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FLOOD MITIGATION AND FLOOD RISK MANAGEMENT IN MALAYSIA

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ABSTRACT

Flooding is perhaps the only significant natural hazard in Malaysia. It has been estimated that some 29,000 sq. km or 9 percent of the total land area of Malaysia are flood prone affecting some 2.7 million people or 15 % of the total population. The average annual flood damage has been estimated at RM 100 million (1982 price levels). Since 1971, the Government of Malaysia has implemented various strategies and programmes to address the problem of flooding on a nation-wide basis. To date, some RM 930 million have been expended for structural measures for flood control while flood mitigation plans have been developed for 17 major river basins and urban drainage masterplans for 27 towns. Besides the implementation of the various structural and non-structural programmes for flood control, a disaster relief mechanism has also been established to carry out relief operations in the event of a major flood disaster. This mechanism is aimed at providing assistance to flood victims and covers various emergency relief operations such as dissemination of information, rescue and evacuation of flood victims and provision of food, clothing and medical supplies.

INTRODUCTION

Malaysia covers an area of 330,400 sq. km comprising of two regions, namely Peninsular Malaysia and the States of Sarawak and Sabah. Situated just north of the equator, it experiences a tropical monsoon climate. The average annual rainfall is estimated at 2420 mm for Peninsular Malaysia, 2630 mm for Sabah and 3830 mm for Sarawak. The bulk of the surface water resources are derived from the South West Monsoon (from May to August) and the North East Monsoon (November to February).

The topography of Peninsular Malaysia is characterized by a central spine (with ground elevations of up to 2000 meters above mean sea level) which slopes steeply to the relatively flatter undulating coastal plains on the eastern and western sides. In the states of Sabah and Sarawak, a similar terrain exists but the higher grounds are found in the interior along a northeast-southwest direction, bordering the boundary with Indonesia. There are more than 150 river systems in the country. The river courses are relatively short with steep gradients in the upper stretches and comparatively flat and meandering stretches in the lower reaches. Flood flows are therefore transient in the upper reaches but increase in duration and intensity towards the coastal plains The bulk of the population are concentrated in towns and villages situated in riverine valleys and coastal plains and hence are prone to flood damage.

Flooding is perhaps the only significant natural hazard in Malaysia. Malaysia is fortunate that it is not affected by typhoon and earthquake. The severity of flooding is also considered mild when compared to other countries in the region. Despite this, the problem has escalated over the years as the country becomes more developed. Since 1960, the country has experienced major floods in the years 1967, 1971, 1973, 1979, 1983, 1993 and 1995. It has been estimated that some 29,000 km^2 or 9% of the total land area are flood prone, affecting more than 2.7 million people or about 15 % of the total population. Figures 1 & 2 show the flood prone areas in the country. There is, however, very little reliable data on flood loss or damage. The National Water Resources Study (1982) has estimated an average annual flood damage at RM 100 million (1982 price levels).

However, this figure is likely to be a gross under-estimate as a result of rapid socio-economic development in the past decade which has led to significant increase in land and property prices.

FLOOD MITIGATION PROGRAMMES

The Government is the main party responsible for the provision of infrastructural development works for flood control. The problem of flooding is, however, a historical and complex one and hence a systematic and rational approach is required in order to ensure cost effectiveness. The broad strategies that have been adopted by the Government comprise the following :-

(a) Establishing appropriate and workable institutions for implementing flood control works and flood relief operations

(b) Carrying out river basin studies with emphasis on flood mitigation for major river basins and drainage masterplan studies for towns which are subject to flash flooding as a result of urbanisation.

(c) Implement structural measures such as flood control dams, river improvements, levees, diversions, detention storages, pumping installations to alleviate flooding in existing flood prone areas.

(d) Implement various non-structural measures such as flood risk mapping, flood forecasting, flood proofing to reduce flood losses.

The Department of Irrigation and Drainage (DID) under the Ministry of Agriculture is the primary government agency responsible for implementation of flood mitigation works. Flood mitigation has been accepted as a Federal Government responsibility because most of the state governments are lacking in resources, in terms of manpower and finance, to cope with this natural hazard. In 1971, the Federal Government established the Permanent Commission on Flood Control to cope with the increasingly serious problem of flooding which has caused a nation-wide concern. This Commission, currently headed by the Minister of Agriculture has been entrusted with the functions of taking measures to reduce the occurrence of floods and in the event of unavoidable flooding, to minimise the damage and loss of life and property. The Commission meets about twice a year to review progress and to approve new strategies and programmes.

