturmada etkili olmuştur. Kampanyalarda okullar öncülük etmiş, özel sektör önemli katkılarda bulunmuştur. Bu hareket giderek 1980'lerde sivil toplum kuruluşlarının oluşmasına ve ulusal ölçekte bir şemsiye örgütlenmeye (Ulusal Çevre Heyeti) yol açmıştır. Vergi muafılığı tanınan bu Heyet'e yapılan bağışlar, çevre koruma amaçlı kampanya ve girişimlerde etkin olmaktadır. Ancak çevre konularının, halk katılımını kapsayacak ve kurumsal planlama süreçlerinde yer almasını sağlayacak biçimde yeniden kurgulanması gereği vardır.

Arazi kullanımı ve planlama, ulaşım, su kaynakları yönetimi, hava kirliliğinin denetimi, atık yönetimi, doğa koruma gibi kimi konularda Singapur'un buluşçu ve başarılı uygulamaları vardır.

Çevre Bakanlığı, URA'ya su havzalarının korunması, çöp ve arıtma tesislerinin kurulması, yeni gelişmeler için doğru yer seçimi ve yakın çevre ile uyumu konularında önerilerde bulunur. Bakanlık, plan ve yapılaşma önerilerinin atık, çevre kirliliği konularında aldığı önlemleri denetler. Sanayi yatırımları, su havzaları açısından özellikle irdelenir.

Kara Ulaşım İdaresi'nin çevre konusundaki uygulamaları arasında özellikle üçü buluşçu niteliktedir. Alan Ruhsatı Uygulamaları belirli saatlerde belirli alanlarda trafik sıkışıklıklarını önlemek amacıyla elektronik olarak denetlenmektedir. Çok etkili olan bu yöntem, kent merkezinde kirliliğin azalmasına, buradaki erişim hızının artmasına ve kamu ulaşım araçlarının tercih edilmesine yol açmıştır. 'Park Et-Eriş' sistemi kapsamında toplu taşıma sistemlerine bağlı otoparklar düzenlenmiştir. Özel araç sahipliği ve kullanımı ise giderek artan maliyetlere konu edilmektedir.

Konut, sanayi ve işyerlerinin su gereksinmelerinin ancak yarısını kendi kaynaklarından karşılayabilen Singapur, su kaynakları işletmeciliğini ulusal bir güvenlik konusu düzeyinde tutmak zorunda kalmıştır. Su havzalarının korunması, yağmur suyunun toplanıp kullanılması, daha az su kullanımı sağlayan yöntemlerin geliştirilmesi, atık suların yeniden kullanılması, su kullanım hovardalığının önlenmesi, tüm kullanımın sayaçlara bağlanması, şebeke verimliliğinin artırılması, her yapının su tesisat gereçlerinin düzenli olarak teknik denetim altında tutulması, tesisatçılık bilgi ve pratiğinin yaygınlaştırılması için düzenli eğitim verilmesi gibi uygulamalar Altyapı Kurulu'na bağlı Su İşleri Yönetimi'nin başlıca uğraş alanlarıdır. Bu uygulamalar yoluyla pek çok ülkede %50 düzeylerinde olan kayıp su miktarı %5'lere indirilebilmiştir.

Su kirliliğinin önlenmesinde de birden fazla yöntem başvurulmaktadır. Kirletici sanayi birimleri su havzalarından uzakta tutulmakta, sanayi atıklarında kirleticilerin belirli düzeyleri aşmaması için, bu birimlerin açılmasından önce arıtma tesislerinin kurulmuş olması zorunlu tutulmaktadır. Singapur'un tamamı, 6 büyük kapasiteli arıtma tesisi ve 130 pompa ile bağlantılı bir pis su şebekesi ile kapsamıştır. Yeni yapılmakta olan bir derin ana toplayıcı ve iki merkezi arıtma tesisinden oluşan sistem ile daha az yüzölçümü kullanılacak ve pompalama gereği ortadan kalkacaktır. Singapur Nehri ve Kallang havzasının aşırı kirliliği on yıllık bir program ve 125 milyon ABD Doları harcanarak doğal özelliklerine yeniden kavuşturulmuştur. Alınan önlemlerle, çok yüksek yağış gören bir rejime sahip olmasına karşın, Singapur'da su baskını tehlikesi geride kalmış ve taşkına maruz alan hemen hemen kalmamıştır.

Singapur'daki yer darlığı, hızlı ekonomik gelişme ve sanayileşme, atık işletmeciliğinde de özel yaklaşımlar gerektirmiştir. Zararlı atıklar kesin denetim altında tutulmakta, katı atıklar kaynaktan azaltılıp yanabilir atıklar bu yolla yok edilmekte, küller ve yanmaz atıklar ise deniz doldurma işlerinde kullanılmaktadır. Günde 7,600 ton düzeyinde toplanan atıkların %70'i yakılmaktadır. 2000 yılında tamamlanacak ve 666 milyon ABD Doları'na mal olacak yeni bir merkezi çöp yakma merkezi günde 3,000 ton katı atık yakan dünyanın en büyük merkezi olacaktır. Ancak katı atıkların kaynaktan azaltılması amacıyla bunları yaratanlar tarafından dönüştürülmesini özendirme üzere özel merkezler geliştirilmiş, (fabrika, otel gibi) büyük kuruluşlarda kendi içlerinde dönüştürme birimleri (1995'te 1,255 adet) kurulmuş, kamu-özel ortaklıkları (1995'te 58 adet) oluşturulmuş, çevre dostu ürünlere yeşil etiket uygulaması başlatılmıştır. Biyolojik ve kimyasal tehlikeli atıklar Çevre Bakanlığı'nca toplanıp işlem görmektedir. Ancak kimi özel firmaların da (1996'da 110 adet) bu alanda çalışmalarına ruhsat verilmektedir.

