(9) Manpower requirement

In DID and PWD manpower shortage has been experienced definitely in many ways, especially experienced engineers and technitians in operation and maintenance. There exists a tendency to ignore operation and maintenance work. Necessity of improving the quality of staff was reported, too.

Shortage of construction labours is also serious in Sabah. Most skilled workers, are from West Malaysia.

4.2.2 State individual report

The information obtained in the interview, which was made by the study with officials of some state departments and statutory bodies, is herein described. The listed opinions, which were made verbally, do not always present the policy of the organizations concerned, but they are regarded as indications of the major problems and needs recognized by the officials.

SABAH DID

Water Shortage and Induced Problems

(1) River water shortage was experienced in some irrigation schemes of double cropping during drought period.

Water Management

(1) Drainage and irrigation ordinance was not updated yet, though DID was disjointed from PWD in 1967.

(2) There is not a single institution which solely has the responsibility for low water management. The low water management, therefore, has been done independently by individual state of present. One authorized body which is responsible for the comprehensive management of river water usage is requested to be established in order to manage the following problems:

(a) There is no documented rule with respect to the priority of river water usage.

(b) The river water usage in the rural area is not controled and the condition is completely unknown, though river water has been used by the private sector at present. Water users usually consult PWD and DID before project implementation but no registration is made.

(c) There is no written agreement with respect to river water usage, only coordination has been done by individual project base.

(d) There was no example with respect to compensation discharge.

(3) The coordination with respect to usage of river water is made between PWD and DID. For example, PWD tried to construct a intake for Kota Kinabalu water supply in the Moyog river at first, but it was planned to move to the other river after discussion with DID because there is a irrigation scheme in the downstream of the river. In Membakut project (Irrigation and D&I water supply) water management problem was solved after the PWD intake was moved from the downstream of a barrage to the upstream.

(4) No coordination with respect to international usage of river water was experienced.

(5) Land development in river catchment has not been controlled at all. The development is becoming a cause of low flow decrease and flood increase.

(6) District Offices lease reserve land along rivers which is under the control of the Land Survey Department for storing timbers and other purpose. DID gives comments only on that matter. DID basically has no objection but is anxious about that no follow-up action is done after leasing.

(7) District Offices give the license of digging out sand, gravels and stones. Unified standard for application and approval is necessary because the procedure is different district by district at present.

(8) No departments or agencies control errosion in river catchment at present.

(9) Regular land survey along the river reserve land is necessary in order to manage perfectly because river course changes day by day and sometimes it crosses private land.

(10) There is a duty list for Officers in the work of operation and maintenance.

(11) There is no irrigation dam, but are pumping stations and weirs for irrigation schemes.

Flood and River Control

(1) Flood in urban area is minor because large rivers does not run across towns in Sabah. Flood in towns is generally caused by poor drainage systems. The town drainage of Kota Kinabalu, Sandakan and Tawau is under JKR responsibility as a part of town planning.

(2) There is no flood forecasting system. The Kinabatangan project is the only one project which is under the DID headquarter. Flood rescue action is done by the district officer with assistance of police.

(3) The DID district officers carry out the river training (clearing) with the budget of the State Government responding to the request of residents.

(4) Watershed management is not done.

(5) The study and measurement with regard to the tidal and back water effect is ongoing. Water sampling is also done in the study and samples are sent to the Chemistry Department for laboratory testing.

(6) Irrigation intakes are generally moved to the upstream whenever salinity intrusion is experienced.

(7) Continuous dredging for the purpose of river maintenance is not done except particular projects (for example, canalization, deepening and widening).

(8) The flood mitigation projects funded by the Federal are done in the following rivers: Telipok, Api Api, Bongan, Bandau, Langkong and Tandek.

Water Pollution and Environmental Impact

(1) Quality of river water has been measured at only irrigation intakes but no single purpose monitoring of river water has been done yet.

(2) Monitoring of water pollution caused by pig waste was requested at the Sibuga river near Sandakan from DOE.

(3) The major environmental effect due to the copper mining in the Lohan river was reported to be silting. Effect on the water quality was reported to be not so serious.

Water Resources Development Plans and Needs

(1) Comprehensive future plans including demand projection have not been done yet. Study is restricted to specific projects.

(2) There is no storage dam in Sabah, but are many irrigation intakes and weirs especially in the west coast area.

(3) Irrigation projects are planned with the design drough of 7 day discharge having the return period of 5 years. This criterion is not definite.

Water Saving Measures

(1) Intensification measures of water usage efficiency is going to be tried, but no concrete action has been done yet.

(2) Concrete lining will be applied as a way of reducing water leakage from canals.

Problems Associated with Project Implementation

(1) Project implementation is necessarily involved in large or small problems case by case. Land acquisition for infrastructures in irrigation projects such as canals and roads is one of the largest problems.

(2) No water rate is charged for irrigation water use.

Manpower Requirement

(1) Manpower shortage has been experienced definitely in many ways, especially experienced engineers and staff in operation and maintenance. There exists a tendency to ignore operation and maintenance work.

(2) DID is facing difficulties in creating new posts to strengthen the manpower in the department.

SABAH PWD

Water Shortage and Induced Problems

(1) The capacity of water supply facilities has not been large enough to meet the demand of domestic, industrial and commercial water in Kota Kinabalu, Sandakan, Labuan, Tawau, Lahad Datu, Semporna, Beaufort and Kota Beludu. The conditions is going to be improved by extension programs. The water sources which did not dry up even in drought period was found.

Water Management

(1) There are 25 PWD water works in 4 Residencies in the State of Sabah.

(2) The PWD headquarters are in charge of planning and design of water facilities while the PWD divisional offices are in charge of supervision of construction and operation and maintenance of the facilities.

(3) As the water supply is under the responsibility of the State Government, no specific actions with regard to the water management, such as, inter-state or inter-agency agreements, resistration of water usage and water related facilities, water management committees and multi-purpose development problems was experienced.

(4) Watershed has not been managed. The catchment of intakes has been reserved only.

Flood and River Control

(1) Urban and town drainage is under the responsibility of PWD. DID is responsible for the rural agricultural drainage. Flood is generally not so serious inside towns except in the residential area in Kota Kinabalu, Beaufort and Tawau.

(2) Silting generally causes no problems except at intake sites at every town.

(3) Salinity intrusion was experienced at only the two intakes at Lahad Datu and Papar during dry spell.

Quality of Water Resources

(1) Quality of surface water is usually good. Treatment of water quality generally difficult.

(2) Iron contents of ground water is high but it is treated by aeration.

Water Pollution and Environmental Impact

(1) Monitoring of river water has been done at PWD intake and treatment sites. Only simple testing is done by technitians at the sites and water samples are sent to the water laboratory in Kota Kinabalu, which is responsible for quality of supply water, for chemical testing weekly (minor) and monthly (major). Only simple qualitative bacteria testing is done monthly or in case required.

It will be rather difficult to execute countermeasures promptly, though problem of water quality is observed because of manpower shortage.

(2) The DOE monitoring of water quality will start from November, 1981.

(3) Rubber and palm oil mills should treat the effluent by their own treatment plant under the act.

(4) PWD is responsible for only urban sewerage system. Sewerage is under the responsibility of the Local Authority (Municipal Council) but PWD executes planning, design, construction and operation and maintenance on the behalf of the Local Authority now because the Authority has no engineers and qualified staffs. The institutional frame work is precisely presented in the draft final report on Institutional Management and Financial Studies (August, 1981).

(5) Sewerage system were studied or under study for Kota Kinabalu, Labuan, Tawau, Sandakan, Lahad Datu and other three satellite towns.

(6) The following sewerage systems were adopted in Sabah:

(a) outflow to the sea,

(b) oxidation system,

(c) stabilization system (lagoon),

(d) package, and

(e) individual septic tank system.

All the sewage of Sandakan and Tawau and some part of Kota Kinabalu has been discharged to the sea. The outflow systems are generally very old because they were build by the British.

The oxidation system is very effective in the tropical area because land cost is cheap and operation and maintenance is easy. The individual septic tank system is used for private houses.

(7) In Sandakan there is a pig culture in the upstream of the PWD intake. Therefore PWD requested the owner to install the treatment facility for pig effluent.

(8) A budget of 82.2 million M$ were requested for sewerage in Sabah but only 18.8 million M$ were approved under HMP. It could be increased in 1983.

Water Resources Development Plans and Needs

(1) The Kudat rain storage earth dam, which was constructed for water supply about 10 years ago, is the only dam in Sabah. The active storage capacity is 600 MG (2.73×10^6 m^3). Construction of 5 dams of water supply purpose were proposed for 4 MP in Sabah. The Sepagaya concrete dam (water supply to Lahad Datu) and the Timbangan concrete dam (water supply to Semporna) were already under construction. The Bukit Kuda earthfill dam, the Kerupang fill dam and the Pagar fill dam were proposed for water supply in Labuan and they are under

design stage. (See major features of these dams in Table 6.)

(2) The water source problems will be met in Labuan and Sandakan only. Problems in Labuan is the most urgent. Development of groundwater and construction of three small dams were proposed to be completed by around 1985. The feasibility of the new water source in the Padas river of which water was diverted to Labuan by a submarine pipeline system was also studied.

Remarks: In the interview held in October, 1981, it was reported by PWD that construction of the 3 dams were approved in order to supply enough water to the newly approved sponge iron project (450 million M$) but the submarine pipeline was not approved yet because the methanol and power plant project (750 million M$) was not approved yet. However, it was reported by the other source that the sponge iron project was changed from Labuan to the State of Trengganu in December, 1981.

As for Sandakan, two alternative future surface water sources are under feasibility study; that is, one intake in the Kinabatangan river and the other one intake and a dam in the Meliau river. River water is planned to be diverted from either site to Sandakan by a pipeline system.

(3) The present intake of Kota Kinabalu water supply is in the Moyog river but a new intake was decided to construct in the Tuaran river under the phase 1 of the Stage 1 extension program. The pipeline from the Tuaran intake to Kota Kinabalu is under construction and it is scheduled to be completed by 1984. The demand up to 1990 will be met by the phase 2 works of the Stage 1 program. The Stage 2 program which would meet the demand up to 2000 was planned but it was not approved by ADB.

Water Saving Measures

(1) There is no plan of water recycle use.

(2) The unaccounted-for-water is estimated to be 20 - 40% including:

(a) leakage,

(b) inaccuracy of meter equipment,

(c) unmetered residents, and

(d) usage for fire works, schools and churches (free of charge).

The survey on the efficiency of the distribution system was finished for Kota Kinabalu and it was started for Sandakan.

Problems Associated with Project Implementation

(1) Land acquisition and resettlement problems were not experienced, but it generally takes long time to get mutual agreement. The right (power) of acquiring lands for water supply facilities is seldom used though it is prescribed in the water ordinance. It is tried not to be used. The compensation cost is usually different from the Government price. It is higher than the Government price but is cheaper than the Market price.

(2) The public objection against the development for water supply is very rare in Sabah at present because it results in the happiness of residents. Planning is made in technical level but claims are seldom submitted from politicians and residents.

(3) PWD budget is facing difficulty. The single water rate of M$2.0/1,000 gallons (4,550 m^3) has been fixed from 1961. There is no distinction between domestic use and industrial and commercial use. The new system of water rate is under study.

Manpower Requirement

(1) Manpower is insufficient especially at skilled operators, such as electritians, plumbers and fitters. Therefore, the operation and maintenance sites are tried not to be distributed.

(2) Manpower shortage in sewerage section is serious, too.

SABAH ELECTRICITY BOARD (SEB), Hydraulic Section

Water Management

(1) SEB has no experience with regard to the problems of water management because the Tenom Pangi hydropower project, which is scheduled to be commissioned around 1984, is the first project in Sabah.

(2) The minimum river maintenance flow is not a matter of discussion because the Tenom Pangi project is a run-of-river type and there is no specific demand in the downstream area.

(3) There is no international agreement with regard to water usage between Malaysia and Indonesia because no development has been planned in the rivers across the national boundary.

Water Resources Development Plans and Needs

(1) There is no inventory of potential hydropower sites. The hydropower potential survey will be done.

The Tenom Pangi project (66 MW) is the only hydropower site which is under construction. The Kinabatangan project is under feasibility study. The feasibility studies on the Sook site (35 MW) and the Papar site (45 MW) will be started. (See major features in Table 6.)

(2) The mini-hydropower (≤1,000 kW) schemes are under design stage and two schemes are under feasibility stage. (See major features in Tables 7 & 8.)

(3) Future plan of purchasing electricity from Sarawak is a matter of the State headquarters and therefore it is completely unknown.

Problems Associated with Project Implementation

(1) Major Government problems are:

(a) funding,

(b) resettlement will be a big problem because the natives have strong reluctance to part from home land,

(c) water right, and

(d) demand center is distributed and large scale development is not efficient.

(2) The price of construction materials is higher by about 20% than that of Peninsular Malaysia. Escalation is assumed to be 7 - 10% annually.

Manpower Requirement

(1) There is no manpower problem except shortage of skilled engineers. It might be solved by imported skilled engineer.