Since 1972, many studies have been carried out to address the flooding problems affecting many of the larger river basins and population centers. Flood mitigation plans have been developed for 17 major river basins and 27 towns. The list of rivers and towns covered by these studies is given Table 1 and 2 respectively Based on these studies, various structural and non-structural measures have been proposed. Structural measures include channel improvement, bunding, flood bypass, poldering, pumping, flood storage dams and flood detention basins. Non-structural measures include flood forecasting and warning, flood zoning and flood risk mapping and resettlement of affected population.

The commitment of the Government to flood mitigation works is reflected in the steady increase of development funds as follows :-

Period	Expenditures (RM million)	Remark
1971-1975	14	Second Malaysia Plan
1976-1980	56	Third Malaysia Plan
1981-1985	182	Fourth Malaysia Plan
1986-1990	232	Fifth Malaysia Plan
1991-1995	449	Sixth Malaysia Plan

For the period from 1971 to 1995, a total of about RM 930 million have been spent on the flood mitigation programme mainly for structural measures. Under the Seventh Malaysia Plan (1996-2000), about RM 900 million have been allocated for flood control works Flood mitigation activities now constitute the largest workload of DID

Under non-structural measures, DID also operates flood forecasting services for major river basins which are flood prone. To date, flood forecasting systems based on real time rainfall and river stage information have been installed for 8 river systems namely Sg. Kelantan, Sg. Pahang, Sg. Perak, Sg. Klang, Sg. Johor, Sg. Muar, Sg. Sadong and Sg. Kinabatangan. In addition, there are 132 flood warning stations, 62 flood warning boards and 47 flood warning sirens at strategic locations in the flood prone areas of the country.

A pilot project on the preparation of flood risk maps for the upper Klang River Basin (including the capital city of Kuala Lumpur) has been completed in 1988. The Klang River Basin has a catchment area of 1,288 sq km and is the most developed and densely populated area in the country supporting a population of about 3 million people. The study resulted in the preparation of flood risk maps (scale of 1 in 10,000) which show the extent of flooding due to various discharges and rainfall intensity-duration-return periods. These maps provide useful reference to town planners and land owners in the planning of future development in the flood prone areas of the Klang Valley.

Flood insurance as a non-structural measure for flood management is little practised in Malaysia. Many private insurance companies do provide insurance against flood losses for a premium but few property owners have subscribed to such coverage. It is not a legal requirement to have flood insurance, neither is there any incentive or immediate plan to promote flood insurance as an instrument for flood risk management in this country.

The future scope or demand for flood mitigation works in the country up to the year 2000 has been identified by the National Water Resources Study in 1982. In brief, the study proposed the improvement of 850 km of river channels, the construction of 12 dams, 82 km of flood way and the resettlement of about 10,000 people. These works are aimed at providing protection to 50 % of the population living in flood prone areas by the year 2000. However, due to limitation of funds, many of the recommended flood mitigation works have yet to be implemented. In the mean time, the flooding problem, particularly in urban areas has further aggravated due to the rapid pace of urbanisation. By the year 2000, it is projected that about 60 % of the population will be resident in urban areas as compared to 34% in 1980.

THE KLANG VALLEY FLOOD MITIGATION PROJECT

The largest flood mitigation project ever implemented in Malaysia is the Klang Valley Flood Mitigation Project. Between the period 1949 and 1994, there were seven large floods which affected the Klang River Basin which includes the capital city of Kuala Lumpur and neigbouring major townships of Petaling Jaya, Shah Alam and Port Klang. The worst of these floods is the one which occurred on 5th January 1971, affecting some 122 sq. km with a maximum depth of inundation of about 4 meters for durations of up to 5 days. A total of 180,000 people were affected and the flood losses were estimated at RM 35 million (based on 1977 price levels).

To address the flooding problem in the capital city, the Kuala Lumpur Flood Mitigation Project was launched in 1973. The main objective of the project is to improve the quality of life of the people in the Federal Territory/ Klang River Valley by reducing the negative effects of flood by the implementation of flood mitigation works to support the projected socio-development in the capital city.

The estimated cost of the Klang Valley Flood Mitigation Project is RM 760 million to be implemented over a period of 30 years starting from 1975. The major engineering works include the following :-

- Raising of the Klang Gates Dam by 3.05 m at a cost of about RM 3.4 million to provide a total flood storage capacity of 6.2 million m^3.

- Construction of Batu Dam at a total cost of RM 20 million for water supply and flood control. The active flood control storage capacity is 4.44 million m^3.

- Improvement and canalisation of the main river systems (Sg. Klang, Sg. Gombak and Sg Batu) over a distance of about 100 km to cope with the 1 in 100 year flood at an estimated cost of about RM 480 million.

- The construction of a 3 m^3/sec pumping installation at Kg. Baru at a cost of RM 2.6 million

to cope with the drainage needs of 35 ha of low-lying lands in the Kg. Baru area.