Çevre sağlığı programları kapsamında sokak satıcıları, altyapısı ve hijyen koşulları denetlenen çok sayıda pazar yerinde toplanmıştır. Bu program, (sivrisinek, fare gibi) zararlılarla mücadele eğitimlerini, bulaşıcı hastalık denetimi ve karantina uygulamalarını da kapsamaktadır.

Hava kirliliğinin en aza indirilmesi amacıyla başvuru alan girişimler, sanayilerin yer seçimi kararları ve yakıt türlerinin denetimi, emisyon düzeylerini standartların altına çekmek için gereken tesisatın yapımı, sabit kirlenmelerin (1996'da 50,000 adet) düzenli denetimi, kurşunsuz benzin tüketiminin özendirilmesi, araçların düzenli denetimi, atıkların yakılması yasağı, ozon tüketen maddeler kullanımının izne bağlanması, vatandaş şikayetlerinin izlenmesi gibi işleri kapsar.

Doğa koruma girişimleri ise, genellikle sivil toplum kuruluşlarınca yürütülmektedir. Singapur Doğa Topluluğu 1960'ta yaptığı ilk Ana Plan kapsamında, yüzölçümü toplamı adanın %5'ini oluşturan 28 koruma bölgesi belirlemiştir. Aynı plan ile flora ve fauna koridorları oluşturulmuştur. Kentsel yeşil alanlarda ise etkin bir peyzaj programı uyarınca bir milyon ağaç dikimi gerçekleştirilmiştir.

Sanayi, meslek, akademik ve kamu temsilcilerinden oluşturulan bir Çevre Gürültü Denetim Birimi 1994'te kurulmuştur. Bu program kapsamında trafik koşulları, iş ve konut çevrelerinde kabul edilebilir gürültü düzeyleri belirlenmiş, gürültü azaltma yöntemleri geliştirilmiş ve ölçüm istasyonları kurulmuştur.

Çevre konularında çalışan Singapur firmaları, Endonezya ve Çin'de sanayi parkları geliştirmekte, çevre denetim konularındaki bilgi ve deneyimlerini yabancı ülkelere ihraç etmektedirler. Bu teknik bilgi birikimine dayanarak kurulan çevre mühendisliği ve halk sağlığı eğitim merkezi, Endonezya, Malezya ve Vietnam ile çevresel işbirliği anlaşmaları imzalamış olan Singapur için bölgesel olanakların geliştirildiği bir odaktır. Tüm bu başarılarla karşın Singapur'a yöneltilen eleştiriler de şöyle özetlenebilir:

- Singapur'da yatırım projelerinin izin alma sürecinde Çevresel Etki Değerlendirmeleri'ne henüz yaygınlıkla başvurulmamaktadır.
- Halk katılımının, çevre niteliklerini de kapsayacak biçimde doğru ve yeterli boyutlara eriştilmesi gereği vardır.
- Atıkların geri dönüştürülmesindeki oranlar henüz Japonya düzeyine erişilememiştir.
- Çevre planlama yöntemleri 'yukarıdan aşağı' ve düzenleyici araçlara dayanılarak yürütülmektedir. Oysa daha az merkezi yönlendirme ve daha etkili katılım süreçleri geliştirilmelidir.

Singapur, çevre planlama deneyiminden öğrenilecek çok şey vardır:

- Uygulamalara, temel konularla başlanmalı, sanitasyon, zararlı denetimi, yiyecek hijyeni gibi sağlık konuları ile havza ve nehir kirliliği gibi gözle görülür somut konular öncelikle ele alınmalıdır.
- Arazi kullanımı, ulaşım planlaması gibi birbirini tamamlayan başlıca sektörler eşgüdüm altına alınmalıdır.
- Çevre koruma önlemleri, yer seçimi ve yapılaşma işlemleri, olağan işleyiş ve süreçlerin bir parçası olmalıdır.
- Çevre koruma önlemlerinin alınmasında politikacılara rol edindirmelidir.
- Özendirici ve yasaklayıcı, ekonomik ve düzenlemeci önlemler birlikte kullanılmalıdır.
- Eğitim, izleme ve yaptırım etkinlikleri birlikte ve güçlü kuruluşlar aracılığıyla yürütülmelidir.
- Özel sektörün ilgisi çekilmeli ve yeni yöntemler geliştirmede denemeler yapmaktan çekilmemelidir.

Çevre niteliklerinin geliştirilmesi, toplumların yükselen eğitim ve beklenti düzeyleri ile tutarlı olacak biçimlerde, kamu organları tarafından daha yoğun bir uğraş konusu edilmeli ve buna yer veren yeni planlama stratejileri benimsenmelidir.

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