SANDAKAN PWD DIVISIONAL OFFICE

Water Shortage and Induced Problems

(1) The water supply pressure has been controlled with the following daily program in Sandakan.

Time	Pressure
4 - 6 AM	80 - 90%
12 - 2 PM	100%
4 - 6 PM	100%
the other time	30%

The dry spell is usually from May to July.

Water Management

(1) Mapping of pipeline networks is under survey by consultants because the existing pipeline is very old and the location of the pipeline is not clear.

Water Resources Development Plans and Needs

(1) Twenty one bore hole wells and 2 river intakes are in operation in Sandakan. The total supply capacity is 4.4 MGD (20,020 m^3/d). Present water demand is 6 MGD (27,300 m^3/d).

In the short term extension plan, 13 new bore holes drill and redrilling of 5 old wells were planned in order to upgrade the supply capacity to 7 MGD (31,850 m^3/d).

The population increase is larger than the projected value and Sandakan will be promoted to Municipality.

Alternative 8 river water sources were studied as a long term extension program and the Meliau dam and water diversion project (12 km) was proposed by the consultant because the supply capacity of groundwater is not enough. ADB, however requested to execute further feasibility study comparing the Meliau site with the Kinabatangan site because the Miliau project is very costly and involves in loan risk. The disadvantage of the Kinabatangan site is i) the intake site is submerged by floods, ii) the stream course of the Kinabatangan river moves iii) water quality is bad. The study will be completed around November, 1982. The date of commission of the long-term program will be delaied until around 1987 - 1988. PWD, therefore, is anxious about whether the supply capacity of the short-term program is enough or not by the commencement of the long-term program. The result of 6 bore holes was discharged very much.

TAWAU PWD DIVISIONAL OFFICE

Water Shortage and Induced Problems

(1) From February to June it is usually dry spell. Water is supplied by water tank trucks to the residents where water supply is stopped.

(2) Water supply operation time is 24 hours in Tawau except in an area of the southern part.

Water Management

(1) No competitive water usage was experienced between domestic water supply and irrigation.

Flood and River Control

(1) Flood occurs every year but it is not serious. There is no loss of life and the flood period is about 2 - 3 days.

(2) There is the Kukusan flood bypass plan in the Tawau river drainage project.

Water Pollution and Environmental Impact

(1) Water quality is monitored by weekly sampling for chemical and bacteria tests. No problems was reported. The upstream of the Tawau river is the area of palm oil and coco plantation.

Water Resources Development Plans and Needs

(1) Districts of Tawau (the main office), Semporna and Lahad Datu is under the control of Tawau PWD divisional office.

There is no dams in Tawau. The Timbangan concrete gravity dam (45 feet = 13.7 m high) is under construction for Semporna water supply. The Sepapaya concrete dam is under construction for Lahad Datu water supply. (See the major features in Table 6.)

(2) The served population in the Tawau urban area is 85,000. Water supply to the rural area is not planned at present but it will be necessary in the future.

(3) Phase I Tawau urban extension works having additional capacity of 4.5 MGD (20,500 m^3/d) are under construction with ADB loan and are scheduled to be completed by October, 1982.

(a) North road water works, present capacity 2 MGD (9,100 m^3/d), completed 1970.

(b) Kuhara water works, present capacity 0.5 MGD (2,275 m^3/d) is upgraded to 1.5 MGD (6,830 m^3/d) by June, 1981.

The total supply capacity will meet the demand of up to 1985. The capacity shortage, which is estimated to be 1.5 MGD in 1981, will continue by the time of completion of the Phase I works.

The Phase II program after 1985 is not known.

(4) The north road water works consists 2 reinforced concrete reservoir having each 1.5 MGD daily regulation capacity. The present total capacity of 5 steel service tanks is only 1.0 MGD (4,550 m^3/d) and is too small to regulate the daily demand.

(5) All the water is taken from the Tawau river at present. The catchment area is 32 sq.mi/es (82.9 km^2).

The total facility capacity is 7 MGD (31,900 m^3/d) in the Tawau river by 1985. The minimum yield capacity of the Tawau river was estimated to be 11.8 MGD (53,700 m^3/d) at the north road intake and 12.4 MGD (56,400 m^3/d = 0.65 m^3/s) at the Kuhara intake in the preliminary report of 1975 (Ref. 6).

In the report the demand was projected to be 14 MGD (63,700 m^3/d) around 1995 - 2005 and a new water source was proposed in the Murtai Kanan (catchment area = 85.5 km^2).

Problems Associated with Project Implementation

(1) Construction cost becomes high because price of construction materials is high and lack of skilled labours. Most construction materials are imported and shipping is usually delayed several weeks. Quality of stones and aggregates are bad and the price is very high because aggregates are not controlled by the Government. The price of steel and cement is controlled by the Government, but there exists black market price depending on the supply and demand. All electricity should be supplied by own generators. Repair of machinery is very difficult because of shortage of mechanics and parts.

(2) Manpower shortage of construction labours is serious. Most workers, who are mainly Malay are invited from West Malaysia. Malay and Philippine labours are usually not skilled. Indonesians have communication problem. The day work rate is M$45 - 60/d for skilled masonries or carpenters and M$70/d for plasterers.

(3) Project cost estimate by consultants is usually lower estimate.

(4) Specifications is usually so severe that it does not necessarily meet the local conditions, for example, in case of ADB project.

SARAWAK DID

Water Management

(1) The drainage and irrigation department is in charge of the following work in the stage of planning and design:

(a) drainage schemes for agricultural land (mainly paddy),

(b) irrigation,

(c) hydrology,

(d) flood mitigation (mainly urban area),

(e) river clearing and conservation, and

(f) protection and widening of river.

The problem on river water contamination is under the Environmental Department.

(2) Water for irrigation schemes are mostly served by pumping stations and a little gravitation. There are no irrigation weirs and barrages at present (Oct., 1981). Payaselanyan is a small scheme.

(3) Law of registration of river water use and the priority of water use during drought period is recognized to be necessary.

Flood and River Control

(1) Flood damage is generally not serious. It is more serious in the Peninsula. Loss of life is very rare.

(2) Flood mapping and flood prone zoning have not been done yet. Records of flood damage also have not been made yet. The flood area record of the flood of 1963, of which recurrence interval is estimated to be more than 50 years, was the only data.

(3) There is no flood forecasting system in Sarawak at present, but the first pilot scheme will be started in the Sadong river from 1982.

(4) DID started to concentrate urban drainage projects as a part of flood control measures. Urban drainage scheme was planned for the following area:

(a) Kuching town,

(b) Lanng industrial estate in Sibu,

(c) Sibu urban, and

(d) Bintulu is under the Bintulu Development Authority.

The town sewerage is separated from the drainage schemes.

(5) Kuching town experienced flood in 1980. It concentrated in town only for a few hours. The rainfall was 16 inches (406 mm/ 6 hours); the average 68 mm/hour.

(6) Tidal effect is very severe in Sarawak. The range of tidal effect and back water effect have been measured in the major rivers.

(7) There may be almost no bad effect from mining works in rivers in Sarawak.

(8) Bank erosion, which is caused by tidal bore and waves due to high speed boats, is notable in the Rajang river and the Sadong river. The bank erosion problem is under the duty of the Marine department. The department established the speed limit for the high speed boats.

(9) Silting problems were reported in the Sadong river, the Lupar river, the Baran river and the Miri river, but dredging project is not planned for these rivers. Ships navigate during high tide.

Water Pollution and Environmental Impact

(1) River water is generally soft (pH 6.2).

(2) Saw mill dust was major pollutant. Water conservation measures may be needed.

Water Resources Development Plans and Needs

(1) The rural water supply study, which is financed by ADB, is under negotiation and it will start next year.

(2) Development of underground water and rainfall collection are hoped as practical measures of supplying water to the coastal area.

Problems Associated with Project Implementation

(1) Budgeting of urban drainage is normally the responsibility of the Land Survey Department or Government. Survey, planning, design and implementation of the projects normally carried out by DID. Maintenance is the responsibility of the municipal council.

(2) Land acquisition problem was time factor (i.e. time delay) only. Compensation is under the duty of the Land and Survey Department.

Manpower Requirement

(1) DID was disjoined from PWD in 1967.

The DID staff number was frozen in the period from 1976 to 1979; that is, zero new post. The number of staff was doubled in the period from 1979 - 1981.

(2) Manpower shortage is chronic, especially for skilled and semi-skilled staff because provision of new posts are generally delayed 1 - 2 years.

Training problem of the staff is also necessary.

(3) Implementation of 4 MP might be delayed because of manpower shortage.

SARAWAK PWD

Water Shortage and Induced Problems

(1) Discharge of surface water source (i.e. river) is very large in Sarawak and no shortage of surface water source has been experienced at present (Oct., 1981) except the coastal rural area. Some intakes operated in small streams may experience some water shortage during dry spell.

(2) Water shortage is very serious in the coastal rural area. Cholera breaks out in dry spell, mostly every year. The total number of cases of cholera until October 14 in 1981 was reported to be 13 for the First Division, 6 for the Third Division, 5 in the Sixth Division in the newspaper, the Sarawak Tribune.

The coastal line is generally peat swamp and the water quality is not adequate for drinking. The surface water contains sulfur and dug well water contains iron. A piped water supply system has been requested for this area, but it is physically and economically impossible because the villages are completely isolated. Drastic measures including ground water development have been searched for.

A project of rainfall collection by roofing during dry spell is going to be proposed for the coastal area. The service capacity will be 3 gallons (13.7 lit)/person/day.

Water Management

(1) PWD supplies fully treated or semi-treated water to the urban and the legal* rural town of which population is large than 1,000 by organized pipeline systems. The community water supply of untreated gravity water has been supplied to the residents in remote rural area under guidance by MOH (60% of villages). Rural water supply is sometimes conducted by joint venture with JKR and MOH.

* This definition is not authorized according to the information from SPU.

(2) There are 40 PWD water works in the seven divisions in Sarawak in October, 1981.

(3) The water supply regulation of 1958 were amended in 1964 based on the water ordinance.

(4) Pumping stations are operated by electricity or Diesel engines depending on the site conditions. Gravitational supply is done in mountainous area.

(5) In selecting pumping stations, following three significant items are taken into account:

(a) navigation,

(b) discharge required for the neighbour PWD intake structures,

(c) fact of salt intrusion.

(6) PWD has the charge of many kind of public works including gas supply and therefore the work load is very heavy.

(7) There are 35 Water Authority under the director of PWD Sarawak. They are fully subsidized by the State Government and are responsible to submit a monthly report to the state PWD.

(8) One third of the construction cost of the rural water supply is subsidized by the State and the two third is granted by the Federal Government.

(9) Monitoring of water quality has been done by taking two samples in a week at the PWD pumping stations.

Flood and River Control

(1) Salinity intrusion has been experienced at almost all the PWD intakes in a drought period from June to July in Sarawak. Pumping operation is done during low tide with the requirement of less 500 ppm of salinity when it is experienced. These intake structures are planned to be moved to the upstream where no intrusion occurs. Salinity intrusion were reported at Sarikei, Balingian, Binatang, Daro, Matu Dalat, Igan, Kut, Muka, Tatau, Kuala Tatau, Awat Awat and Kuala Lawas. At Sarikei and Balingian it is reported to be serious.

Water Pollution and Environmental Impact

(1) Sewerage section is on the way of establishment in PWD and no public sewerage system has been operated except those in army camps in Sarawak.

(2) British Standard which follows WHO Standard has been adopted for monitoring sewage water but BOD has not been evaluated yet.

(3) Sewerage systems are under feasibility study or under construction with EPU Federal loan of 4 MP in Kuching, Sibu, Bintulu and Miri.

(4) Gravity water supply by MOH may experience sanitary problems in the future.

Water Resources Development Plans and Needs

(1) The study reports consisting water demand projection were prepared for only Kuching, Sibu, Bintulu and Miri. No reports were prepared for the other towns because no particular need arised. Water demand forecasting was done up to 1985 except Bintulu and Miri which were projected up to 1990. In other words, long term demand forecasting has not been done yet.

(2) Water supply implementation program was made until 1985 because of budget limitation while demand forecast was made until 1985 or 1990 depending on the site conditions.

(3) Population census is considered to be involved in error of at least 5%. This error will not be adjusted until around 1982 - 1983.

(4) Water supply facilities is designed for the drought with the recurrence interval of 20 years.

(5) It is considered to be rather difficult to serve piped water for all the citizens in Malaysia until 1990. The target year of 2000 may be more realistic. The treated water is not necessarily absolute requirement. Semi-treated or non-treated

water may be acceptable depending on the site conditions.

(6) Development cost of ground water (tube-well) is very expensive in Sarawak. Only two ground water project is under construction; that is, Kabong pilot scheme (0.5 MGD = 2,275 m^3/d, served population 4 - 5,000) and Belawai (0.5 MGD, served population 4,000).

(7) Quality of surface water is quite satisfactory for rural water supply in the mountainous area.

Problems Associated with Project Implementation

(1) The water rate was set about 12 years ago and revision was not made after that. The water rate was not distinguished for industrial and commercial use. The rate will be revised in the near future. Increase of about 21% has been proposed.