- The construction of the Batu Flood Retention Pond (68 ha) together with a 3.4 km long Sg. Gombak diversion channel at an estimated cost of about RM 45 million to provide a total flood detention storage of about 3.5 million m^3 during a 1 in 100 year return period flood.

- The improvement of 8 major tributaries (namely Sg. Jinjang, Sg. Belongkong, Sg. Keroh, Sg. Kemunsing, Sg. Pencala, Sg. Kerayong, Sg. Kuyoh and Sg Bohol) with a total length of about 44 km at an estimated cost of about RM 120 million.

Figure 3 shows the schematic layout of the various structural works under the Klang Valley Flood Mitigation Project.

By the end of 1995, the Government has spent a total of about RM 290 million on the project. The major works completed are the raising of Klang Gates Dam, the construction of Batu Dam and the Kg. Baru pumphouse. The other components of works are in varying stages of progress ranging from 35 to 60 %. The project is scheduled for completion in the year 2007.

In addition to the structural measures, the government has always established the Federal Territory and Klang Valley Development and Planning Division (formerly known as Klang Valley Planning Secretariat) under the Prime Minister's Department to undertake the macro-planning of development activities in the Klang river basin to ensure that adverse environmental impacts are minimised and adequate infrastructural support facilities, including flood control works, are implemented to support the projected future developments.

INSTITUTIONS FOR FLOOD RELIEF OPERATIONS

Despite the implementation of the various long term programmes on flood mitigation as elaborated in Section 2 above, the risk of flooding, can at best be minimised but not totally eliminated. Therefore, it is necessary to establish a reliable mechanism for flood relief operations so that assistance can be provided to flood victims in an orderly and effective manner in the event of any flood disaster.

The Malaysian National Disaster Relief Committee (MNDRC), headed by the Minister of Information with its secretariat at the National Security Council is the highest level organisation for flood relief operations. The membership of the MNDRC comprises Deputy Minister of Finance, Deputy Minister of Transport, Chief of Defence Forces, Inspector-General of Police, the Chief Secretary to the Government and the Secretary of the National Security Council. The Committee is responsible for planning, coordinating and supervising disaster relief operations covering floods and other hazards. At the State and District levels, similar committees have been established comprising representatives from various government departments and agencies, local authorities and voluntary organisations. At least once a year, normally just before the start of the North East Monsoon, the Committee conveneS a meeting of all its members to ensure that all the concerned parties are in a state of readiness to cope with flood disaster which normally occurs during the period of late October to mid February.

At the Federal level, a National Disaster Control Center has been established at the office of the National Security Council. The State Disaster Control Center is usually placed in the office of State Security Executive Committee or at the State Secretariat Lastly, the District Disaster Control Center is normally located at the District Police Office. At Department/ Agency level, Relief Operation Rooms are also established at the national, state and district levels of all relevant agencies, such as the Ministry of National Unity and Community Development, Ministry of Works, Department of Irrigation and Drainage, Meteorological Services Department, Ministry of Domestic Trade & Consumer Affairs, etc.

Detailed preparation for relief operation is normally made at the district level. Amongst other things, the relief operation plan covers the following :-

(a) Establishment of flood relief machinery.

(b) Communication and command system.

(c) Recording of water level to indicate the normal, alert and danger levels.

(d) A record of all flood prone areas.

(e) Preparation of evacuation centers.

(f) Establishment of supply centers, forward bases and sources of supply.

(g) Locating helicopter landing ground.

(h) Flood warning system.

THE ACTUAL FLOOD RELIEF OPERATIONS

The Malaysian National Disaster Relief and Preparedness Plan makes maximum use of available resources within the government machinery and voluntary organisations to provide assistance to the victims of flood. Each Ministry or agency is required to draw up its own contingency plan which can be triggered into action in response to the different stages of warning. The involvements of the various agencies are described under the following headings :-

(a) Information dissemination

(b) Evacuation measures

(c) Immediate supplies of food, clothing and medical care.

Information Dissemination

The Ministry of Information is primarily responsible for dissemination of flood information to the public in advance of any impending disaster. This is achieved through the help of the police and the mass media such as radio, television and newspapers.

During monsoon season, the Malaysian Meteorological Services (MMS) issues daily weather bulletins and warnings of any heavy rainfall and/or strong wind. These information were passed on to relevant agencies at the State and Federal levels, including the National Disaster Control Center.

The Department of Irrigation and Drainage maintains a network of rainfall stations throughout the country. For the flood prone river basins, telemetry and radio transmissions are used to transmit real-time data to the DID headquarters where flood forecast are made using empirical and computer models, where appropriate.

Evacuation Measures

This is the task of rescuing and evacuating flood victims to pre-determined relief centers. The immediate task of rescuing and evacuating flood victims to pre-determined relief centers is undertaken by the Department of Civil Defence, Welfare Department and Local Authorities. In the event of a major disaster, the National Disaster Control Center may request for military assistance through the Ministry of Defence.

When the Director of Civil Defence Department receives a warning that a disaster is impending, he will direct a skeleton staff to be on stand-by. When natural disaster has occurred, all Civil Defence Control Centers will be activated and Civil Defence voluntary personnel will be required to report for duty and to carry out the required relief operations.

The Police under the Ministry of Home Affairs is responsible for related operations of crowd and traffic control, prevention of looting, protection of life and property and the provision of radio communication links.

The Ministry of Youth and Sport is responsible for organising the youths to assist in disaster relief operations. The required manpower are derived from youth clubs and youth organisations

Immediate Supplies

After the flood victims have been evacuated to the relief centers, it is necessary to cope with the needs of food, clothing and medical care. In addition, relief operations must also be organised for the delivery of food, clothing and medical supplies to those victims in areas that have become isolated by flood.

The Ministry of Domestic Trade and Consumer Affairs is responsible for ensuring sufficient stock of food at reasonable prices in all flood prone areas.

The Ministry of National Unity and Community Development is responsible for the acquisition, storage and distribution of food before, during and after the occurrence of a natural disaster.

The Ministry of Health is responsible for providing and coordinating efforts in health care for flood victims.

A simplified flow chart showing the operation of the flood relief mechanism covering the interactions of the various committees, disaster control centers, information dissemination and relief operations is given in Figure 4.

LONG TERM PROGRAMME FOR FLOOD MANAGEMENT

The long term solution to the flooding problem requires an understanding of the root source of this problem. While the rainfall regime has changed little over the years, the same cannot be said of runoff which is affected by the properties of the ground cover and in particular its permeability characteristics. The clearing of forest for agriculture and the conversion of agriculture to urban landuse are generally acknowledged as key factors that have led to higher runoffs from developed catchment areas. This is a phenomenon which has been recognised and acknowledged worldwide as the primary cause of flooding in urban areas.

At present, some 60% of the total land area in Malaysia is still under natural forest cover. Development activities in the forested watershed are carefully monitored and controlled by the Forestry Department. A National Forestry Policy was adopted in 1977 and embedded in this policy is the concept of sustainable utilisation of forest resources with due consideration to flood hazard mitigation and environmental preservation.

In recent years, the rapid pace of urban development has given rise to a new form of flooding known as flash flooding in urban areas. Unlike the Monsoonal flood, these are caused by short duration, high intensity localised storm in urban areas where catchment characteristics have been altered as a result of urbanisation. Flash flooding is a major nuisance or disturbance to the urban dwellers who aspire a quality living environment. Serious efforts are being implemented by the Government to address the problem of flash flooding in urban areas based on strategies which aim at minimising the drainage impact of future urban development.

The institution and mechanism for flood relief operations have been in place for more than 20 years. A wealth of experience has been acquired over the years and the mechanism has been continuously reviewed and improved to ensure that it is efficient and effective. This is evident from the fact that there are few incidents of loss of lives in the floods of recent years as compared to similar situations some 10-20 years ago. Advanced warning in the form of flood forecast and efficient information dissemination are the primary factors that have contributed to the above success.

CONCLUSIONS

Malaysia does have to cope the problem of flooding which if uncontrolled, can pose a major obstacle to its planned socio-economic development. Flood mitigation has been given due attention by the Government which has strongly committed itself to the creation of a favourable environment for socio-economic growth of the country as well as to maintain a quality living environment Towards these objectives, the Government has incurred a total of about RM 930 million on flood mitigation programmes in the past 25 years and a large budget of about RM 900 million has also been approved for implementation of similar works under the current Seventh Malaysia Plan (1996-2000).

In addition to structural and non -structural measures to mitigate flood damage, there is also an elaborate mechanism to provide relief operations in the event of a major flood. This mechanism

has been in place for more than 20 years and has proven effective in coping with major flood hazard in the country. As a result, there are few incidents of loss of lives in the major floods of recent years as compared to situations some 10 to 20 years ago.

Through the vigorous implementation of the above strategies and measures, Malaysia hopes to achieve her future socio-economic development and progress with due consideration to the environmental factors and in particular the risk and hazard of flooding.