(2) The public water use for fire extinguishing drill, schools and hospitals is counted as unaccounted-for water use. Unaccounted-for water is about 15 - 30% including stolen water in Sarawak.

SARAWAK ELECTRICITY SUPPLY CORPORATION (SESCO)

Water Management

(1) Consultation with regard to the river minimum maintenance flow was not held in the planning stage of the Batang Ai hydropower project but the guarantee outflow of 94 m^3/s at the dam site was taken into consideration. The average inflow is estimated to be 121 m^3/s at the dam site (catchment area 1,200 km^2).

The dam is under construction and is scheduled to be completed by 1985. The installed capacity is 92 MW and the active storage capacity is 750 x 10^6 m^3.

Water Resources Development Plans and Needs

(1) The feasibility study on the Pelagus (Raja 284) hydropower project, of which installed capacity and firm energy was estimated to be 770 MW and 4,900 GWh respectively, will be finalized around June or July, 1982. The site investigation was completed. This project will meet the future demand of Sabah and Sarawak after 1990. The catchment area is 20,919 km^2 and the mean inflow is 2,000 m^3/s at the site. The maximum active storage capacity is 3.0 x 10^9 m^3 and the reservoir surface area is 380 km^2.

(2) The feasibility study on the Balu 037 hydropower project, of which installed capacity and firm energy was estimated to be 2,580 MW and 17,200 GWh respectively, will be finalized around middle of 1983. The project will meet the future demand of Sabah, Sarawak and some part of the Peninsula after 1994. The catchment area is 14,764 km^2 and the mean inflow is 1,560 m^3/s at the site. The maximum active storage capacity is 27.1 x 10^9 m^3 and the reservoir surface area is 730 km^2.

It has not been decided yet to implement either the Palagus site or the Balu site at first.

Problems Associated with Project Implementation

(1) Land acquisition and resettlement is quite difficult and complex.

The number of submerged residents was estimated to be about 10,000 in the Pelagus project and about 5,000 in the Balu project respectively. Consultation was already made to the residents in the project area.

KUCHING WATER BOARD

Water Shortage and Induced Problems

(1) Shortage of water supply was experienced in 1977 and 1978. It was caused by insufficiency of the capacity of the water supply facilities, but was not caused by shortage of river water. The problem was completely solved after completion of the Batu Kitang facilities.

(2) Quantity of river water being enough, no competition of water usage river occurred. Water is used for water supply only in the upstream of the Sarawak River.

Water Management

(1) There are no dams which cross rivers in Kuching. The two rain impounding reservoirs in the Matang Scheme (9,100 m^3/day) do not cross rivers and the minimum maintenance flow and the compensation discharge were not taken into account for the capacity.

(2) Definition of Urban and Rural is as follows:

	Population
Urban	> 10,000
Minor urban (or Minor town)	1,000 ~ 9,999
Rural (or village)	< 1,000

Flood and River Control

(1) No salinity intrusion was experienced at the intakes of the Kuching water board in the Sarawak Kiri river even during the period of high tide. The tidal range of the Sarawak Kiri is about 15 feet (max. to min.) (4.6 m) and 22 feet (6.7 m) at the river mouth.

Water Pollution and Environmental Impact

(1) Feasibility study on the sewerage system in Kuching has been requested to be carried out.

The cost of sewerage system of Kiching is estimated to be very expensive because of the week mud foundation of 3 - 4 feet (0.9 - 1.2 m) depth.

Water Resources Development Plans and Needs

(1) Kuching Water Board supplies water to the area of 84 square miles (218 km^2). The served area will be expanded in the future.

Seventy five % (190,000) of the Kuching Rural District Council (population 252,000) and 100% of the Kuching Municipal Council (population 74,000 area 7.8 sq.mile = 20.2 km^2) are served by the Board at present (Oct., 1981). The present total supply capacity of the Board is 14 MGD (63,700 m^3/d) and the present total supply quantity is 11.5 MGD (52,325 m^3/d). The present number of service connection is about 26,000.

The target service factor in the area of the Kuching Rural District Council was adjusted to be 90% from 100% for 1990. The target has not been established for 2000 yet.

(2) The rate of increase of the industrial water demand is projected to be 10% per year. The industrial consumption rate is estimated to be 1,500 gallon (6.83 m^3)/acre (4,050 m^2)/d, but this value is considered to be too high because the major users are light industries such as timber and agricultural products.

(3) Construction of additional supply capacity of 9 MGD is scheduled to be commenced from 1983 and be completed by end 1984 and also 10 MGD (45,500 m^3/d) will be required after 1988.

Construction of a barrage in the downstream or a storage dam in the upstream will be required in the Sarawak Kiri river for the domestic and industrial water supply in the future. Therefore, a feasibility study on the Bengoh damsite in the upstream of the river will start. The purpose is combination of domestic and industrial water supply and flood mitigation.

Problems Associated with Project Implementation

(1) Budgetary constraint is extremely large. Construction cost of water supply systems is extremely expensive because the demand centers are distributed in remoted area. It is desirable to request consumers to contribute the capital required for the individual main tranks. Therefore different water rate may be realistic.

(2) Operation and maintenance cost is high because of pumping operation. Power cost is estimated to be 40% of the production cost.

Manpower Requirement

(1) Manpower of skilled technicians is insufficient.

SIBU WATER BOARD

Water Shortage and Induced Problems

(1) Shortage of water supply capacity was experienced before 1979 but it was solved after completion of a new treatment plant in 1979 except in a part of conjected town area where the size of pipelines was too narrow to supply the demand and upgrading the pipeline was ongoing.

Water Management

(1) No permission or license is required for the factory water utilization. The management of the Sibu area of the Rajang river is under the duty of the Marine Department.

Flood and River Control

(1) Change of river water level is 8 - 10 feet (2.4 - 3.0 m) in the Sibu area in the Rajang river. No saline water problem was experienced a halfway upstream between Binatang and Sibu in the Rajang river.

(2) Ships are navigated to Tanjung Maning in the Rajang river.

Water Pollution and Environmental Impact

(1) Management of water quality is under the control of the Sibu urban district council because there is not a branch of DOE in Sibu at present.

(2) The upper Lanang new industrial site estate is located in about 4 miles (6.4 km) upstream from the intake of the Sibu water supply. It is feared that the river water might be polluted by the effluent from timber and sago refinery factories in the site. The industrial site was completed in 1979 but no problem was experienced so far because establishment of factories was delayed. Monitoring of water quality has not been made at the industrial site but it has been done with WHO standard at the Sibu intake.

The official considers that it is a good idea to move the Sibu intake from the present location to the upstream of the industrial site or construct a new intake at the upstream after 1992.

(3) For water treatment a rapid sand filter system and following chemicals are used:

(a) alumina sulphate,

(b) sodium aluminam,

(c) chlorine,

(d) sodium silico fluoride, and

(e) soda ash (Soda carbonate).

Water Resources Development Plans and Needs

(1) The Sibu Water Board supplies water to the Sibu urban district area (17.5 sq. miles = 45 km^2), a army camp (3 sq. miles = 7.8 km^2) and the upper Lanang industrial estate in 1981. The number of served connections is 12,300.

(2) The capacity of the treatment plant was upgraded as follows:

1963 from 1 MGD (4,550 m^3/d)	to 1.5 MGD
1973 from 1.5 MGD	to 3.5 MGD
1979 from 3.5 MGD	to 6.0 MGD (27,300 m^3/d)

All withdrawal has been done at one pumping station which is located upstream of the Sibu town in the Rajang river.

The capacity will be enlarged to 12 MGD (54,600 m^3/d), which will be satisfied up to 1992, by 1984 under 4 MP. The rate of increase of service population was projected to be 6% in the most urban area by 1992. There is no plan for the demand after 1992.

(3) The water consumption of the upper Lanang estate is small at present. The major user is sawn timber factories and the maximum consumption is estimated to be 200,000 gallons (910 m^3/d).

Problems Associated with Project Implementation

(1) The unaccounted-for water which consists of leakage, regular flashing and fire extinguishing is estimated to be about 15%. The supply for public facilities is charged.

(2) There was no land acquisition and resettlement problem.

Manpower Requirement

(1) There is no manpower problem.

BITULU PWD

Water Shortage and Induced Problems

(1) Water shortage in the coastal area becomes a cause of epidemic of cholera. The Government supplies warer containers (400 gallons = 1.82 m^3) for rainfall stock to the residents.

Water Resources Development Plans and Needs

(1) The present supply capacity is 2.5 MGD (11,380 m^3/d) and the production rate is 2.0 MGD. A new water supply project of 8.5 MGD (38,680 m^3/d), which is planned to meet the demand of 1994, is under construction and it is scheduled to be operated in 1983.

A contingency plant of 1.0 MGD (4,550 m^3/d) was planned for the Kidurong industrial estate as an immediate measure before 1983, but the site selection has not been done because there is a problem of fertilizer utilization in the catchment.

(2) In the new water supply project the Sika reservoir and pumping station are under construction in the Sibiu river, the tributary of Kemena river. Water quality of the Sibiu river is good enough. The other water source will be needed after 1995.

Some engineers doubted of the operation and maintenance cost and problems due to the pumping operation of the Sika reservoir.

BINTULU DEVELOPMENT AUTHORITY

Water Shortage and Induced Problems

(1) Water shortage due to plant capacity was experienced at the initial stage of the development because the population was increased to 3 ~ 4 times suddenly.

Water Pollution and Environmental Impact

(1) There is also environmental section in the authority.

(2) Water for cooling LNG plants was pumped from the sea and discharged to the sea after usage.

(3) There is a sewerage system in the central residential area. Two sanitation ponds of 4 acres (1.6 ha) was build temporary purpose.

The development plan of the residential area is described in the Report on Inflastructures on Kidurong Residential Estate, 1980.

Water Resources Development Plans and Needs

(1) The port was completed in January, 1981 and construction of the Kidurong industrial estate is ongoing. The industry consists of urea and ammonia plant (major water user), palm oil processing, timber base light industry, aluminum refinery (not confirmed) and power generation.

The urban development consists of shopping center, schools for training including an agriculture university (1983), recreation center, central sewerage systems and moving the present airport.

The new water supply system including the Sika reservoir is required to be completed before the commission of the urea plants in 1983.

MIRI PWD

Water Shortage and Induced Problems

(1) Water shortage was experienced in the coastal area and development of ground water will be necessary.

(2) The capacity of the present water supply system is not enough and many residents experienced water shortage and the treated water has been bought from the Shell corporation.

PWD Supply Capacity (equates to the production capacity)	2 MGD
From Shell Corporation	0.5 MGD
Total Consumption (industrial use is negligible)	2.5 MGD (11,400 m^3/d)

The served population is 37,000 excluding the Shell portion while the total population in the Miri district is 100,000 in 1980.

The problem of supply shortage will be solved after the completion of the new project (2 MGD = 9,100 m^3/d) which will meet the demand of up to 1983.

Water Management

(1) The water supply system of the Shell Corporation, of which employees is 5 - 10,000, is completely independent on PWD and it is not under the ordinance. The Shell Corporation was founded around 1910.

(2) There is no other water user inside the catchment of the present PWD intake because it is gazetted by PWD.

Flood and River Control

(1) A flood with the return period of 20 years was experienced in 1980.

Water Pollution and Environmental Impact

(1) Septic tanks are used among urban households.

(2) Water pollution due to a saw mill was not experienced because it was outside the intake catchment.

Manpower Requirement

(1) Manpower problems have been experienced.

5. CONSTRUCTION COST SURVEY

5.1 Cost Data Collected

The PWD schedule of rates for the supply of Labour, materials, tools, plants and appliances and the updated project cost of three dam projects which was under construction in Sabah and Sarawak were collected from PWD, SEB and SESCO as listed below:

	Item	Price Level	Source Obtained
(1)	Updated capital cost of the Tenom Pangi hydropower project	Oct. 1981	SEB
(2)	Updated project cost of the Batang Ai project	End 1980	SESCO
(3)	Estimated project cost based on contract tenders	End 1980	Project office of New Bintulu Water Supply
(4)	Daywork rates for labour, material and plant hire for the Tenom Pangi hydropower project	May 1978	SEB
(5)	Schedule of rates for the supply of labour, materials, tools, plants and appliances, revised edition	Aug. 1981	PWD Sabah

5.2 Construction Materials and Escalation Trend

In the States of Sabah and Sarawak shortage of most kinds of construction materials and labours were experienced. The construction cost is considered to be more expensive than that in the Peninsular Malaysia by about 20 - 30%. The escalation trend is also considered to be higher. The cause of trend of higher construction cost is considered to be as follows:

(1) Most construction materials and labours are transported from the west Malaysia or imported from foreign countries;

(2) Project sites are generally very isolated and higher transportation cost is charged; and

(3) Market is very small and amount of stock is limited and demand is always competing.

REFERENCES

1. Government of the State of Sabah, KOTA KINABALU WATER SUPPLY MASTER PLAN STUDIES, Watson and Majukonsult, November, 1977

   VOL. 1 REPORT
   VOL. 2 DRAWINGS
   VOL. 3 SUMMARY OF REPORT

2. JKR Sabah, FINAL REPORT FOR A PROPOSED WATER SUPPLY SCHEME INVOLVING A SUBMARINE PIPELINE FROM THE MAINLAND TO LABUAN ISLAND, Engineering-Science Inc. and Konsultant Kumpulan SDN., October, 1981

   - TECHNICAL FEASIBILITY STUDY, COST ESTIMATES AND FINANCIAL PLAN
   - PRELIMINARY ENGINEERING DESIGN

3. Government of the State of Sabah, LABUAN WATER SUPPLY, WATER RESOURCES AND WATER SUPPLY STUDIES, Watson and Majukonsult SDN. BHD., December, 1978

   VOL. 1 REPORT
   VOL. 2 SUMMARY OF REPORT

4. The State of Sabah, SANDAKAN WATER SUPPLY EXTENSION SCHEME, FEASIBILITY STUDY, Kampsax-Kruger Consulting Engineers and Sepakat Setia Perunding SDN. BHD., June, 1980

   EXECUTIVE SUMMARY
   VOL. 1 TECHNICAL AND FINANCIAL REPORT
   VOL. 2 MAPS AND DRAWINGS
   VOL. 3 BACKGROUND DATA
   VOL. 4 GROUNDWATER DATA, TABLES, FIGURES AND EXPLANATION

5. JKR Sabah, EXTENSION OF THE LAHAD DATU WATER SUPPLY, Sepakat Setia Perunding SDN. BHD., January, 1976

   - PRELIMINARY REPORT
   - SUPPLEMENTARY REPORT

6. JKR Sabah, EXTENSION OF THE SEMPORNA WATER SUPPLY, PRELIMINARY REPORT, Sepakat Setia Perunding SDN. BHD., November, 1975

7. JKR Sabah, EXTENSION OF THE TAWAU WATER SUPPLY, PRELIMINARY REPORT, Sepakat Setia Perunding SDN. BHD., September, 1975

8. JKR Sabah, KOTA BELUD WATER SUPPLY EXTENSION SCHEME, PRELIMINARY DESIGN REPORT, Konsultant Kumpulan SDN. & Engineering-Science Inc., April, 1980

9. SESCO, MASTER PLAN FOR POWER SYSTEM DEVELOPMENT, German Agency for Technical Cooperation Ltd. (SAMA Consortium), April, 1981

SUMMARY
VOL. 1 TEXT
VOL. 2 ANNEXES
VOL. 3 APPENDICES
VOL. 4 COMPUTER PROGRAM DOCUMENTATION

10. SESCO, MICRO-HYDROELECTRIC RECONNAISANCE STUDIES, SARAWAK, Snowy Mountains Engineering Corporation, December, 1973

11. GOM, BATANG AI HYDROELECTRIC PROJECT, FEASIBILITY REPORT, Snowy Mountains Engineering Corporation, December, 1978

12. SESCO, PRELIMINARY STUDIES OF HYDROPOWER POTENTIAL AND DEVELOPMENT OF RAJANG RIVER BASIN IN SARAWAK, December, 1977

13. GOM, KINABATANGAN RIVER BASIN RESERVOIR PROJECT, DRAFT INTERIM REPORT, Japan International Cooperation Agency, March, 1981

14. SEB, SHORT-TERM ENGINEERING STUDY, Electrowatt Engineering Service, February, 1980

VOL. 1 REPORT SUMMARY
VOL. 2 SYSTEM PLANNING

15. GOM, PREFEASIBILITY STUDY LIMBANG RIVER BASIN, Kingdom of Belgium, January, 1980

VOL. 1 STUDY SUMMARY AND MAIN REPORT
VOL. 2 ANNEX: SOCIO-ECONOMIC AND INSTITUTIONAL ASPECTS
VOL. 3 ANNEX: CLIMATE, BASIN HYDROLOGY AND CIVIL ENGINEERING WORKS
VOL. 4 ANNEX: AGRICULTURAL ASPECTS
VOL. 5 MAPS

16. GOM, ENGINEERING REPORT ON TENOM PANGI POWER PROJECT, Nippon Koei Co., Ltd., July, 1977

17. GOM, FEASIBILITY REPORT ON TENOM PANGI POWER PROJECT, Nippon Koei Co., Ltd., February, 1974

TABLES

Table 1 BASIN DIVISION AND CATCHMENT AREA

Sabah				Sarawak			
	Basin	Catchment Area (km^2)	Effective Area (km^2)		Basin	Catchment Area (km^2)	Effective Area (km^2)
201	Pensiangan	5,971	5,971	227	Lawas	1,080	977
202	Serudong	1,308	1,155	228	Trusan	2,768	2,598
203	Kalabakan	1,371	1,288	229	Limbang	3,920	3,865
204	Brantian	741	678	230	Baram	22,325	21,822
205	Umas Umas	553	408	231	Miri	788	263
206	Merutai Besar	558	473	232	Sibuti	935	790
207	Tawau	888	683	233	Niah	1,345	1,117
208	Kalumpang	2,792	2,284	234	Buai	1,440	1,242
209	Silibukan	2,714	2,154	235	Similajau	1,268	935
210	Segama	5,558	4,787	236	Kemena	6,000	5,745
211	Kinabatangan	16,755	15,752	237	Tatau	5,150	4,790
212	Segaliud	2,335	1,632	238	Balingian	2,518	1,548
213	Labuk	6,829	5,969	239	Mukah	2,625	1,486
214	Sugut	3,094	2,826	240	Oya	2,005	1,277
215	Paitan	1,474	1,086	241	Rajang	51,053	46,035
216	Bengkoka	1,866	1,463	242	Kerian	1,675	849
217	Bongan	2,126	1,823	243	Saribas	1,900	799
218	Kadamaian	1,336	1,171	244	Lupar	6,813	5,209
219	Tuaran	1,247	1,139	245	Sadong	3,645	2,935
220	Putatan	629	494	246	Sarawak	3,358	2,152
221	Papar	805	785	247	Kayan	1,838	1,549
222	Kimanis	607	547				
223	Membakut	736	338				
224	Padas	9,180	8,475				
225	Labuan	86	46				
226	Lakutan	1,291	1,173				
Total of Sabah		72,850	64,600	Total of Sarawak		124,449	107,983

Table 2 WATER SOURCE OF D/I WATER SUPPLY IN MAJOR CITIES IN SABAH (1/3)

Name of City	Location of City	Surface Water Source: Basin No.	Surface Water Source: Name of River	Present and Future Conditions of Water Source
Tawau	217	217	Tawau Merotai Kanan	Potential supply capacity of the Tawau river is enough up to 1994. New water source is proposed in the Merotai Kanan river after 1995.
Semporna	218	218	Mentalitip & Gadang Gading	Extension works of the existing intake is on-going. Water is transported from 2 different river systems by a pipeline system. One small concrete dam is under construction in the Timbangan river. Shallow wells are in operation.
Lahad Datu	219	219	Timbuau & Sepagaya	One intake is in the Timbuau river. Water is also transported from the Sepagaya river by a pipeline system. One small concrete dam is under construction in the Sepagaya river.
			Segama	Two alternative intake sites are proposed in the Segama river as a future water source.
Sandakan	212	213 211	Meliau or Kinabatangan	Deep wells 21 borehole well and 2 river intakes are the present water source, but the supply capacity is critical. Two alternative future water source are under feasibility study. One intake in the Kinabatangan river and one intake and a dam in the Meliau river. Water is planned to be diverted from the both sites by pipeline systems.

Table 3 WATER SOURCE OF D/I WATER SUPPLY IN MAJOR CITIES IN SABAH (2/3)

Name of City	Location of City	Surface Water Source: Basin No.	Surface Water Source: Name of River	Present and Future Conditions of Water Source
Kota Belud	218	218	Wariu (5 miles upstream from Kota Belud)	Development of surface water is not required. The existing 3 shallow large diameter well is capable to supply up to 1985. The deep borehole source adjacent to the Tempasuk river is capable to supply up to 2000 and cost is 20% cheaper than the source of surface water.
Tuaran and Tempasuk	219	219	Tuaran	The existing intake is in the Tuaran river upstream of Tuaran. The supply capacity of the river is large enough in the future.
Kota Kinabalu	220	220	Moyog	The intake of the existing supply system is in the Moyog river, upstream of Kg. Pogunon.
		219	Tuaran	Water is planned to be transported from the Tuaran river by a pipeline system in the Stage 1 development. The supply capacity will be enough up to 1990.
		221	Papar	In the Stage 2 development water is planned to be diverted from the Papar river by a pipeline system after 1990.
Papar and Kimanis	221	221	Papar	An intake is in the Papar river. A headworks will be required for the Stage 1 extension program at the same site of the existing sites in the Papar. The capacity of the Stage 1 will be enough up to 1990.

Table 4 WATER SOURCE OF D/I WATER SUPPLY IN MAJOR CITIES IN SABAH (3/3)

Name of City	Location of City	Surface Water Source: Basin No.	Surface Water Source: Name of River	Present and Future Conditions of Water Source
Tenom	224	224	Padas	Intake is at the upstream of the Tenom Pangi hydropower site near Tenom.
Beaufort	224	224	Padas	Intake is at about 5 km upstream from Beaufort in the Padas river.
Labuan	225	225	Kerupang, Pagar and Kuda	Deep wells are in operation. Kerupang, Pagar and Kuda dams were commissioned to be completed by 1984 - 85.
		224	Padas	If the development of the new industrial estate (methanol) is approved, water diversion will be required from the Padas river by a submarine pipeline system. The intake is planned at the upstream of Beaufort.

Table 5 WATER SOURCE OF D/I WATER SUPPLY IN MAJOR CITIES IN SARAWAK

Name of City	Location of City	Surface Water Source: Basin No.	Surface Water Source: Name of River	Present and Future Conditions of Water Source
Miri and Lutong	231	231	Miri	The capacity of extension plan is enough up to 1983. Quantity of water is considered to be enough in the future, too.
Bintulu	236	236	Sibiu (a tributary of the Kemena river)	The new water supply scheme in the Sibiu river is under construction and will be commissioned in 1983. Water is pumped up from the Sibiu river to the Sika reservoir in the Sika river. The supply capacity is planned up to 1995. New water source will be required after 1995.
Sibu	241	241	Rajang	One intake is located just upstream of Sibu in the Rajang river. Discharge of the river is large enough in the future but the new industrial estate is developed about 6.5 km upstream from the intake. Water pollution is worried in the future.
Sarikei	241	241	Sarikei (a tributary of the Rajang river)	Two intakes are in operation and one intake is under construction under 4 MP.
Sri Aman	244	244	Undap (a tributary of the Lupar river	An intake is in operation in the Undap river about 15 km upstream from Sri Aman.
Kuching	246	246	Sarawak	Batu Kitang intake is in operation in the Sarawak river about 15 km upstream from Kuching. A barrage or a dam will be required in the upstream of the Sarawak river in the future. Two impounding reservoirs of the capacity of 9,100 m^3/day (2 MGD) are in operation in the Sibulu river (Matang Scheme).

Table 6 LIST OF EXISTING AND PLANNED DAMS IN SABAH

Name	Basin No./ River	Purpose/ Year of Commission	Organi-zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^3 m^3/d)
EXISTING						
Kudat rain storage reservoir	217, Bongan	WS	PWD	-	2.73	4.55 (1 MGD)
UNDER CONSTRUCTION						
Timbangan dam	208, Kalumpang	WS/end 1983	PWD	27.7	0.82	9.12 (2 MGD)
Sepagaya dam	209, Silibukan	WS/mid 1984	PWD	23.2	1.91	9.12
Tenom weir	224, Padas	HY: 66 MW/ 1984	SEB	7,815	4.7	Run-of-river
UNDER DETAILED DESIGN						
Bukit Kuda dam	225, Labuan	WS	PWD	0.2	3.64	
Kerupang dam	225, Labuan	WS	PWD	0.5	0.28	12.29 (2.7 MGD) by 3 dams
Pagar dam	225, Labuan	WS	PWD	0.8	0.36	
UNDER PLANNING						
Balat dam	211, Kina-batangan	FM, HY: 34 MW	(DID)	10,730	5,000	-
Meliau dam	213, Labuk	WS	PWD	58	18	-
Sook dam	224, Padas	HY: 35 MW	SEB	1,770	400	-
Papar dam	221, Papar	HY: 45 MW	SEB	350	-	-

Remarks; WS: Domestic and industrial water supply
FM: Flood Mitigation HY: Hydropower

Table 7 LIST OF EXISTING AND PLANNED DAMS IN SARAWAK

Name	Basin No./ River	Purpose/ Year of Commission	Organi-zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^3 m^3/d)
EXISTING						
Two dams under Metang scheme	246, Sarawak	WS	Kuching Water Board	2.0	0.41 (gross)	9.12 (2 MGD)
UNDER CONSTRUCTION						
Batang Ai dam	244, Lupar	HY: 92 MW/ 1985	SESCO	1,200	750	Guaranteed outflow 94 m^3/s
Sika reservoir	236, Kemana	WS/1983	PWD	-	1.55 (gross)	38.6 m^3/s (8.5 MGD) at first stage
UNDER PLANNING						
Pelagus (Raja 284) dam	241, Rajang	HY: 770 MW/ 1990	SESCO	20,919	1,200	-
Bakun (Balu 037) dam	241, Rajang (Balui)	HY: 2,580 MW/ 1994	SESCO	14,764	16,200	-