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1. Economic Planning Unit, " National Water Resources - Volume 1", October 1982, Japan International Cooperation Agency

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3. Ir Neo Tong Lee, " An Integrated Approach for Solving Urban Flooding Problems in Malaysia", Keynote address at the Seminar on Urban Drainage and Flood Mitigation organised by Institution of Engineers, Malaysia, Kuala Lumpur, 8-9 May 1995

4. Ab. Khadir b. Othman, "Flood Relief Machinery in Malaysia" , paper presented in Joint Seminar on Forecasting and Warning Systems by Infrastructure Development Institute, Japan and Department of Irrigation and Drainage, Malaysia, Kuala Lumpur, 15 March 1995

5 Department of Statistics, Malaysia, "Population Report for Local Authority Areas", 1991

TABLE 1 - LIST OF RIVER BASIN STUDIES

	Name of River	Catchment Area (sq. km)	Date of Completion
1.	Pahang	29,300	1973
2.	Limbang	3,670	1976
3.	Kelantan	13,100	1977
4.	Kinabatangan	16,800	1977
5.	Terengganu	4,580	1978
6.	Samarahan	860	1982
7.	Lower Perak	14,700	1983
8.	Batu Pahat	2,100	1985
9.	Golok	2,175	1985
10.	Johor	7,350	1985
11.	Besut	1,230	1988
12.	Krian	1,418	1988
13.	Kelang	1,288	1989
14.	Kelantan	13,100	1989
15.	Kurau	965	1989
16.	Kinta	2,540	1994
17.	Muda	4,150	1995

TABLE 2 - LIST OF TOWNS WITH DRAINAGE MASTERPLAN

	Name of Town	Date of Completion	Population* (in 1991)
1.	Kuala Lumpur	1978	1,145,342
2.	Raub	1979	44,677
3.	Butterworth	1979	224,647
4.	Alor Setar	1981	322,354
5.	Sandakan/Tawau/Kota Kinabalu	1981	676,720
6.	Kuantan	1982	199,484
7.	Melaka	1982	296,897
8.	Seremban	1982	182,869
9.	Johor Bahru	1982	328,436
10.	Bintulu	1982	86,132
11.	Kelang	1982	243,355
12.	Kota Bharu	1983	219,582
13.	Kuala Terengganu	1983	228,119
14.	Kangar	1983	63,845
15.	Port Dickson	1986	68,258
16.	Muar	1988	174,554
17	Teluk Intan	1991	48,278
18.	Pulau Pinang	1991	395,714
19	Labuan	1992	54,241
20.	Taiping	1994	183,069
21.	Kulim	1996	128,356
22	Sg Petani	1996	114,763
23.	Cukai	1996	17,765
24.	Langkawi	1996	42,938
25.	Batu Pahat	1996	129,713
26.	Miri	1996	121,785
27.	Sibu	1997	126,381

(* Population based on 1991 Census)