Remarks; WS: Domestic and industrial water supply
HY: Hydropower

Table 8 MINI HYDROPOWER SCHEMES IN SABAH

Name (after nearest kg)	River	Districts & No. of Households	Installed Capacity (kW)	Isolated or Connected *	Capital Cost (10^6M$)
Sites approved by F.E.P.U					
Melangkap	Panataran	Kota Belud (240)	500	Connected	5.21
Kiau	Kadamaian	Kota Belud (244)	135	Isolated	2.49
Pukat	Tuaran	Tuaran (742)	285	Connected	2.503
Poring	Mamut	Ranau (476)	250	Connected	2.816
Tenompok	Mesangoh	Tambunan (158)	80	Isolated	1.43
Tambunan	Tandulu	Tambunan (660)	120	Connected	3.199
Tomani	Patian	Tenom (1125)	500	Isolated	3.523
Bombalai	Tawau	Tawau (935)	840	Connected	7.454
Merotai	Merotai Kechil	Tawau (1553)	800	Connected	3.575
Tagap	Pandiruan	Ranau (236)	250	Isolated	2.920
Pilot project sites and others (Two sites will be selected)					
Nahabah	Wariu	Kota Belud (530)	250	Isolated	5.522
Marak Parak	Kinaram	Kota Marudu (320)	135	Isolated	3.171
Carabau	Bambangan	Ranau (919)	400	Connected	4.935
Long Pa Sia	Pa Sia	Sipitang (70)	25	Isolated	0.737
Kundasang	Mesilau	Ranau (To be determined)	300	Isolated	2.5
Kundasang	Liwagu	Ranau (546)	110	Connected	1.313

Remarks; The construction of the approved sites will be commenced in late 1982.

*: Isolated power station or connected to existing power systems.

Source; SEB

Table 9 MINI HYDROPOWER SCHEMES IN SARAWAK

Name	River System	Catchment Area (km^2)	*Installed Capacity (kW)
Kalamuku	Lamas	26	1,000
Mediou	Trusan	36	500
Saliban	Limbang	20	200
Kejin	Baram	11	420
Nagemah	Rajang	340	140
Giam	Rajang	14	200
Batu Lintang	Lupar	27	50
Semadang	Sarawak	15	125
Lundu	Kayan	4.5	180
Sematan	Serayau	8.7	360

Remarks; *: Preliminary estimate

Source; SESCO

Table 10 MEAN ANNUAL RAINFALL AND RUNOFF BY BASIN IN SABAH AND SARAWAK

Basin No.	Catchment Area (km^2)	Mean Annual Rainfall (mm)	Mean Annual Runoff Depth (mm)	Mean Annual Rainfall (10^6 m^3)	Mean Annual Runoff (10^6 m^3)
201	5,971	2,491	1,492	14,870	8,906
202	1,308	2,093	1,051	2,740	1,375
203	1,371	2,168	1,134	2,970	1,555
204	741	2,071	1,027	1,530	761
205	553	2,013	962	1,110	532
206	558	2,080	1,036	1,160	578
207	888	2,262	1,238	2,010	1,099
208	2,792	2,233	1,206	6,230	3,367
209	2,714	2,639	1,655	7,160	4,493
210	5,558	2,549	1,556	14,170	8,647
211	16,755	2,660	1,332	44,570	22,324
212	2,335	3,161	2,275	7,380	5,313
213	6,829	3,272	2,388	22,340	16,306
214	3,094	3,255	2,371	10,070	7,335
215	1,474	3,506	2,625	5,170	3,869
216	1,866	2,700	1,268	5,040	2,366
217	2,126	2,582	1,151	5,490	2,446
218	1,336	3,130	1,695	4,180	2,265
219	1,247	3,023	1,952	3,770	2,434
220	629	3,126	1,831	1,970	1,152
221	805	3,190	1,897	2,570	1,527
222	607	3,106	1,812	1,890	1,100
223	736	3,064	1,769	2,260	1,302
224	9,180	2,110	1,027	19,370	9,432
225	86	3,376	2,093	290	180
226	1,291	2,900	1,602	3,740	2,068
227	1,080	3,762	2,479	4,060	2,677
228	2,768	2,999	1,703	8,300	4,713
229	3,920	3,884	2,699	15,230	10,581
230	22,325	3,794	2,607	84,700	58,205
231	788	2,976	1,646	2,350	1,297
232	935	2,745	1,399	2,570	1,308
233	1,345	2,681	1,333	3,610	1,793
234	1,440	2,993	1,661	4,310	2,392
235	1,268	3,378	2,068	4,280	2,622
236	6,000	3,918	2,640	23,510	15,837
237	5,150	3,912	2,632	20,150	13,554
238	2,518	3,830	2,548	9,640	6,417
239	2,625	3,914	2,632	10,270	6,910
240	2,005	3,369	2,060	6,750	4,131
241	51,053	3,991	2,492	203,750	127,201
242	1,675	3,637	2,227	6,090	3,731
243	1,900	3,547	2,139	6,740	4,065
244	6,813	3,612	2,204	24,610	15,013
245	3,645	3,716	2,306	12,540	8,404
246	3,358	4,193	2,730	14,080	9,167
247	1,838	4,793	3,334	8,810	6,128

Table 11 POTENTIAL HYDROPOWER SITES IN SABAH

Name of Site	Name of River	Installed Capacity (MW)	Energy Output (GWh/y)
Tenom Pangi	Padas	66	464
Sook	Padas	35	220
Rayok	Padas	65	-
Lower Halogilat	Padas	144	990
Upper Halogilat	Padas	98	-
Papar	Papar	45	171
Moyong	Moyong	7	-
Tamparuli	Tuaran	35	-
Balat	Kinabatangan	34	342
Deramakot	Kinabatangan	78	387
Milian	Milian	50	236
Kuamut	Kuamut	46	241
Total		703	3,051

Source; SEB

Table 12 MAJOR FEATURES OF RAJANG RIVER HYDROPOWER DEVELOPMENT IN SARAWAK

Project		Pelagus (Raja 284)	Bakun (Balu 037)	Muru 040	Bela 010
Name of River		Rajang	Balui	Murum	Belaga
Mean Discharge	m^3/s	2,000	1,560	310	230
Mean Net Head	m	39	159	291	112
Max. Active Storage Volume	$10^9 \times m^3$	3.0	27.1	6.0	6.8
Reservoir Area	km^2	330	730	210	390
Installed Capacity	MW	770	2,580	940	260
Energy	GWh	5,600	18,100	6,600	1,800
Capital Cost	$10^6 \times$ M$	1,480	2,690	1,080	730
Energy Cost	M$/kWh	4.1	2.3	2.3	5.3
Proposed Year of Commission	1st stage	1990	1995	2004	2009
	2nd stage	-	2001	-	-

Remarks; Data on June, 1982

Source; 9

FIGURES

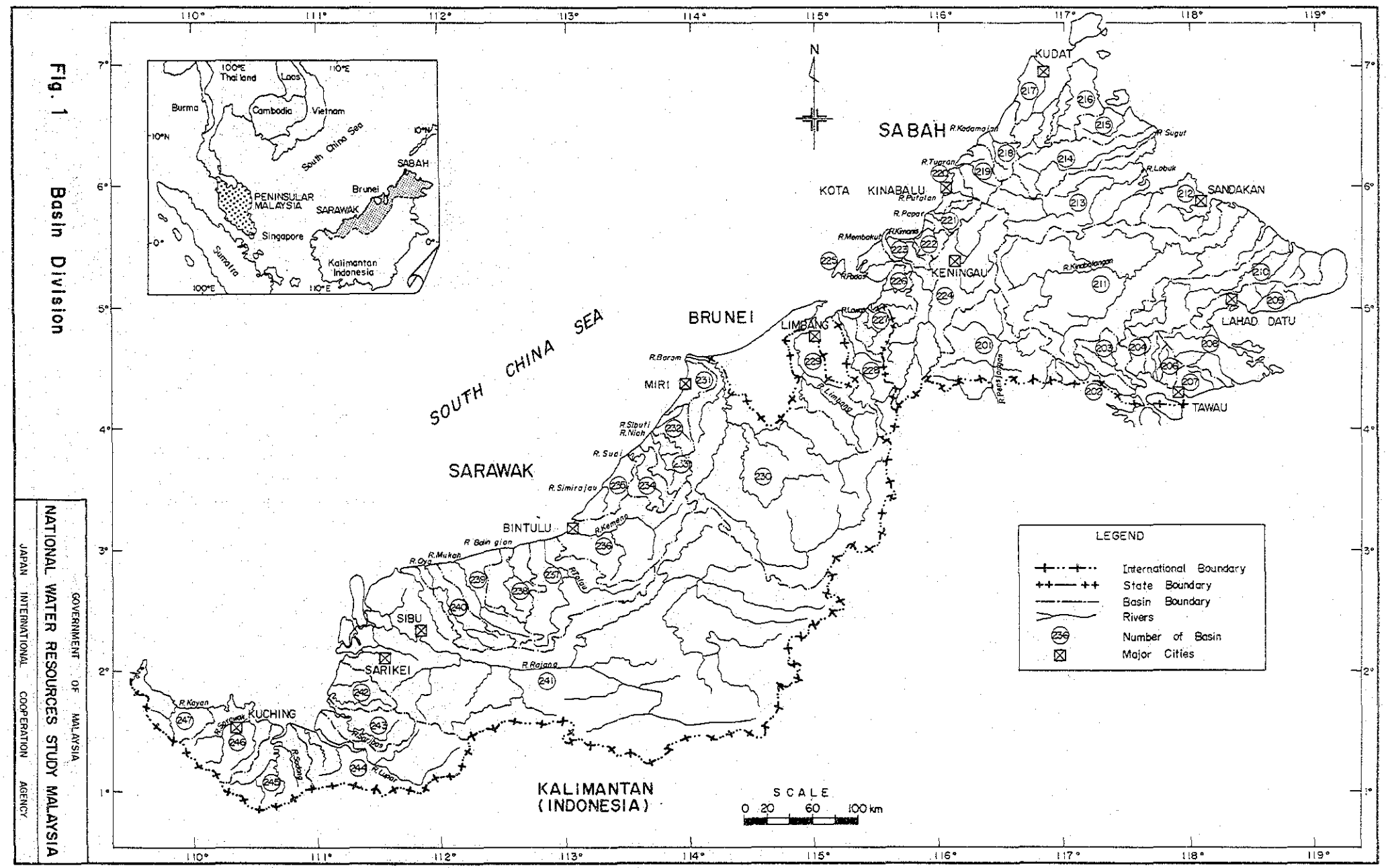
Fig. 1 Basin Division
NATIONAL WATER RESOURCES STUDY MALAYSIA
GOVERNMENT OF MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY
SABAH
SARAWAK
BRUNEI
SOUTH CHINA SEA
KALIMANTAN (INDONESIA)
KUDAT
KOTA KINABALU
SANDAKAN
KENINGAU
TAWAU
LAHAD DATU
LIMBANG
MIRI
BINTULU
SIBU
SARIKEI
KUCHING
Thailand
Laos
Burma
Cambodia
Vietnam
South China Sea
PENINSULAR MALAYSIA
Singapore
Sumatra
Brunei
Kalimantan Indonesia
SCALE
0 20 60 100 km
LEGEND
International Boundary
State Boundary
Basin Boundary
Rivers
Number of Basin
Major Cities