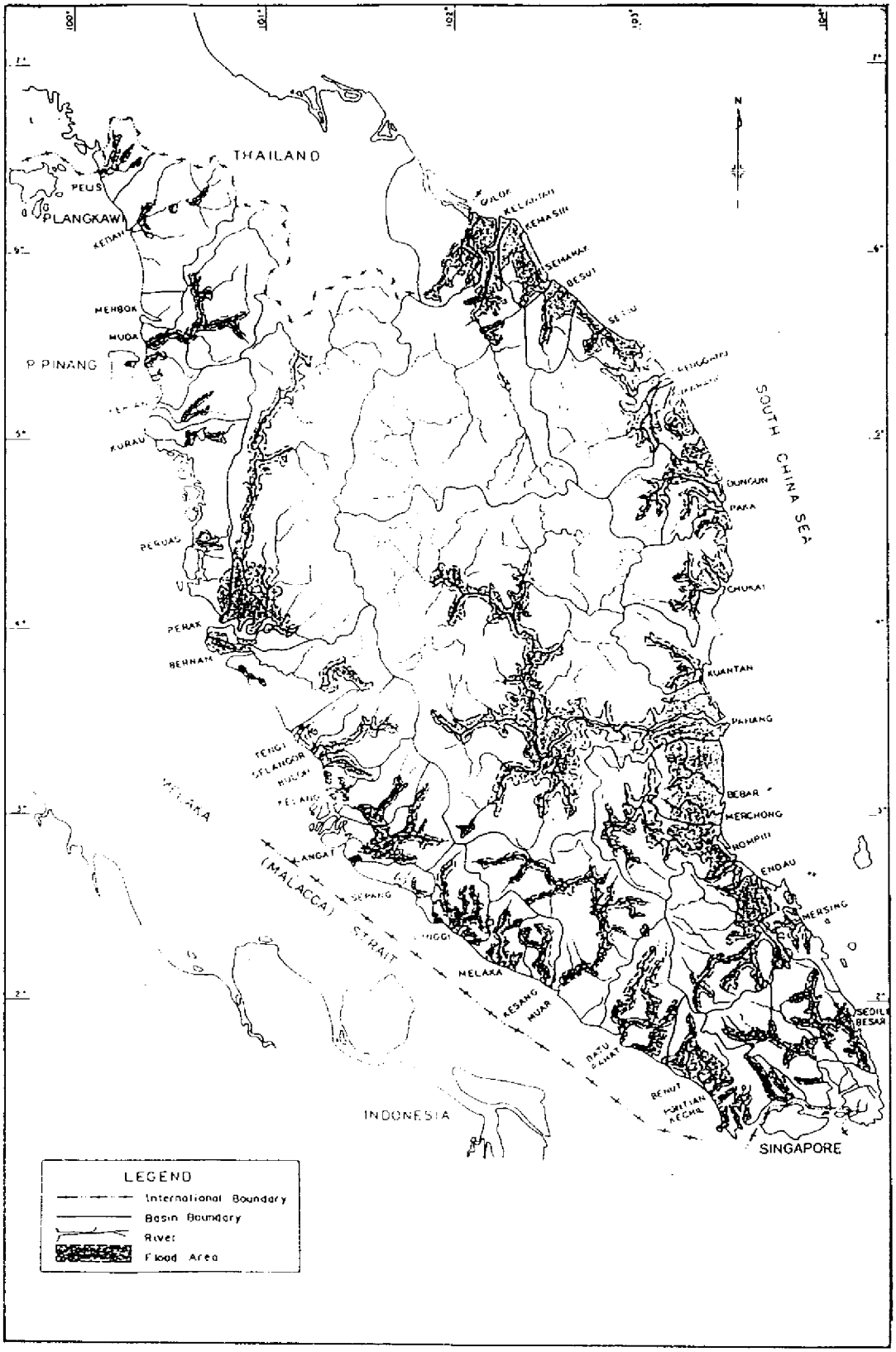

FIGURE 1 - FLOOD PRONE AREAS IN PENINSULAR MALAYSIA

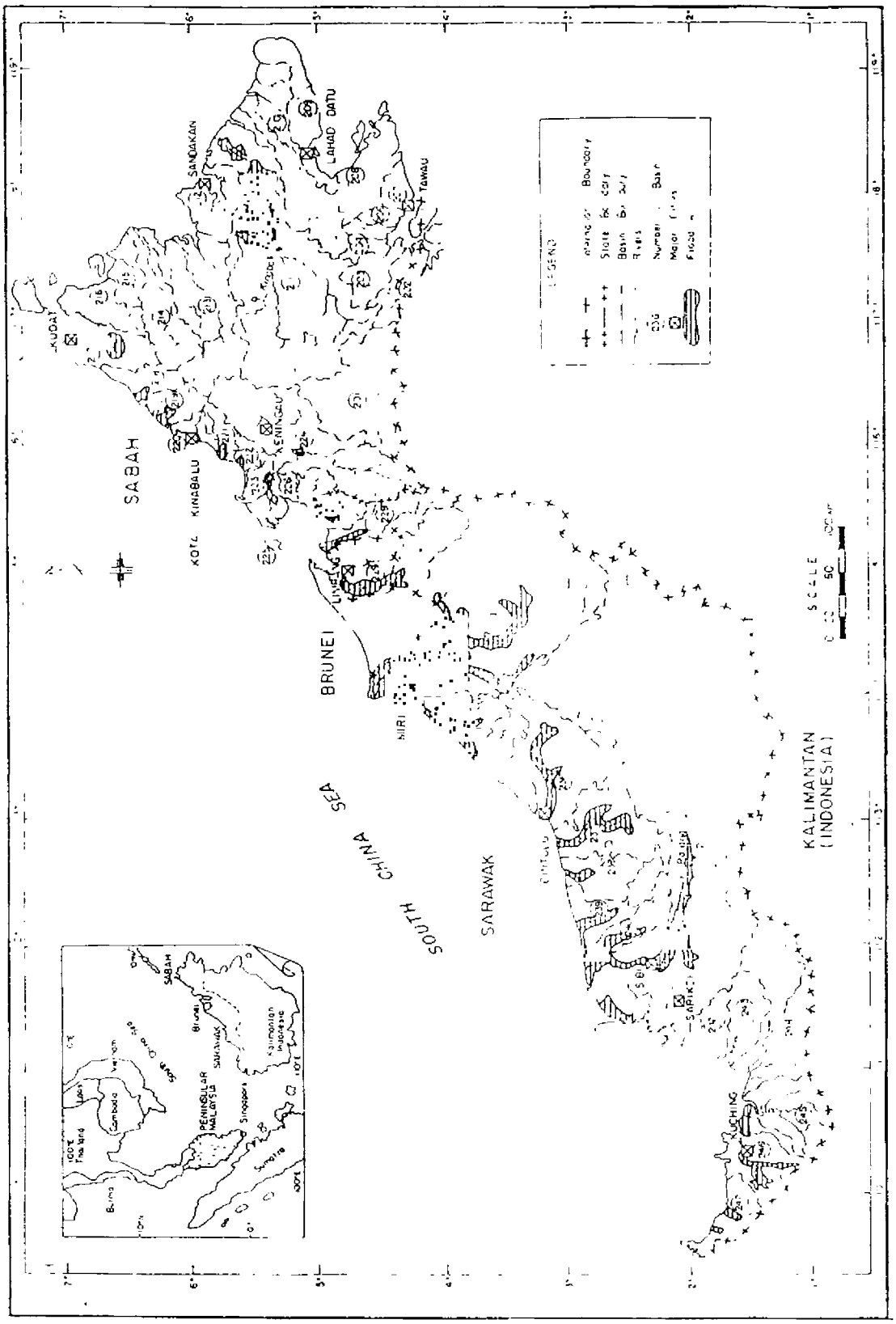