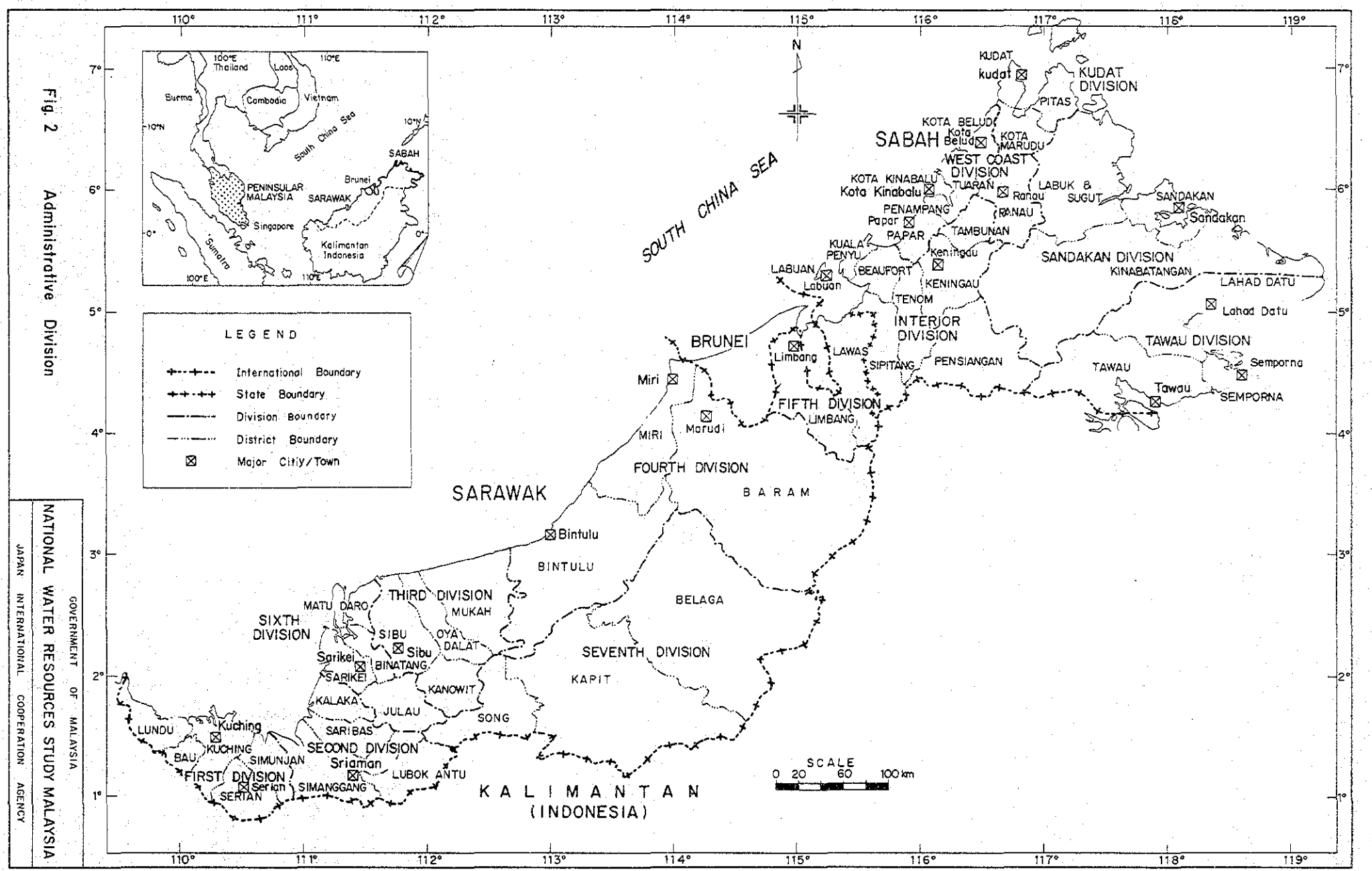
Fig. 2 Administrative Division
NATIONAL WATER RESOURCES STUDY MALAYSIA
GOVERNMENT OF MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY
LEGEND
International Boundary
State Boundary
Division Boundary
District Boundary
Major City/Town
SOUTH CHINA SEA
SARAWAK
SABAH
BRUNEI
KALIMANTAN (INDONESIA)
KUDAT DIVISION
WEST COAST DIVISION
SANDAKAN DIVISION
INTERIOR DIVISION
TAWAU DIVISION
FIFTH DIVISION
FOURTH DIVISION
THIRD DIVISION
SIXTH DIVISION
SEVENTH DIVISION
SECOND DIVISION
FIRST DIVISION
BARAM
BINTULU
BELAGA
KAPIT
SONG
KANOWIT
MUKAH
OYA
DALAT
SIMUNJAN
SIMANGGANG
LUBOK ANTU
SARIBAS
JULAU
KALAKA
BINATANG
MATU DARO
LUNDU
BAU
SERIAN
PITAS
KOTA BELUD
KOTA MARUDU
TUARAN
LABUK & SUGUT
RANAU
PENAMPANG
PAPAR
TAMBUNAN
KUALA PENYU
BEAUFORT
KENINGAU
TENOM
KINABATANGAN
LAHAD DATU
SEMPORNA
LAWAS
LIMBANG
SIPITANG
PENSIANGAN
TAWAU
MIRI
MARUDI
SCALE
0 20 60 100 km
Kudat
Kota Belud
Kota Kinabalu
Ranau
Papar
Keningau
Labuan
Sandakan
Lahad Datu
Semporna
Tawau
Limbang
Miri
Marudi
Bintulu
Sibu
Sarikei
Kuching
Sriaman
Serian
Thailand
Laos
Burma
Cambodia
Vietnam
South China Sea
Brunei
Singapore
Sumatra
Kalimantan Indonesia
PENINSULAR MALAYSIA
SARAWAK
SABAH

Fig. 3 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 201-206 (I / II)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

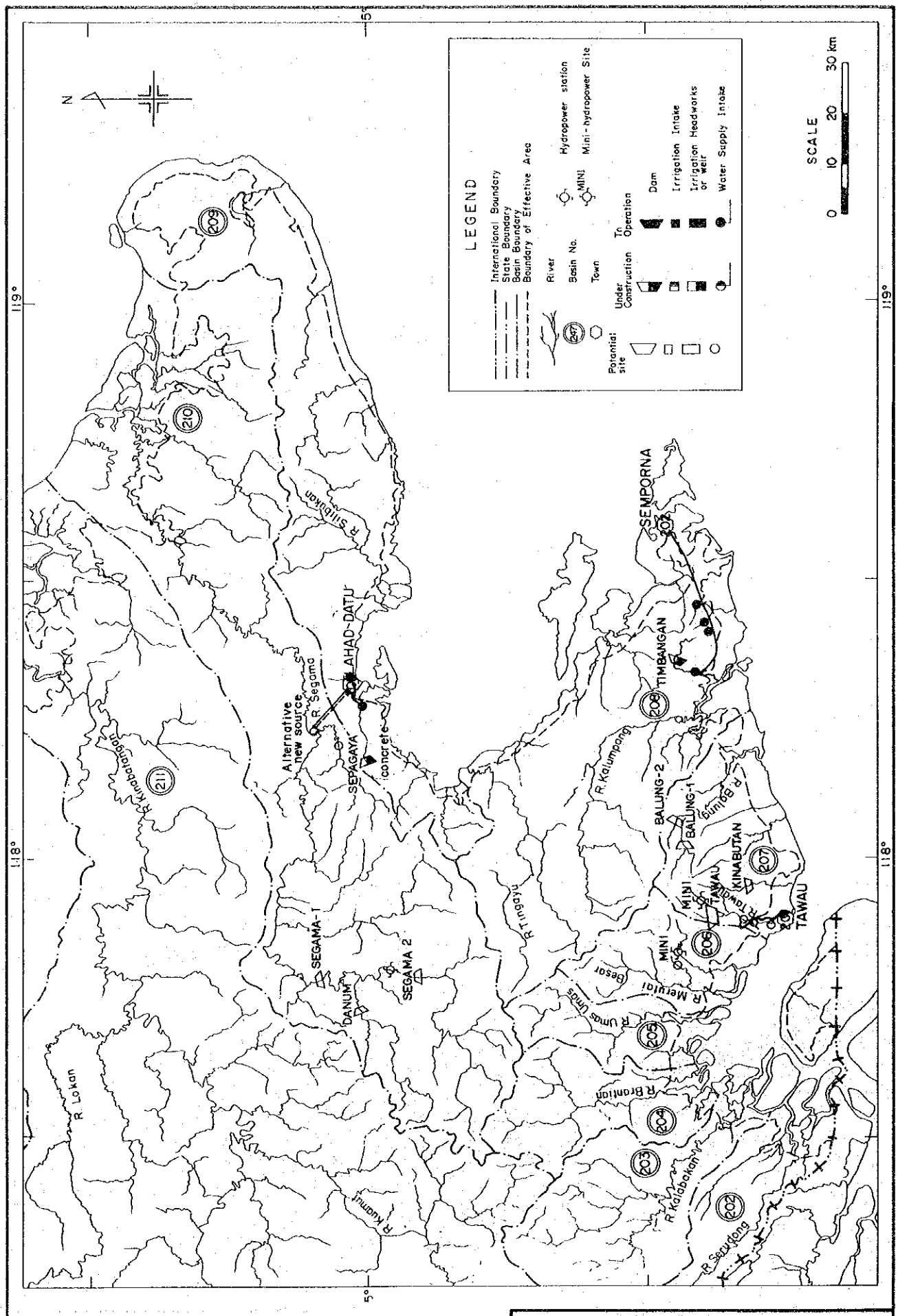

Fig. 4 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 207-210 (2/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

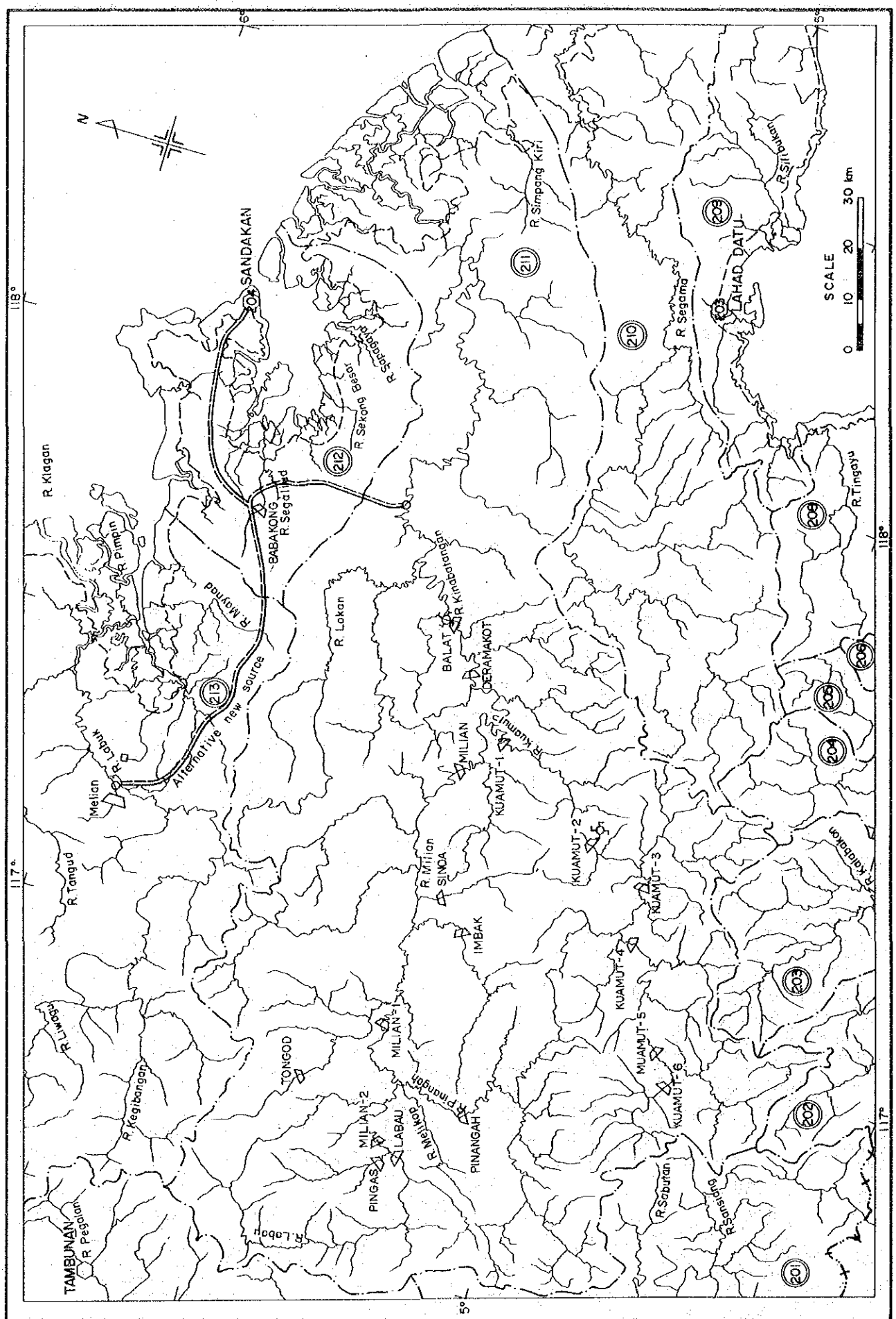

Fig. 5 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 211-212 (3/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 213-218 (4/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

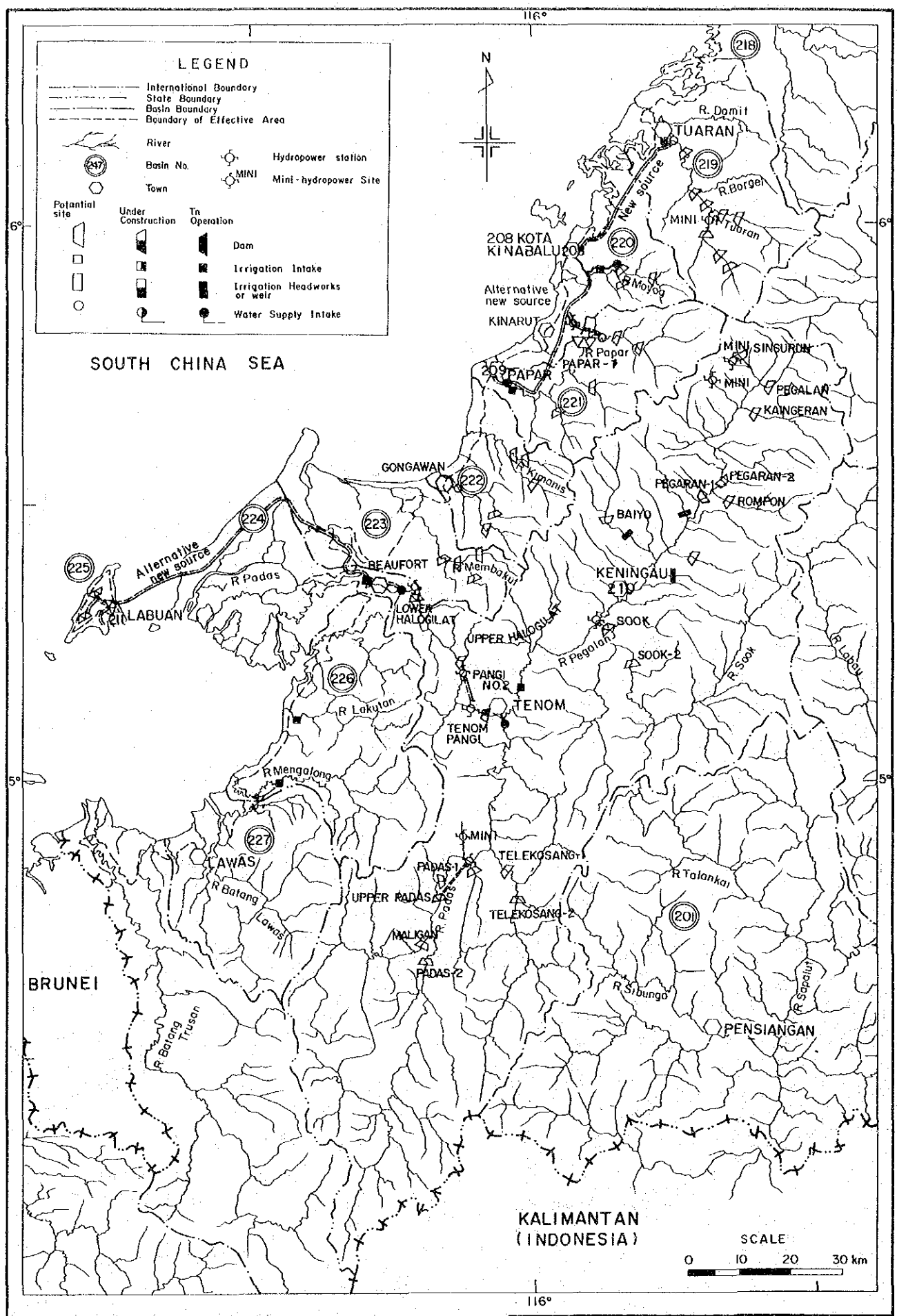

Fig. 7 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 219-217 (5 / 11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

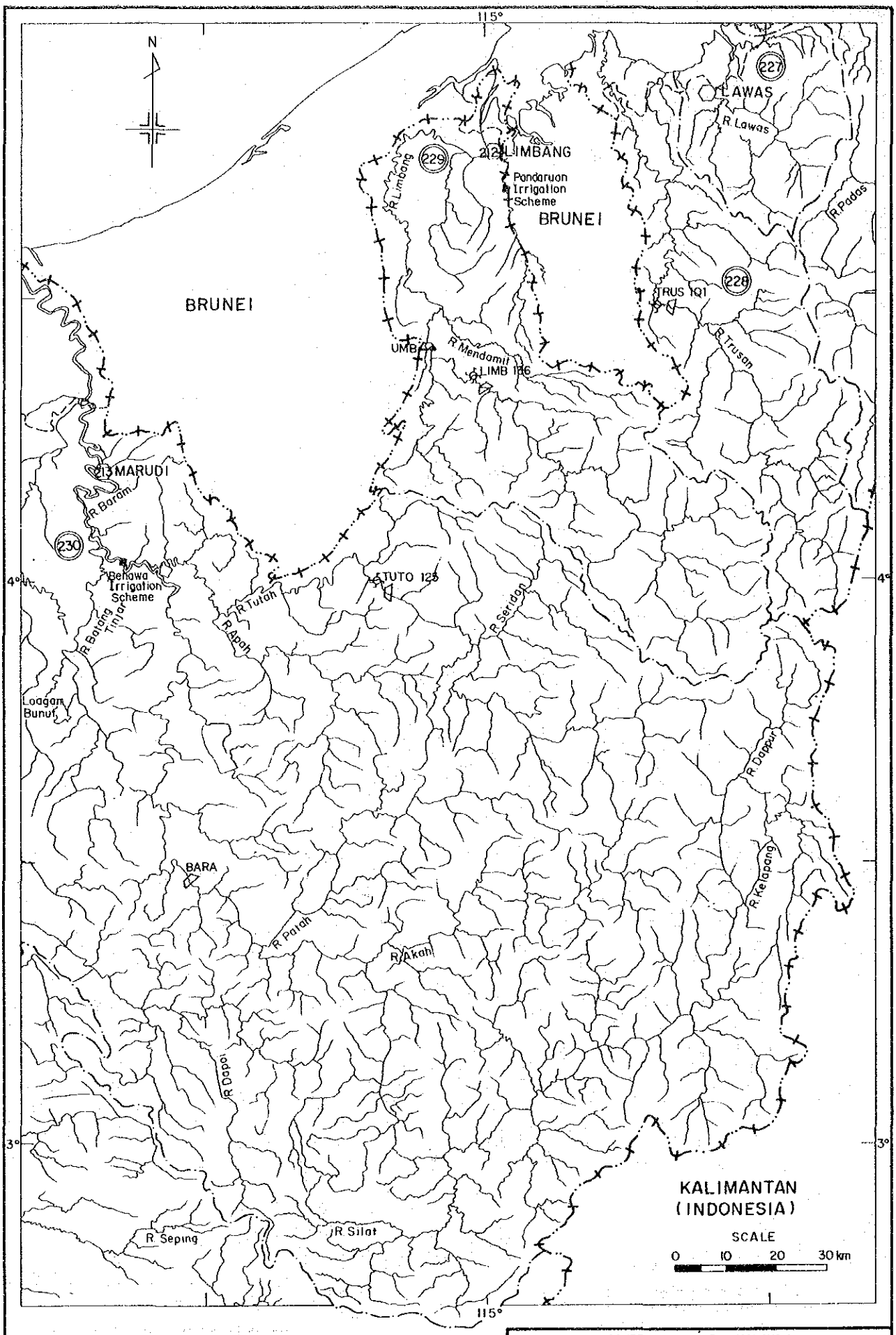

Fig. 8 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 227 - 230 (6 / 11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

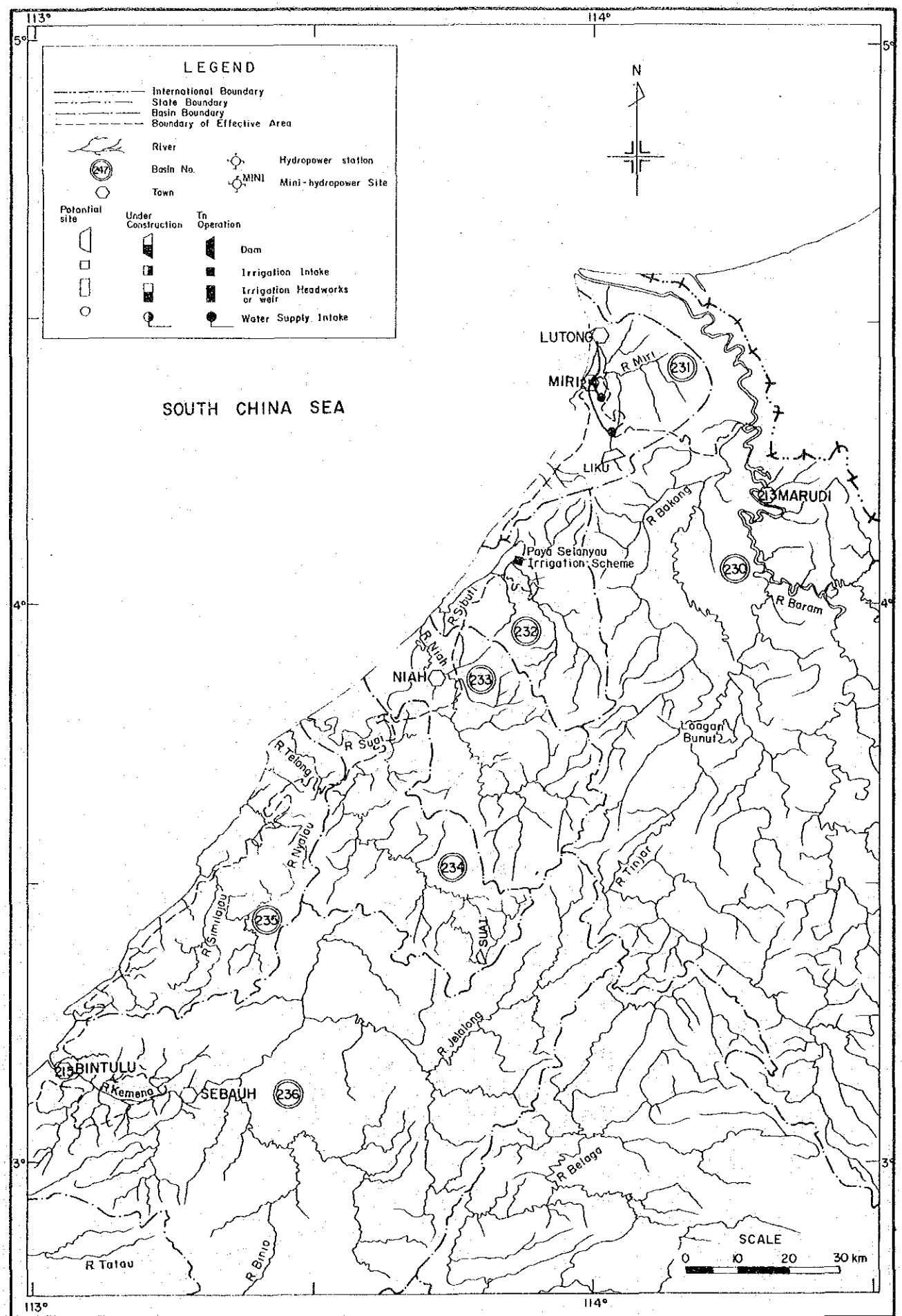

Fig. 9 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 230-235 (7/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 10 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 236-240 (8/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

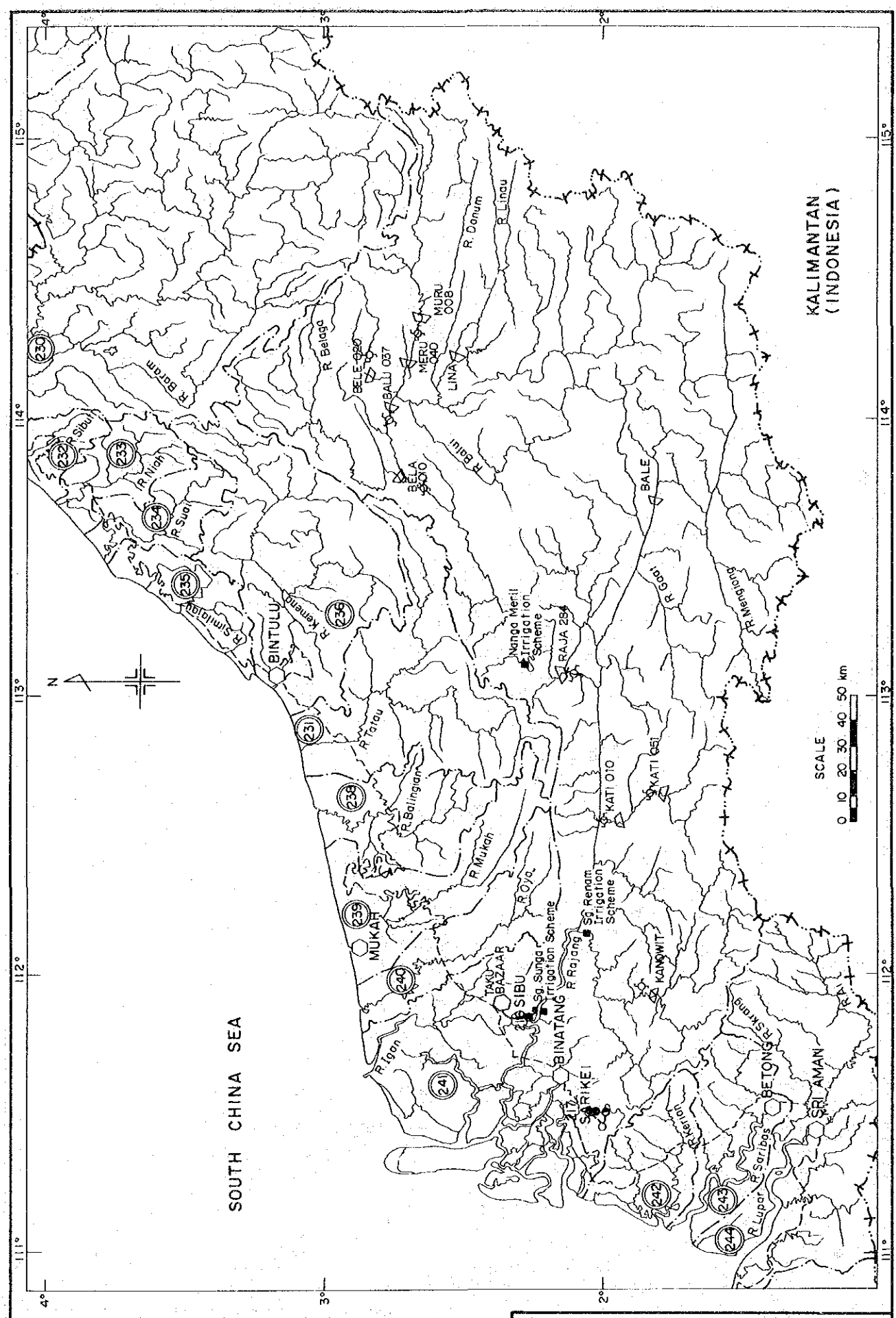

Fig. 11 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 241 (9/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