FIGURE 2 - FLOOD PRONE AREAS IN SARAWAK AND SABAH

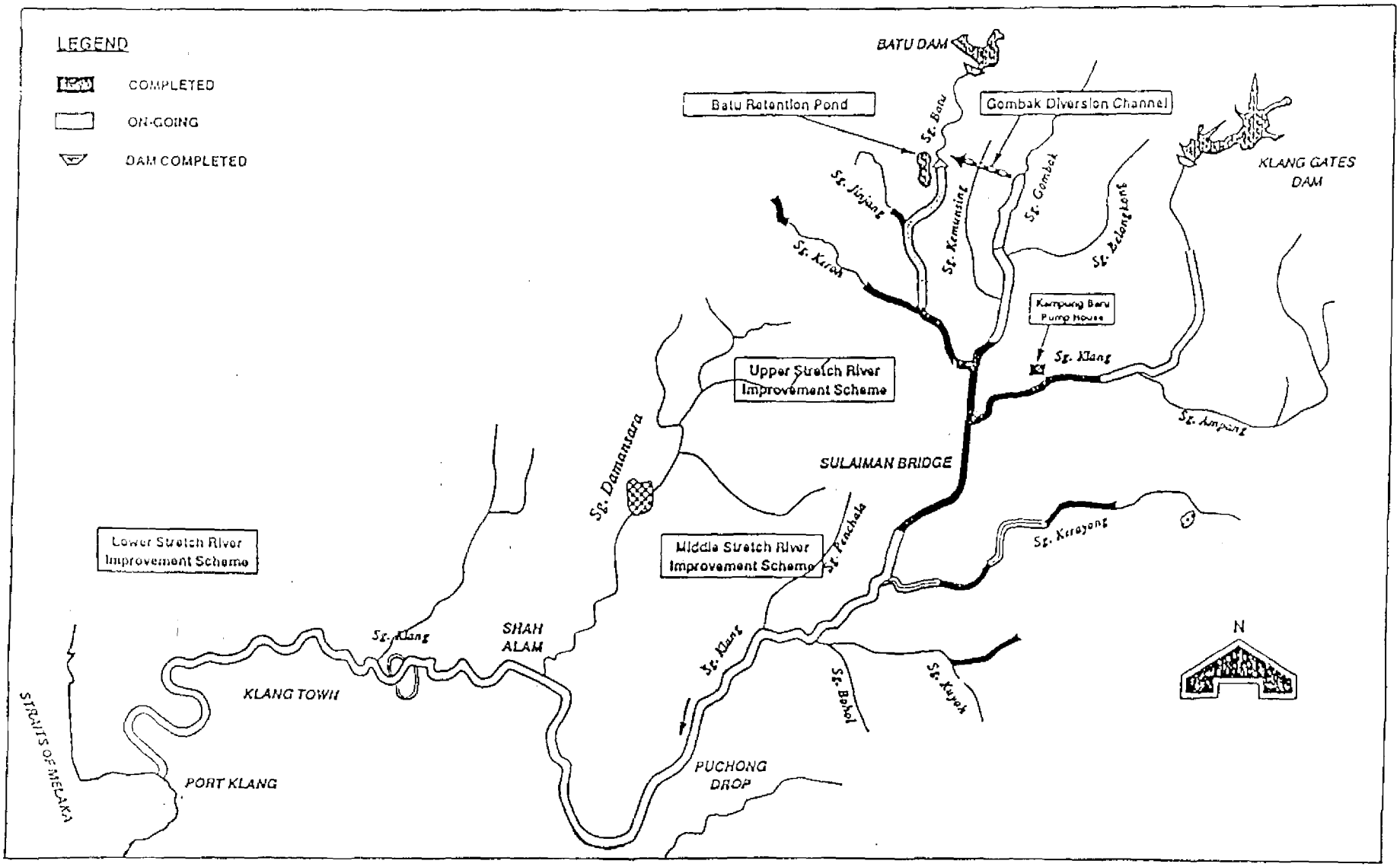

FIGURE 3 - LAYOUT OF THE KLANG VALLEY FLOOD MITIGATION PROJECT

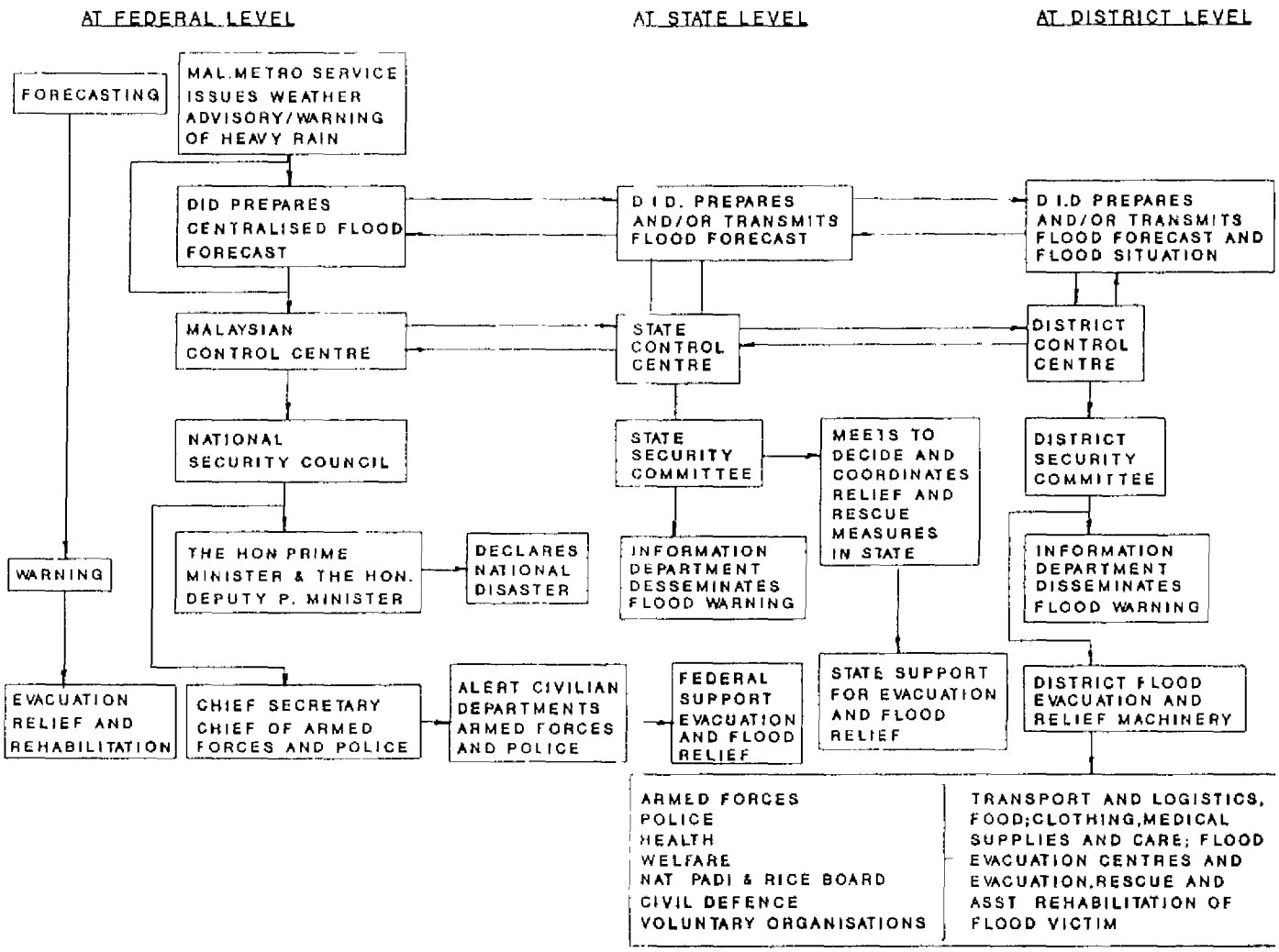

FIGURE 4 - FLOOD DISASTER RELIEF CONTROL MACHINERY