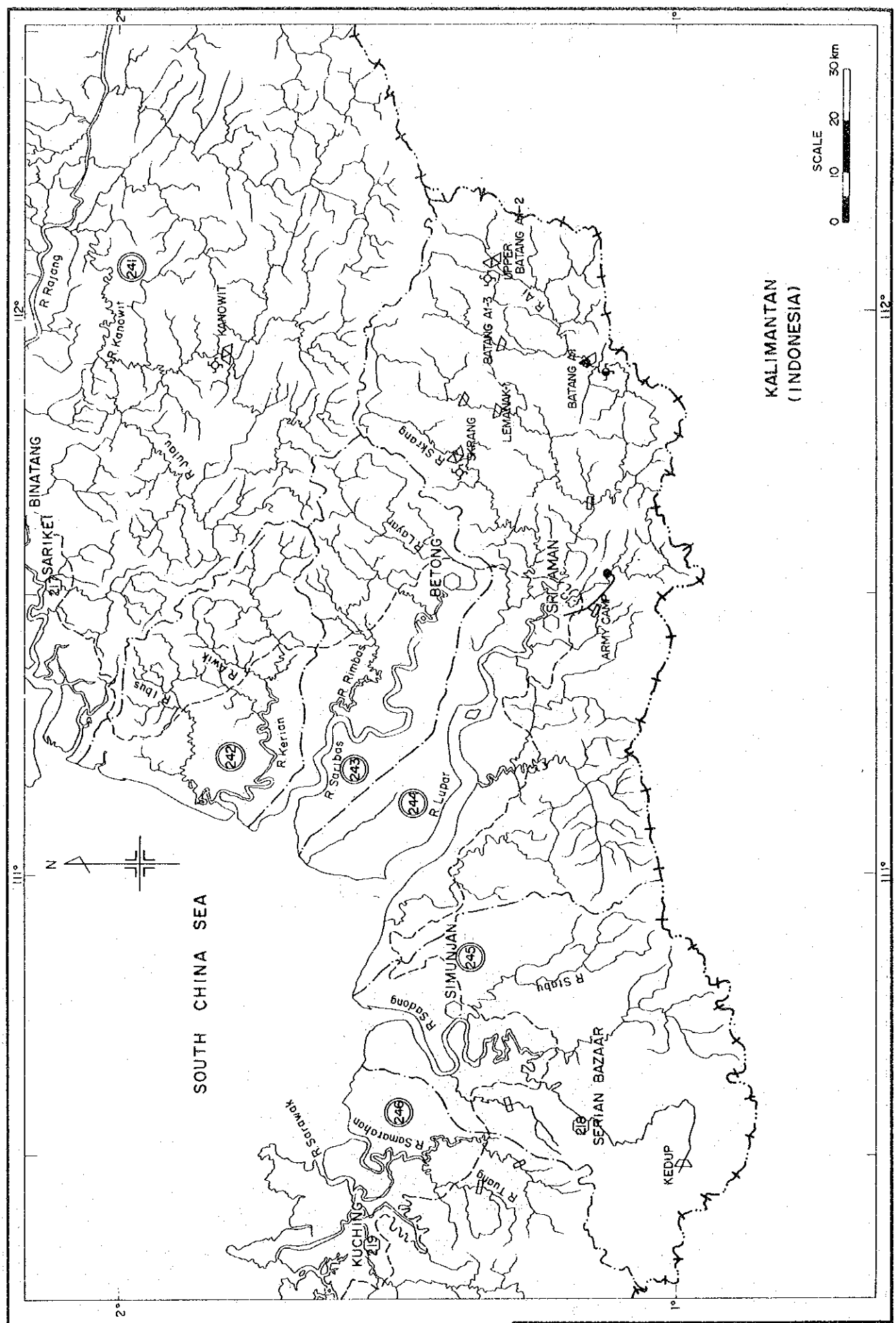

Fig. 12 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 242-244 (10/11)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

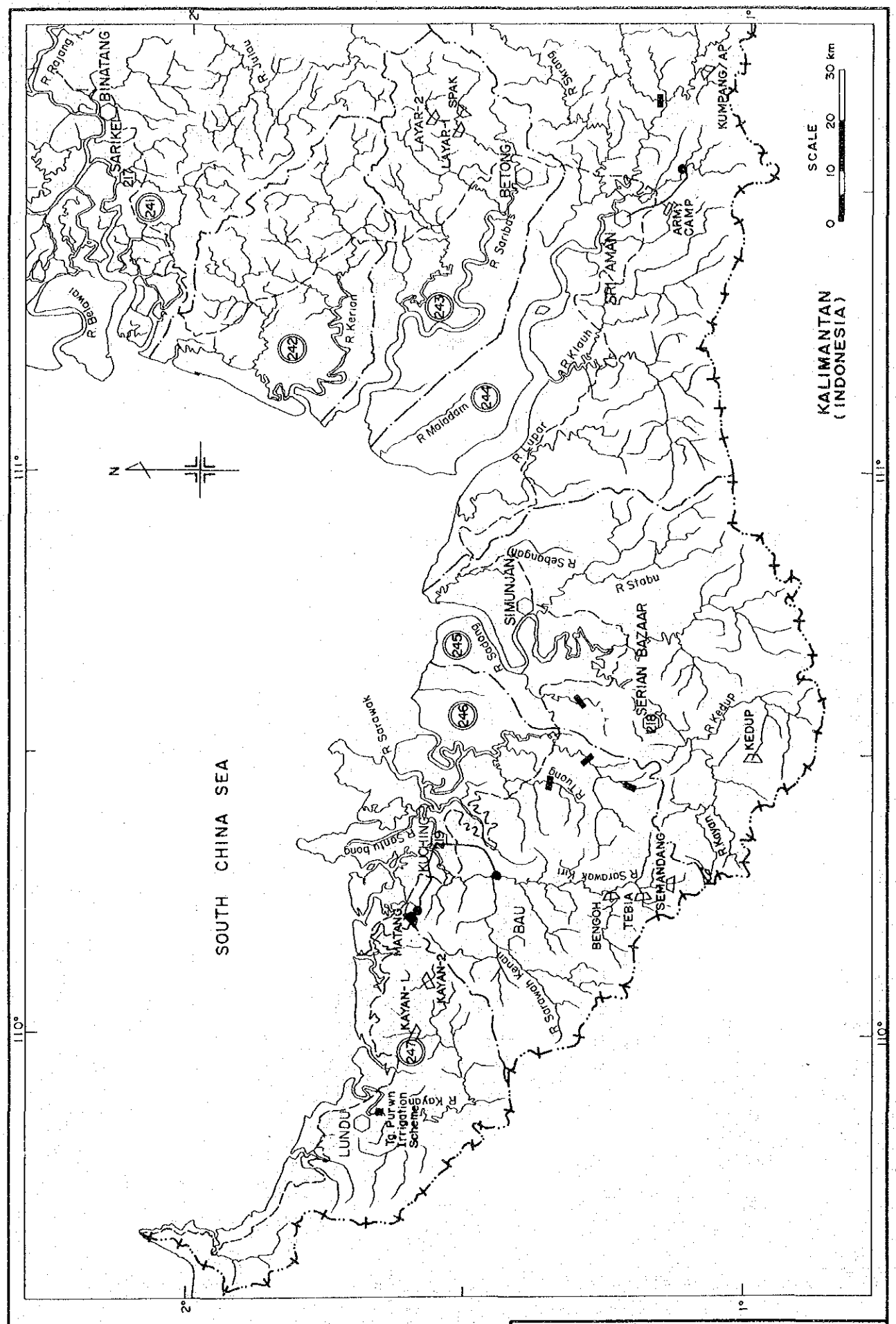

Fig. 13 Water Source Facilities in Operation & Under Construction and Potential Dam Sites in Basins 245 - 247 (II / II)

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

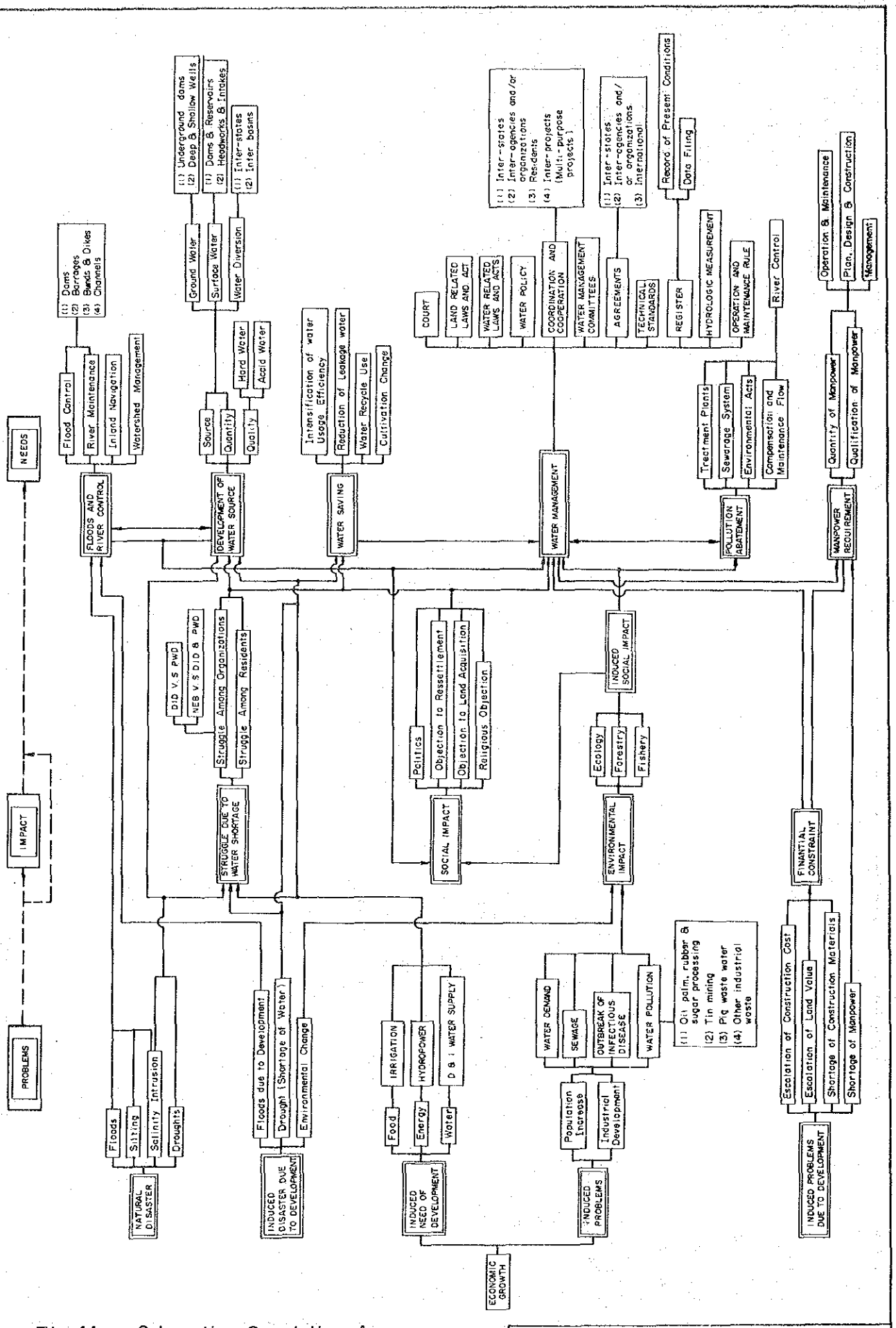

Fig. 14 Schematic Correlation Among Problems & Needs in water Resources Development.

GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY