Tables VII.2.11 and VII.2.12 show the bird record in the survey areas. These tables show that 65 species for Lebir dam project and 140 species for Pergau hydroelectric project have been observed. Among these species, pheasants, hornbills and carnivorous birds are considered to be endangered.

The pheasants are ground living birds that are found in primary and secondary forests. The outstanding one is Great Argus Pheasant which is normally found in primary forests.

The hornbills are the primary indicators of tropical Dipterocarp forests. According to the previous studies, 6 species are observed. They are Black hornbill, Rhinoceros hornbill, Helmeted hornbill, Wrinkled hornbill, Bushycrested hornbill and Wreathed hornbill.

Carnivorous birds are famous for their wide territory during their food phase of livelihood, and six species are observed. They are Black eagle, Crested serpent eagle, Short-toed eagle, Blythis hawk eagle, Black kite and Black-shouldered kite.

2.4.3 Assessment of existing fauna

Fauna in the State of Kelantan is rich and comprises typical tropical species. Furthermore, many endangered species are observed. They are Stump-tailed macaque, Indian elephant, Red dog, Leopard panther, Malaysian tiger, Banteng, Malaysian tapir, Sumatran rhinoceros, Pheasants, Hornbills and carnivorous birds. The reason why such abundant species exist in the basin is due to the fact that the Kelantan River basin still keeps the abundant nature in spite of nature destruction by many land development.

2.5 Ethnicity

2.5.1 General

The population is overwhelmingly Malay (92.4% of the population) in the State of Kelantan. Chinese constitute 5.6% of the population, while Indians and others constitute 2.0%.

It is reported that Orang Asli, indigenous group of Malaysians, is gradually accepting to live in the specific area adjusted by the Orang Asli Department (JOA). But, its progress is rather slow.

The current population of Orang Asli is about 72,000 in Peninsular Malaysia, sharing less than 0.5% of the Malaysian population. Orang Asli is classified into three ethnic groups which comprise various tribes; Negritos, Senoi and Proto-Malay.

The Negritos, the smallest ethnic group, is considered as the earliest migrant group among the present West Malaysian inhabitants. They are nomads living in the north of the Peninsular such as the States of Perak, Kelantan, Kedah and

Pahang and also in South Thailand.

The Senoi constitutes the largest ethnic group, and is localized mainly in the centre of the Peninsular such as the States of Pahang, Perak and Kelantan.

The Proto-Malays speak an archaic form of Malay and are concentrated in the south of Peninsular. The way of life is similar to that of the rural Malays.

Among the Orang Asli, around 60% are living in the jungle, while some villages are located near Malay villages. Their economy is based on hunting, fishing, gathering wild roots, cutting and selling rattan or product of temporary jobs.

There are 18 settlements of Orang Asli in the survey area as shown in Fig.VII.2.8. Population and member of families are shown Table VII.2.13.

The biggest settlement is Kuala Betis which is located along the Nenggiri River. Almost all settlements of Orang Asli are observed along the Nenggiri River system, and all settlements are located in the upper reaches of the Kelantan River system.

2.5.2 Brief description of the settlements

There are 18 settlements of Orang Asli in the State of Kelantan. Almost all settlements were established by JOA which has provided schools, clinics and religious schools. A main objective is to provide a more permanent settlement to the Orang Asli.

Orang Asli has no common public facilities like hospitals. A new approach should be considered to integrate the Orang Asli communities with the general Malaysian communities, when the resettlement of Orang Asli is unavoidable for the implementation of projects.

2.5.3 Socio-demographic profile

The majority of Orang Asli living in the State of Kelantan is Senoi and Negritos. They may be further classified into dialect groups. The differences between dialect groups are not significant since they understand each other and mix freely.

Orang Asli has been treated as nomadic hunting and gathering people who mainly subsist on wild tubers, fruits, and small game which they hunt with blow pipes and poisoned darts. They are therefore dependent on the forest for their livelihood. The schemes to open the forest threaten their way of live and their existence.

Orang Asli has a strong sense of solidarity to survive in the forest. They go hunting in groups, and all the forest products captured are shared by all. They have no concept to keep private property besides only a few basic essential household items. On the other hand, there are households with better living quarters having more modern essentials such as radio and clothings. The women folk are already using cosmetics.

It has been observed that political power is almost non-existent in the Orang Asli communities. Decisions concerning the problems of the community are made through discussions among its members. Their traditional way of life based on hunting and gathering forest products prevents from making their community larger.

Athough authority in terms of power relationship is weak, there are leaders in the Orang Asli communities. They are called "Penghulu"s (headman) in the Malaysian language. The status of headman is bestowed by JOA. The headman has the power to relate with outsiders.

2.5.4 Assessment of existing ethnicity

The economy of Orang Asli is still based on forest products such as hunting, fishing, gathering wild roots, cutting and selling rattan. Orang Asli has a strong sense of community attachment.

The resettlement of Orang Asli is one of the most significant problems, if their resettlement is inevitable for the development of projects. Therefore, it is necessary for dam planning which is one of methods of flood mitigation to notice on resettlement problems such as location, method of community maintainance, etc.

2.6 Public Health

2.6.1 General

Malaria, acute respiratory infections and diarrhoea diseases have high infection percentage. However, the most prevalent disease is malaria in the State of Kelantan. It is reported that schistosomiasis is not in fashion in Peninsular Malaysia.

Malaria is a disease transmitted from person to person by certain species of mosquito belonging to the genus Anopheles, and causes acute bouts of fever which recur at intervals. Table VII.2.14 shows the biological information on Anopheles.

Although malaria has been eradicated in some countries, it is still a major public health problem in many parts of the world including Malaysia as shown in Fig.VII.2.9.

The control measure for the particular species of Anopheles has been established, however, this control measure is not applicable to other environment and species. It will need much time to eradicate malaria.

2.6.2 Present status of malaria

Malaria in the State of Kelantan tends to increase little by little until 1986, while the number of occurrence decreased in 1987. Furthermore, malaria cases in the State of Kelantan share high percentage in Peninsular Malaysia in spite of all efforts of the Department of Health at Kelantan as shown in Fig.VII.2.10.

Figs. VII.2.11 and VII.2.12 show malaria cases per 1,000 population in the State of Kelantan and infection area, respectively. Gua Musang is the highest infectious area, followed by Kuala Krai and Jeli. Almost all the upper reaches of the Kelantan River system are in the infection or prone area.

On the other hand, the newest statistics on malaria cases of Orang Asli have shown that there were 1,320 malaria cases in Kelantan as compared with 115 cases in 1980. One of reasons for the increase of malaria cases is that remote areas become more accessible, and due to this transportation, more accurate number of the malaria cases is confirmed.

According to the Department of Public Health, now DDT (Dichloro Diphenyl Trichloro Ethane) is only one insecticide which exterminates Anopheles.

2.6.3 Assessment of existing public health

The most serious problem for public health in the State of Kelantan is to share high percentage in malaria cases among Peninsular Malaysia.

The second problem is Anopheles from Thailand, according to the Department of Public Health. Extermination of Anopheles in Thailand much relies on the effort of her government.

On the other hand, the hinterland of the State of Kelantan is the highest infectious area of malaria. Unceasing efforts are required to eradicate malaria in these regions, because they are living far from urban area.

3. ENVIRONMENTAL IMPACT BY FLOOD MITIGATION PLAN

3.1 General

The environmental impact study was made based on the review of the existing environmental impact assessment reports available in the study area.

Flood mitigation in the downstream reaches of the Kelantan River is contemplated by regulating flood flow by dam in the upstream reaches and river improvement in the downstream river stretch.

The creation of the reservoir by dam will bring about the transformation of the existing natural riverine ecosystem to man-made lacustrine ecosystem, although this change may be brought with some time lag. Thus, the environmental impact study was made for the various items comprising river environment, flora, fauna, ethnicity and public health.

3.2 River Environment

3.2.1 Change in water quality

The proposed reservoir area is covered with such tropical rain forest as Dipterocarpus. It is generally said that the growth of timber in the tropical forest is not so rapid, and consequently the nutritions discharged from timber decomposition are not so remarkable. However, if the activity of the tropical environment is suspended by such physical external pressure as river impounding, plant will be decomposed and a lot of organic matters will occur in the reservoir. This phenomenon will be accelerated by change of ecosystem capable to cope with the external pressure flexibly to closed type ecosystem such as the stagnation of river water.

Sufficient technical studies on these aquatic changes have not been carried out. Besides, the ecosystem in the tropical region comprises a lot of factors, and no data showing the phenomena for man-made lake are available. Then, the impact on water quality was presumed based on the available knowledge.

Water quality of the reservoir is considered to be affected by the impounding with a lapse of time. As the water rises after the commencement of impounding, large quantities of nutrients will be released into the reservoir from soil and vegetation. It is anticipated that the submerged vegetation will reduce the dissolved oxygen caused by the release of nutritious and organic matters, and this will lead to high levels of BOD and COD. The excessive release of nutritious and organic matters will lead to eutrophication of reservoir and the associated deterioration of water quality.

On the other hand, the level of total phosphorus is not high at the upper reaches of the Kelantan River system. Therefore, the eutrophication will not occur by nutrients from rivers which flow in a reservoir. However, the value of parameters showing water pollution such as BOD and COD will increase. To cope with such pollution of the water quality, clearing of the reservoir area will be needed.

The level of SS is high at the upper reaches of the Kelantan River. Therefore, it is necessary to predict the impact on SS by dam construction. However, since the data about prediction is not available, study on this matter should be made by referring to the example in other dam projects prior to the implementation of dam scheme.

With the change in the river environment that river changes to reservoir, the fish fauna is anticipated to change to lacustrine fauna. But, it is considered that many existing fish species would be able to adapt to the new environment.

3.2.2 Evaluation and conservation measure on environment

Impacts on river environment are considered not so significant, except for the case of eutrophication. The large number of trees left behind in the reservoir area is a major factor regarding eutrophication. However, it is difficult to predict how many trees are allowable. Therefore, vegetation clearing prior to the impounding is required to be considered.

The new man-made lake will have both advantageous and disadvantageous impacts. The new reservoir to be created by dam construction will have the following advantages:

(i) To provide habitat for plankton and benthos which are important food for fish,

(ii) To enhance reproduction and survival of many fish species, and

(iii) To provide the possibilities of tourism centre using the access roads newly constructed for the dam construction.

On the other hand, the following disadvantages are anticipated:

(i) The submerged vegetations contribute to decrease oxygen of deep waters in the reservoir, if vegetation clearing is not performed.

(ii) Deoxygenation will be a cause of fish kill or limit of their distribution, if vegetation clearing is not performed properly.

(iii) Timber or dead trees obstruct boating and other lacustrine sports, if the cleared trees are not removed outside the reservoir.

(iv) A large scale reservoir creates a condition suitable for aquatic weed growth.

(v) The trap of sediment by the dam may have some influence to the change of the coastal line.

The following conservation measures are considered to cope with such environmental impacts:

(i) Trees in a reservoir area are recommended to be cleared prior to impounding to prevent from eutrophication in the reservoir. The cleared trees should also be removed outside the reservoir.

(ii) Reforestation must be considered to reduce the impacts of sedimentation in the river basin.

(iii) Since the new reservoir will have a possibility of cultivations of fishery, fishery plans should be contemplated.

(iv) To reduce the impacts of aquatic weed growth, periodical monitorings are required.

(v) The change of coastal line is the resultant of complex phenomena by the westward littoral current, tractive force of sand and so on. Therefore, the change of coastal line under the condition with the dam or dams shall be discussed separately when the dam project is implemented.

3.3 Flora

There are five proposed reservoirs to be contemplated for flood mitigation in the downstream reaches of the Kelantan River basin. Tropical rain forest distributes almost uniformly in the proposed reservoir areas. It has been reported that density of tree in the rain forest is about 1169 nos/ha is Peninsular Malaysia. The reservoir area to be submerged is estimated at 390 km^2 for Dabong, 120 km^2 for Nenggiri 250 km^2 for Lebir and 130 km^2 for Kemubu. Applying these reservoir areas to the density of tree in the rain forest of 1169 nos/ha, the number of tree in the forest in the reservoir area is estimated at 45 million nos for Dabong, 14 million nos for Nenggiri, 29 million nos for Lebir and 15 million nos for Kemubu. It has been estimated that the number of tree in the rain forest in whole Kelantan State is 1750 million nos. Comparing this figure with the number of tree in the proposed reservoirs, deforestation due to construction of dam is considered to scarcely exert to the flora because number of tree in the rain forest in Dabong reservoir which has the largest reservoir area among five proposed dam schemes corresponds to only 2.5%.

The existing EIS reports state that there are no data about precious or rare species and forest groups in the proposed reservoir areas. This means that it is impossible to describe a definite statement about environmental impacts on precious or rare species by dam construction.

3.4 Fauna

The creation of the reservoir area due to the dam construction may result in the impact to animals inhabitated there. However, degree of its impact by respective reservoirs cannot be compared unless the living distribution of wildlives is made clear. Since such data are not available, it is only considered in this time to minimize the impact to the wildlives by evacuating them from the anticipated reservoir area.

It will be major problem whether the evacuated wildlives can create new territories or not nearby the reservoir area. Since broad rain forest is spreading in the upstream reaches of the Kelantan River basin, it is considered that the creation of reservoir scarcely exerts to living of the wildlives.

However, it has been experienced in case of Keyir dam project that many mammals with large size remained in the island in the reservoir immediately after reservoir impounding. Thus, sufficient study will be needed for removal of these mammals.

3.5 Ethnicity

3.5.1 Forecast on impact

There are many settlements of the Orang Asli in the upper basin of the Kelantan River, which may be affected by the proposed dam schemes. The Orang Asli settlers who may be affected by the proposed dam schemes are shown in Table VII.3.1. This table shows that the Nenggiri dam scheme has the largest number of the settlers.

3.5.2 Impact evaluation and measure for resettlement

The dam project which is one of methods of flood mitigation plan will have both advantageous and disadvantageous impacts.

The following items are considered to be advantageous:

(i) The Orang Asli has an opportunity to gain money and to obtain basic construction technique, if they are employed at the dam project.

(ii) Statistic of the Orang Asli will be defined by preliminary or detailed environment assessment survey.

On the other hand, the following are disadvantageous:

(i) Resettlement needs to make a new community, new school, new clinic, new road, etc.

(ii) After resettlement, considerable time will be needed to establish a community.

To minimize the influence to the resettlement problem of Orang Asli, sufficient consideration should be given to the following matters for flood mitigation planning by dam:

(i) It is necessary to pay an attention that their dwelling places should be selected so as not to compel any drastic changes in their way or pattern of life.

(ii) Any settlement area for the Orang Asli should be secured at the places located near the reservoir and easily accessible to the forest.

(iii) Since they have experienced resettlements in the past, a due attention should be paid to the selection of location; that is, they should be provided with dwelling places of a permanent basis.

(iv) The new settlement site should not be too far from the present one and should be located 2 km away from the shoreline of the reservoir at least to avoid the occurrence of malaria.

(v) The new settlement should be based on the FELDA or KESEDAR model.

3.6 Public Health

As far as the studies performed so far is concerned, a correlation between man-made lake and occurrence of malaria in the Peninsular Malaysia is not made clear. Thus, it is impossible to predict whether the malaria increases or not due to creation of the reservoir. Several dam projects already implemented in the Peninsular Malaysia. It will be necessary to study on the correlation between man-made lake and occurrence of malaria, referring to the records for the completed dam projects.

4. CONCLUSION

It is concluded that the creation of reservoir by respective dam schemes is considered to scarcely exert to river environment and flora. Regarding to the impact to fauna and public health due to dam construction, there are no data to predict their impact.

There are no available data regarding mineral resources potential. According to the verbal information, there are gold mine in the area between Galas and Lebir rivers. It will be necessary to further survey to obtain more detailed information.

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Table VII.2.1 Water Quality In The Kelantan River System (1/2)
(DID Station)

Name of River		Kelantan River								
Sampling Point		Guillemard Bridge								
Sampling Date		14.1.87	27.1.87	14.2.87	25.2.87	15.3.87	29.3.87	15.4.87	29.4.87	18.5.87
Time of Sampling		10:05	11:00	10:30	12:00	11:00	11:30	11:35	09:50	09:43
Temperature	C	28.0	28.0	28.0	27.0	28.0	28.0	28.0	28.0	30.0
pH		7.6	7.6	7.4	7.3	7.4	7.4	7.3	7.0	6.9
Suspended Solid	mg/l	40.0	72.0	16.0	16.0	26.0	34.0	128.0	77.0	87.0
Dissolved Oxygen (Do)	mg/l	7.1	7.1	7.1	7.1	7.0	7.0	7.3	7.3	7.1
BOD	mg/l	1.2	1.4	1.1	0.90	1.1	1.0	1.3	1.2	1.1
Phosphorus (Total)	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.2	0.25	0.23
Colour (Hazen Unit)		30	10	5	5	10	15	85	30	85
Turbidity (Silica-Scale Unit)		105	120	60	25	80	95	270	80	210
Dissolved Solid	mg/l	61.0	70.0	50.0	60.0	60.0	68.0	80.0	56.0	112.0
Volatile Suspended Solid	mg/l	15.0	20.0	5.0	10.0	12.0	20.0	55.0	30.0	23.0
Total Solid	mg/l	101.0	142.0	66.0	76.0	86.0	102.0	208.0	133.0	199.0
Hardness (CaCo3)		16	18	18	20	20	22	18	17	7
Conductivity	umbos/cm	39	48	49	58	48	48	39	48	48
COD	mg/l	6.4	12.7	3.2	28.7	6.4	25.5	35.1	66.7	6.4
Nitrogen (Ammonia)	mg/l	0.16	0.08	0.10	0.02	0.20	0.24	1.7	1.6	1.3
Nitrogen (Nitrate Nitrite)	mg/l	0.46	0.52	0.8	0.86	0.92	1.0	7.3	3.0	2.6
Nitrogen (Kjeldahl)	mg/l	1.5	1.8	1.5	12.9	6.4	6.4	10.3	4.8	7.0
Chloride	mg/l	1.0	9.0	3.0	3.0	1.0	1.0	2.8	1.0	2.0
Alkalinity (Total)	mg/l	18.0	19.0	25.0	26.0	26.0	27.0	20.0	23.0	7.0
Flouride	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.1	0.1	N.D.
Phosphorus (Ortho)	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.15	0.20	0.1
Arsenic	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Silica (Reactive)	mg/l	12.0	15.0	110.0	12.0	20.0	20.0	19.0	23.0	23.0
Iron (Total)	mg/l	2.0	2.8	0.8	3.2	0.8	0.8	4.8	3.2	2.8
Manganese	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.15	0.1	0.15
Potassium	mg/l	0.1	0.5	0.4	0.4	0.2	0.2	-	-	-
Sodium	mg/l	1.0	1.4	0.9	1.2	1.3	3.1	-	-	-
Sulphate	mg/l	2.0	2.0	2.0	2.0	1.0	1.0	N.D.	N.D.	N.D.
Barium	mg/l	0.9	N.D.	N.D.	N.D.	0.9	N.D.	N.D.	N.D.	N.D.
Calcium	mg/l	4.8	6.0	5.6	5.2	6.8	6.0	3.2	0.7	2.0
Magnesium	mg/l	N.D.	N.D.	0.97	1.7	0.73	1.7	2.4	0.7	0.5

Notes: N.D. means Not Detected and - means Not Observed.

Table VII.2.1 Water Quality In The Kelantan River System (2/2)
(DID Station)

Name of River		Kelantan River								
Sampling Point		Guillemard Bridge								
Sampling Date		15.6.87	15.7.87	28.7.87	16.8.87	15.9.87	13.10.87	31.10.87	29.11.87	16.1.88
Time of Sampling		11:00	10:44	11:45	11:01	10:30	13:56	12:25	11:10	10:40
Temperature	C	29.0	29.0	28.0	28.0	29.0	29.0	29.0	29.0	29.0
pH		7.1	6.8	6.8	6.7	7.0	7.0	7.2	7.3	7.3
Suspended Solid	mg/l	64.0	36.0	244.0	63.0	184.0	122.0	173.0	155.0	84.0
Dissolved Oxygen (Do)	mg/l	7.0	7.2	7.3	7.2	6.2	7.7	7.4	9.4	7.8
BOD	mg/l	0.9	1.2	9.1	1.0	0.3	1.3	0.7	0.2	1.9
Phosphorus (Total)	mg/l	0.2	0.15	0.22	0.32	0.6	0.08	0.05	0.1	0.2
Colour (Hazen Unit)		40	15	20	150	150	-	225	150	60
Turbidity (Silica-Scale Unit)		85	45	125	80	135	-	750	425	75
Dissolved Solid	mg/l	86.0	74.0	150.0	94.0	42.0	-	86.0	50.0	7.0
Volatile Suspended Solid	mg/l	15.0	12.0	127.0	31.0	88.0	41.0	120.0	60.0	25.0
Total Solid	mg/l	150.0	110.0	394.0	157.0	226.0	-	259.0	205.0	91.0
Hardness (CaCo3)		24	26	17	21	19	-	15	28	18
Conductivity	umbos/cm	58	58	39	48	58	48	39	48	43
COD	mg/l	6.4	22.0	22.0	45.2	4.1	20.0	20.0	20.0	19.8
Nitrogen (Ammonia)	mg/l	1.7	0.9	1.6	1.8	1.8	1.7	0.01	0.01	0.32
Nitrogen (Nitrate Nitrite)	mg/l	6.6	0.39	0.46	0.18	0.43	2.0	0.21	1.0	2.10
Nitrogen (Kjeldahl)	mg/l	11.0	6.6	3.6	4.2	4.8	3.6	1.21	2.40	2.62
Chloride	mg/l	8.0	1.0	3.0	3.0	1.0	1.0	N.D.	N.D.	N.D.
Alkalinity (Total)	mg/l	31.0	32.0	20.0	22.0	25.0	20.0	19.0	25.0	22.0
Flouride	mg/l	0.1	N.D.	N.D.	N.D.	N.D.	0.4	0.1	0.1	N.D.
Phosphorus (Ortho)	mg/l	0.1	0.1	0.12	0.18	0.5	0.02	0.05	0.05	0.05
Arsenic	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Silica (Reactive)	mg/l	16.0	12.0	10.0	12.0	12.0	55.0	12.0	9.0	2.0
Iron (Total)	mg/l	4.0	0.8	2.8	4.8	1.2	0.4	3.2	2.4	2.8
Manganese	mg/l	0.2	N.D.	0.02	0.02	N.D.	N.D.	N.D.	0.3	0.5
Potassium	mg/l	-	2.0	2.6	1.6	1.7	1.3	1.1	1.4	1.4
Sodium	mg/l	-	4.7	4.6	4.0	4.6	4.8	2.2	2.4	2.3
Sulphate	mg/l	3.0	3.0	3.0	2.0	5.0	N.D.	2.0	N.D.	2.0
Barium	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Calcium	mg/l	8.0	8.0	4.0	4.0	6.0	4.0	4.4	6.0	6.0
Magnesium	mg/l	1.0	1.5	1.7	2.7	1.0	1.9	1.0	3.2	0.7

Notes: N.D. means Not Detected and - means Not Observed.

Table VII.2.2 Water Quality In The Kelantan River System (DID Station)

Name of River		Lebir		Galas		Pergau		
Sampling Point		Kg. Tualang		Dabong		Batu Lembu		
Sampling Date		28.1.87	28.7.87	26.1.86	25.2.86	23.2.87	24.6.87	29.9.87
Time of Sampling		13:45	13:00	14:45	15:45	13:20	10:45	11:35
Temperature	C	-	-	-	-	-	-	-
pH		6.3	6.7	7.0	7.1	7.2	6.9	7.2
Suspended Solid	mg/l	13.0	16.0	21.0	25.0	8.0	105.0	44.0
Dissolved Oxygen (Do)	mg/l	-	-	-	-	-	-	-
BOD	mg/l	-	-	-	-	-	-	-
Phosphorus (Total)	mg/l	-	-	-	-	-	-	-
Colour (Hazen Unit)		10	60	10	5	50	100	70
Turbidity (Silica-Scale Unit)		35	35	60	25	20	425	35
Dissolved Solid	mg/l	77.0	14.0	31.0	25.0	57.0	128.0	75.0
Volatile Suspended Solid	mg/l	-	-	-	-	-	-	-
Total Solid	mg/l	90.0	30.0	52.0	50.0	65.0	233.0	119.0
Hardness (CaCo3)		22	31	20	17	13	11	10
Conductivity	umbos/cm	49	63	39	48	39	29	34
COD	mg/l	0.92	-	-	-	-	-	-
Nitrogen (Ammonia)	mg/l	-	-	-	-	-	-	-
Nitrogen (Nitrate Nitrite)	mg/l	-	0.8	0.26	0.40	0.66	4.6	1.8
Nitrogen (Kjeldahl)	mg/l	-	-	-	-	-	-	-
Chloride	mg/l	7.0	1.0	6.0	3.0	7.0	3.0	1.0
Alkalinity (Total)	mg/l	25.0	32.0	22.0	17.0	16.0	16.0	16.0
Flouride	mg/l	-	-	-	-	-	-	-
Phosphorus (Ortho)	mg/l	-	-	-	-	-	-	-
Arsenic	mg/l	-	-	-	-	-	-	-
Silica (Reactive)	mg/l	18.0	15.0	9.0	6.2	24.0	18.0	19.3
Iron (Total)	mg/l	1.6	0.4	0.4	0.4	0.4	2.8	1.2
Manganese	mg/l	-	-	-	-	-	-	-
Potassium	mg/l	0.1	1.3	N.D.	0.3	0.1	1.7	1.4
Sodium	mg/l	9.0	3.9	1.9	3.0	0.9	5.1	4.2
Sulphate	mg/l	1.0	N.D.	2.0	2.0	1.0	3.0	1.0
Barium	mg/l	-	-	-	-	-	-	-
Calcium	mg/l	6.8	9.2	6.0	6.0	3.6	1.6	1.6
Magnesium	mg/l	1.2	1.9	1.2	0.5	0.9	1.7	1.5

Notes: N.D. means Not Detected and - means Not Observed.

Table VII.2.3 Water Quality In The Kelantan River System (DID Station)

Name of River				Nenggiri		
Sampling Point				Bertam		
Sampling Date		17.2.87	23.3.87	4.4.87	10.5.87	15.6.87
Time of Sampling		12:40	15:00	13:05	14:00	14:00
Temperature	C	-	-	-	-	-
pH		7.6	7.1	7.0	6.9	7.2
Suspended Solid	mg/l	5.0	48.0	6.0	71.0	18.0
Dissolved Oxygen (Do)	mg/l	-	-	-	-	-
BOD	mg/l	-	-	-	-	-
Phosphorus (Total)	mg/l	-	-	-	-	-
Colour (Hazen Unit)		100	50	5	15	30
Turbidity (Silica-Scale Unit)		25	55	20	25	15
Dissolved Solid	mg/l	50.0	61.0	124.0	87.0	119.0
Volatile Suspended Solid	mg/l	-	-	-	-	-
Total Solid	mg/l	55.0	109.0	130.0	158.0	137.0
Hardness (CaCo3)		14	17	16	23	16
Conductivity	umbos/cm	48	39	39	39	48
COD	mg/l	-	-	-	-	-
Nitrogen (Ammonia)	mg/l	-	-	-	-	-
Nitrogen (Nitrate Nitrite)	mg/l	0.92	6.6	3.3	3.0	3.9
Nitrogen (Kjeldahl)	mg/l	-	-	-	-	-
Chloride	mg/l	2.0	1.0	2.0	2.0	3.0
Alkalinity (Total)	mg/l	25.0	18.0	21.0	19.0	22.0
Flouride	mg/l	-	-	-	-	-
Phosphorus (Ortho)	mg/l	-	-	-	-	-
Arsenic	mg/l	-	-	-	-	-
Silica (Reactive)	mg/l	19.0	22.0	20.0	22.0	10.0
Iron (Total)	mg/l	0.4	1.6	0.8	4.0	1.6
Manganese	mg/l	-	-	-	-	-
Potassium	mg/l	0.4	-	-	-	1.9
Sodium	mg/l	1.2	-	-	-	4.2
Sulphate	mg/l	2.0	N.D.	N.D.	1.0	N.D.
Barium	mg/l	-	-	-	-	-
Calcium	mg/l	4.0	4.4	4.0	4.0	60.0
Magnesium	mg/l	0.97	1.4	2.6	3.1	0.2

Notes: N.D. means Not Detected and - means Not Observed.

Table VII.2.4 Water Quality In The Kelantan River System (Lebir Dam EIS Stations)

Name of River		Lebir River												
Sampling Point		SL1	SL2	SL3	SL4	SL5	SL6	SL7	SL8	SL9	SL10	SL11	SL12	SA1
Sampling Date		-	-	-	-	-	-	-	-	-	-	-	-	-
Time of Sampling		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	C	26.0	26.0	26.0	26.5	25.0	25.5	27.0	27.0	27.0	27.0	29.5	28.0	27.0
pH		6.6	6.7	6.9	6.7	6.7	6.4	6.8	6.5	6.4	6.8	7.4	7.6	6.6
Suspended Solid	mg/l	10.0	21.0	14.0	46.0	43.0	49.0	29.0	16.0	197.0	138.0	46.0	-	32.0
Dissolved Oxygen (Do)	mg/l	7.6	7.4	7.3	7.2	7.5	7.5	7.2	7.1	7.0	7.3	7.9	6.5	7.1
BOD	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/l	N.D.	N.D.	N.D.	N.D.	0.03	0.03	N.D.	N.D.	0.17	0.23	N.D.	0.08	N.D.
Colour (Hazen Unit)		-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity (Silica-Scale Unit)		-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Solid	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Suspended Solid	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Solid	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCo3)		-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	umbos/cm	20.0	45.0	35.0	35.0	35.0	35.0	60.0	60.0	60.0	70.0	70.0	80.0	80.0
COD	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia)	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Nitrogen (Nitrate Nitrite)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Kjeldahl)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/l	2.6	2.5	2.6	2.7	2.5	2.6	2.7	2.7	2.6	2.6	2.7	2.7	2.6
Alkalinity (Total)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Flouride	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Ortho)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Silica (Reactive)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron (Total)	mg/l	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.4	1.1	0.4	0.4	0.5	N.D.
Manganese	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Potassium	mg/l	0.8	0.7	0.7	0.8	0.8	0.7	0.7	0.8	1.3	1.6	1.4	1.7	-
Sodium	mg/l	3.0	2.6	2.1	1.8	2.0	2.4	2.9	2.0	2.9	3.2	3.4	3.8	-
Sulphate	mg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Barium	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	mg/l	0.3	0.3	0.2	0.1	0.1	0.1	0.9	1.2	0.7	1.4	-	-	2.8
Magnesium	mg/l	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.2	-	-	0.2

Notes: N.D. means Not Detected and - means Not Observed.
Source: Environmental Impact Statement For The Lebir Dam Project in Malaysia (February, 1988).

Table VII.2.5 Water Quality In The Kelantan River System (Nenggiri Dam EIS Stations)

Name of River						Nenggiri					
Sampling Point		SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9	SN10
Sampling Date		-	-	-	-	-	-	-	-	-	-
Time of Sampling		-	-	-	-	-	-	-	-	-	-
Temperature	C	-	-	-	-	-	-	-	-	-	-
pH		7.5	7.5	7.6	7.5	7.0	8.5	-	7.8	7.5	7.3
Suspended Solid	mg/l	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (Do)	mg/l	9.8	9.4	10.5	9.3	10.5	9.0	10.1	9.9	10.2	10.0
BOD	mg/l	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/l	0.03	0.06	0.02	0.03	0.01	0.01	0.07	0.01	0.03	0.06
Colour (Hazen Unit)		-	-	-	-	-	-	-	-	-	-
Turbidity (Silica-Scale Unit)		32.0	29.0	39.0	29.0	-	-	-	53.0	26.0	31.0
Dissolved Solid	mg/l	-	-	-	-	-	-	-	-	-	-
Volatile Suspended Solid	mg/l	-	-	-	-	-	-	-	-	-	-
Total Solid	mg/l	-	-	-	-	-	-	-	-	-	-
Hardness (CaCo3)		-	-	-	-	-	-	-	-	-	-
Conductivity	umbos/cm	-	-	-	-	-	-	-	-	-	-
COD	mg/l	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia)	mg/l	-	-	-	-	-	-	-	-	-	-
Nitrogen (Nitrate Nitrite)	mg/l	-	-	-	-	-	-	-	-	-	-
Nitrogen (Kjeldahl)	mg/l	-	-	-	-	-	-	-	-	-	-
Chloride	mg/l	-	-	-	-	-	-	-	-	-	-
Alkalinity (Total)	mg/l	-	-	-	-	-	-	-	-	-	-
Flouride	mg/l	-	-	-	-	-	-	-	-	-	-
Phosphorus (Ortho)	mg/l	-	-	-	-	-	-	-	-	-	-
Arsenic	mg/l	-	-	-	-	-	-	-	-	-	-
Silica (Reactive)	mg/l	-	-	-	-	-	-	-	-	-	-
Iron (Total)	mg/l	-	-	-	-	-	-	-	-	-	-
Manganese	mg/l	-	-	-	-	-	-	-	-	-	-
Potassium	mg/l	-	-	-	-	-	-	-	-	-	-
Sodium	mg/l	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/l	-	-	-	-	-	-	-	-	-	-
Barium	mg/l	-	-	-	-	-	-	-	-	-	-
Calcium	mg/l	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/l	-	-	-	-	-	-	-	-	-	-

Notes: N.D. means Not Detected and - means Not Observed.
Source: Nenggiri Dam Project Feasibility Study Environmental Impact Assessment.

Table VII.2.6 List of Fish Species in the Kelantan River System

Name	Name
Acrossocheilus deauratus-Kelah putih	Osteocheilua hasselti-Terbol
Acrossocheilus hezagonolepis-Tengas	Osteocheilua microcephalus-Rong
Acanthopsis choirorhynchos-Pasir, Tali	Osteocheilua spilrus-Rong
Barbichthys laevis-Butu hulu	Osteocheilua melanopleura-Kelabu
Barilus guttatus-Sikang	Osphronemus goramy-Kalui
Channa micropeltes-Toman	Osteochilus hesselti-Terbui
Channa striatus-Aruan	Pangasius microneus-Lawang
Cyclocheilichthys apogon-Temperas	Pangasius sp,-Patin (Cat fish)
Cyclocheilichthys armatus-Temperas	Pristolepis fasciatus-Patong
Epalzeorhynchos siamensis-Selimang siam	Puntioplites Bulu-Tenggalan
Hampala macrolepidota-Sebarau	Puntius daruphani-Kerai
Helostoma temmincki-Tebakang	Puntius schwanefeldi-Lampang Sungei
Kryptopterus cryptoterus-Lais	Puntius lateristriga-Bagoh
Labiobarbus lineatus-kawan	Puntius orphoides-Pipi merah
Leiocassis sp.	Rasbora elegans-Selung
Lobocheilus cornutus-Jemerong	Rasbora bankanensis-Selung
Luciosoma trinema-Nyuar	Rasbora dusonensis-Selung
Mastacembelus armatus-Tilan	Rasbora smatrana-Selung
Mystacoleucus Marginatus-Sia	Scleropages formosus-Kelisa
Mystus Nemurus-Baung	Tetraodon fluviatilis-Buntal
Mystus planiceps-Baung	Tor Tambroides-Kelah
Mystus baramensis-Baung	Wallage Attu-Tapah
Mystus wyckii-Tengku loah	Mcrobrachium rosenbergii-Udang gala
Mystus sp.-Baung	Clyptothorax major-DEPU
Notopterus chitala-Belida	G. platypogonoides-Kenerak Batu
Puntius binotatus-Tebal Sisik	L. lepetocheilus-daun
M. chilopterus-Sia	Laides hexanema-juara
Nemacheilus sp.-Pasir	

Source: (1) Environmental Impact Statement for the Lebir Dam Project in Malaysia (Feb. 1988)

(2) Pergau Hydroelectric Project Volume 6 Environmental and Socio-economy Study (June 1987)

Table VII.2.7 List of Endangered Species (Fish Fauna)

Endangered Species

Scleropages formosus
Notopterus chitala
Rasbora dorsiocellata
Barilius guttatus
Puntius pentazona
Probarbus jullieni

Balantiocheilos melanopterus
Cyclocheilichthys heteronema
Macrochirichthys macrochirus
Labiobarbus leptocheilus
L. ocellatus
L. siamensis
L. lineatus
L. sumatranus
L. fasciatus
Tor tambroides
T. soro
Lobocheilus cornutus
Tylognathus caudimaculatus
Barbichthys laevis
Epalzeorhynchos kalopterus
Crossocheilus oblongus
Homaloptera zollingeri
Sphaerichthys osphoronemoides
Betta pugnax
B. splendens
Helostoma temminckii
Luciocephalus pulcher
Monopterus albus

Acanthopthalmus kuhlii
A. anguillaris
A. muraeniformes
A. vermicluaris
Botia hymenophysa
B. modesta

Lepidocephalus octocirrhus
L. macrochir
Silurichthys phaisoma
Kryptopterus micronema
Wallago attu
Prophagorus nieuhofi
Bagarichthys hypselopterus
Mystus wyckii
Acrochordonichthys ichnosoma
Parakysis verrucosa
Laides hexanema
Anguilla bicolor
Channa micropeltes
C. lucius
Trichogaster leeri
Osphronemus goramy
Parosphronemus deissneri
Nandus nebulosus
Pristolepis fasciatus
Glossogobius giuris
Oxyleotris marmoratus
Mastacembelus maculatus
M. armatus

Table VII.2.8 List of Rare or Extinct Species (Fish Fauna)

Rare or Extinct Species

Chela johorensis
C. laubuca
C. maasi
C. maculicauda
Rasbora dorsimaculata
R. bankanensis
R. borapetensis
R. caudimaculata
R. dusonensis
R. kalochroma
R. maculata
R. taeniata
R. paucisquamis
R. vaillanti
R. pauciperforata
R. rasbora
R. lateristriata
R. meinkeni
R. myersi

Puntus douronensis
P. burmanicus
P. belinka
P. baranoides
P. strigatus
P. everetti
P. leiacanthus
P. birtwistlei
Acrossocheilus hendersoni
A. dukai
Mystacoleucus chilopterus
Osteocheilus microcephalus
O. spilurus
O. kahajanensis
O. triporus
O. brachynotopterus
O. kelabu
O. waandersii
Cyclocheilichthys zwaani
C. siaja
C. janthochir
C. amatus
C. repasson
C. lineatus
C. enoplos
Labiobarbus burmanicus
L. cuvieri
Homaloptera johorensis
H. nigra
H. leonardi
H. ogilviei
H. smithi
H. tweediei
H. wassinkii
Acanthopthalmus javanicus
A. shelfordi
A. pangia
Cobitophis perakensis
Nemacheilus fasiatus
N. masyae

Lepidocephalus furcatus
Vaillamella maassi
Silurichthys indragiriensis
S. schneideri
Ompok leicanthus
Kryptopterus limpok
K. macrocephalus
K. cryptopterus
Wallagonia leeri
W. tweediei
Siluroides hypophthalmus
Parasilurus cochinchinensis
Clarias melanoderma
C. leiacanthus
C. teysmanni
Encheloclarias tapeinopterus
Leiocassis bicolor
L. baramensis
L. fauscus

L. micropogon
L. stenomus
Batasio tengana
Mystus wolffi
M. johorensis
M. gulio
M. pahangensis
M. micracanthus
Glyptothorax platypogonoides
G. platypogon
Acrochordonichthys melanogaster
A. rugosus
Pangasius ponderosus
P. polyuranodon
Hemiramphus tweedie
Doryichthys deokhatoides
Channa bistriatus
C. puncatuts
C. orientulis
C. melanosoma
C. maruloides
C. gachua
Betta picta
B. taeniata
B. anabantoides
B. fusca
B. bellica
B. brederi
Macropodus cupanus
Belontia hasselti
Nandus nandus
Oxyleotris urophthalmus
Macrognathus aculeatus
Mastocembelus perakensis
M. unicolor
M. erythrotaenia
M. guntheri
M. circumcinctus
Chonerhinus naritus
C. modestus

Table VII.2.9 Freshwater Fish Production in the State of Kelantan

(M/Tons)

Year	Lampan Jawa	Leekoh	Tongsang Makan Rumput	Tongsang Kepala Besar	Patin	Tilapia	Jelawat	Udang Galah	Sepat Siam	Total
1970	0.11	0.06	-	-	-	0.22	-	-	-	0.39
1971	0.18	0.14	-	-	-	-	-	-	-	0.32
1972	0.22	0.22	1.78	0.60	-	-	-	-	0.23	3.05
1973	1.38	0.27	0.85	0.98	-	-	-	-	0.83	4.31
1974	0.27	0.12	0.88	0.15	-	-	-	0.08	0.12	1.62
1975	0.33	0.47	0.52	0.13	-	0.12	-	-	0.08	1.65
1976	0.48	1.33	0.32	0.65	-	-	-	-	-	2.78
1977	0.07	0.03	0.11	0.18	-	0.13	-	0.03	-	0.55
1978	0.22	0.06	0.31	0.28	-	0.06	-	0.02	-	0.95
1979	0.04	0.40	0.65	0.34	-	0.03	-	0.03	0.02	1.51
1980	1.13	0.64	6.67	7.40	-	0.28	-	0.02	0.13	16.27
1981	1.53	1.71	3.90	3.77	-	0.05	-	0.03	0.08	11.07
1982	2.36	1.13	4.78	3.45	-	-	0.04	0.04	0.13	11.93
1983	4.15	2.22	4.83	4.01	-	-	1.24	0.23	-	16.68
1984	3.67	2.22	3.22	1.55	-	0.62	5.82	1.28	0.05	18.43
1985	4.95	2.38	3.97	1.93	0.79	0.10	6.33	-	-	20.45

Source : Fisheries Department, Kelantan.

Table VII.2.10 Mammals Recorded in Precious Survey (1/2)

Name (Lebir dam)	Name (Pergau Hydroelectric Project)	
Hylobates agilis-Agile gibbon	Hylomys suillus	Lesser Gymnure
Macaca arctiodes-Stump tailed macaque	Crocidura fuliginosus	Asian White-toothed Shrew
Rattus sabanus-Long tailed giant rat	Suncus etruscus	S E Asian Pygmy Shrew
Bandicoota indica-Large bandicoof rat	Tupaia glis	Common Treeshrew
Tupaia glis-Common tree shrew	Cynopterus horsfieldii	Horsefield's Fruitbat
Rattus whiteheadi-White headed rat	C. sphinx	-
Tragulus javanicus-Lesser mouse deer	Megaerops ecaudatus	Tailess Fruitbat
Trimevesurus sumatranus-Sumatran pit viper	Eonycteris spelaea	Cave Fruitbat
Macaca fascicularis-Long tailed macaque	Macroglossus sobrinus	Long-tongued Fruitbat
Corvus unicolor-Sambur	Nycteris javanica	Hollow-faced bat
Muntiacus muntjak-Barking deer	Rhinolophus affinis	Intermediate Horseshoe bat
Sus spp.-Wild pig	Myotis mystacinus	Whiskered Bat
Tragulus napu-Large mouse deer	Scotophilus kuhlii	House Bat
Elephas maximus-Indian elephant	Hylobates syndactylus	Siamang
Cuon alpinus-Red dog	H. lar	White-handed Gibbon
Ratufa bicolor-Black giant squirrel	Macaca fascicularis	Long-tailed macaque
Ratufa affinis-Cream coloured giant squirrel	M. nemestrina	Pig-tailed macaque
Petaurista petaurista-Red giant flying squirrel	Presbytis obscura	Dusky Leaf-monkey
Herpastes sp.-Mongoose	P. melalophos	Banded Leaf-monkey
Panthera pardus-Leopard panther	Rhizomys sp.	Bamboo rat
Presrtytis obscura-Dusky leaf monkey	Rattus muelleri	Mueller Rat
Panthera tigris-Tiger	R. whiteheadi	Whitehead's Rat
Felis marmorata-Marbled cat	Callossciurus notatus	Plaintain Squirrel
Bos javanicus-Banteng	C. nigrovittatus	Black-banded Squirrel
Tapirus indicus-Malayan tapir	Sundasciurus lowii	Low's Squirrel
Acrtitis binturong-Binturong	S. tenuis	Slender Squirrel
Dicerorhinus sumatransis-Sumatran rhinoceros	Ratufa affinis	Cream-coloured Giant Squirrel
Hystrix brachyura-Malayan porcupine	R. bicolor	Black Giant Squirrel

- to be continued

Table VII.2.10 Mammals Recorded in Precious Survey (2/2)

Name (Lebir dam)	Name (Pergau Hydroelectric Project)	
	Hystrix brachyurus	Porcupine
	Panthera tigris	Tiger
	P. pardus	Leopard
	Felis bengalensis	Leopard cat
	Amblonyx cinerea	Small-clawed Otter
	Helarctos javanicus	Bear
	Viverra sp.	Civet
	Tapirus indicus	Tapir
	Didermoceros sumatrensis	Rhinoceros

Table VII.2.11 Bird Record in the Survey Areas of Lebir Dam (1/2)

Name	Name
Arusianus argus-Great Argus	Elanus caeruleus-Black shouldered kite
Arachnothera longirostra-Little spider Hunter	Eurostopodus temminckii-Malayan eared nightjar
Aegithena lafresnayei-Great iora	Eurystomus orientailis-Dollarbird
Aegithena viridissima-Green iora	Eurylaimus ochromalus-Black yellow broadbill
Aplonis paragensis-Philippine glossay starking	Gracula religiosa-Hill myna
Accipiter sp.-Hawk	Gallus gallus-Red jungle foel
Anthracoceros malayanus-Black hornbill	Hemirpocne coronata-Crested Tree Swift
Buceros rhinocerus-Rhinocerus hornbill	Hemirpocne comata-Whiskered Tree Swift
Blythipicus rubiginosus-Maroon woodpecker	Halcyon smyrnensis-White throated kingfisher
Calyptomena viridis-Green Broadbill	Hypseppmtes criniger-Hairy backed bulbul
Coprychus saularis-Magpie Robin	Hypsipetes malaccansis-Streaked bulbul
Coprychus malabraricus-White rumped shama	Hirundapus giganteus-Brown needletail
Cocomantis merulinus-Plaintive cuckoo	Hypothymis azurea-Black naped monarch
Centropus sinensis-Greater concal	Irena puella-Asian fairy bluebird
Cicomantis merulinus-Plaintive cuckoo	Lonchura leucogasta-White bellied minia
Circaetus gallicus-Short toed eagle	Megalaima chrysopogon-Gold-whiskered Barbet
Dicrurus remifer-Leser racquet tailed drango	Megalaima henricii-Yellow crowned barbet
Dicrurus leucophaeus-Ashy drongo	Megalaima mystacophanus-Red throated barbet
Dicrurus aeneus-Bronzed drongo	Megalaima franklinii-Golden throated barbet
Dicrurus paradiceus-Greater racquet tailed drongo	Megalaima austraris-Blue eared barbet
Ducula aenes-Green imperial pigeon	Milrus migrans-Black kite

Table VII.2.11 Bird Record in the Survey Areas of Lebir Dam (2/2)

Name	Name
Nyctyornis amictus-Red bearded beecater	Pycnonotus zeylanicus-Straw headed bulbul
Orthotomus atrogularis-Dark necked tailorbird	Prionichilus thoracicus-scarlet breasted flowerpecker
Orthotomus sericeus-Ruous tailed tailorbird	Platysmurus leucopterus-Black magpie
Psilopogon pyrolophus-Fire-pufted Barbet	Pellorneus ruficeps-Puff throated babbler
Pericrocotus flammeus-Scarlet Minivet	Rhipidura Javanica-Pied fortail flycatcher
Pericrotus brevivostris-Short billed minivet	Rhinoplax vigil-Helmeted hornbill
Pelargopsis capensis-Stock billed kingfisher	Rhyteceros corrugatus-Wrinkled hornbill
Pitta moluccensis-Blue winged pitta	Spiornis cheela-Crested Serpent Eaggle
Pitta caerulea-Giant pitta	Spizaetus alboniger-Blyths hawk Eaggle
Phaenicophaeus curvirostris-Chestnut breasted malkoha	Turnix suscitator-Barred buttonguail
Picus puniceus-Crimson winged woodpecker	Terpsiphone paradisi-Asian paradise flycatcher
Pycnonotus goiavier-Yellow vested bulbul	

Source: Environmental Impact Statement for the Lebir Dam Project in Malaysia (Feb. 1988)
Source: Environment

Table VII.2.12 Bird Record in Survey Areas of Pergau Hydroelectric Project (1/3)

Name	
Nycticorax nycticorax	Night Heron
Ichthyophaga nana	Lesser Fish-eagle
Pernis ptilorhynchus	Crested Honey-buzzard
Spilornis cheela	Crested Serpent-eagle
Hieraaetus kierneri	Rufous-bellied Hawk-eagle
Spizaetus alboniger	Blyth's Hawk-eagle
Microhierrax fringillarius	Black-thigh Falconet
Argusianus argus	Great Argus Pheasant
Theron olax	Little Green Pigeon
T. curvirostra	Thick-billed pigeon
T. vernans	Pink-necked Pigeon
Ducula badia	Mountain Imperial Pigeon
Macropygia ruficeps	Little Cuckoo-dove
Streptopelia chinensis	Spotted-necked dove
Geopelia striata	Peaceful dove
Chalcophaps indica	Green-winged pigeon
Loriculus galgulus	Blue-crowned Hanging Parrot
Cacomantis merulinus	Plaintive Cuckoo
C. sonneratii	Banded Bay Cuckoo
Surniculus lugubris	Drongo Cuckoo
Phaenicophaeus diardii	Black-bellied Malkoha
P. chlorophaeus	Raffles's Malkoha
P. javanicus	Red-billed Malkoha
P. curvirostris	Chestnut-brested Malkoha
Otus bakkamoena	Collared Scops-owl
Ketupa ketupu	Buff Fish-owl
Collocalia sp.	Swiflet
Hirundapus cochinchinensis	White-vented Needle-tail
Rhapidura leucopygialis	Silver-rumped Swiftlet
Apus pacificus	Fork-tailed Swift
Cypsiurus batasiensis	Asian Palm-swift
Hemiprocne longipennis	Grey-rumped treeswift
H. comata	Whiskered Treeswift
Halcyon smyrnensis	White-throated Kingfisher
Alcedo meniting	Blue-eared Kingfisher
A. euryzona	Blue-banded Kingfisher
Ceyx erithacus	Black-backed Kingfisher
Merops viridis	Blue-throated bee-eater
Nyctyornis amictus	Red-bearded bee-eater
Eurystomus orientalis	Dollarbird
Anorrhinus galeritus	Bushycrested hornbill

Table VII.2.12 Bird Record in Survey Areas of Pergau Hydroelectric Project (2/3)

Name	
Rhyticeros undulatus	Wreathed Hornbill
Buceros rhinoceros	Rhinoceros Hornbill
Rhinoplax vigil	Helmeted Hornbill
Psilopogon pyrolophus	Fire-tufted barbet
Megalaima chrysopogon	Gold-whiskered barbet
M. mystacophanos	Red-throated Barbet
M. oorti	Black-browed Barbet
M. henricii	Yellow-crowned Barbet
M. australis	Blue-eared Barbet
Calorhamphus fuliginosus	Brown Barbet
Sasia abnormis	Rufous Piculet
Picoides canicapillus	Grey-capped Woodpecker
Picus miniaceus	Banded Woodpecker
P. flavinucha	Greater Yellownape
Meiglyptes tristis	Buff-rumped Woodpecker
M. tukki	Buff-necked Woodpecker
Hemicircus concretus	Grey-Buff Woodpecker
Cymbirhynchus macrorhynchus	Black & Red Broadbill
Eurylaimus javanicus	Banded Broadbill
E. ochromalus	Black & Yellow Broadbill
Hirundo rustica	Barn Swallow
H. tahitica	Pacific Swallow
Hemipus picatus	Bar-winged Flycatcher Shrike
Pericrocotus cinnamomeus	Small minivet
P. flammeus	Scarlet Minivet
P. solaris	Grey-chinned Minivet
Irena puella	Asian Fairy Bluebird
Chloropsis cyanapogon	Lesser Green Leafbird
C. sonneratii	Greater Green Leafbird
Pycnonotus atriceps	Black-headed Bulbul
P. jocosus	Red-whiskered Bulbul
P. goiavier	Yellow-vented Bulbul
P. plumosus	Olive-winged Bulbul
P. simplex	Cream-vented Bulbul
P. brunneus	Red-eyed bulbul
P. erythrophthalmos	Spectacled Bulbul
Criniger ochraceus	Ochraceous Bulbul
C. phaeocephalus	Yellow-breasted Bulbul
C. bres	Scrub Bulbul
Hypsipetes charlottae	Buff-vented Bulbul
Dicrurus aeneus	Bronzed Drongo
D. remifer	Lesser Racquet-tailed Drongo
D. paradiseus	Greater racquet-tailed Drongo
Oriolus xanthonotus	Dark-throated Oriole
Platylophus galericulatus	Crested Jay
Corvus macrorhynchos	Large-billed crow
Melanochlora sultanea	Sultan Tit
Sitta frontalis	Velvet-fronted Nuthatch
S. azurea	Blue Nuthatch
Trischastoma bicolor	Ferruginous Babbler
T. abbotti	Abbott's Babbler
Stachyris nigriceps	Grey-throated Babbler
S. poliocephala	Grey-headed Babbler
Malacopteron magnirostre	Moustached Babbler

Table VII.2.12 Bird Record in Survey Areas of Pergau Hydroelectric Project (3/3)

Name	
Macronous gularis	Striped Tit Babbler
M. ptilosus	Fluffy-backed Tit Babbler
Carrulex mitratus	Shestnut-capped Laughing Thrush
Gamsorhynchus rufulus	White-headed Babbler
Alcippe brunneicauda	Brwon Fulvetta
A. peracensis	Mountain Fulvetta
Eupetes macrocercus	Rail Babbler
Erithacus cyane	Siberian Blue Robin
Copsychus saularis	Magpie robin
C. malabaricus	White-rumped Shama
Enicurus ruficapillus	Chestnut-naped Forktail
E. schistaceus	Slaty-backed Forktail
E. leschenaultii	White-crowned Forktail
Myophonus caeruleus	Blue Whistling Thrush
Abroscopus superciliaris	Yellow-bellied warbler
Phylloscopus inornatus	Inornate Warbler
Orthotomus sutorius	Long-tailed tailorbird
O. atrogularis	Dark-throated tailorbird
Prinia rufescens	Rufescent Prinia
P. flaviventris	Yellow-bellied prinia
Muscicapa latirostris	Asian Brown Flycatcher
M. thalassina	Verditer Flycatcher
Cyornis concreta	White-tailed Flycatcher
C. banyumas	Hill Blue Flycatcher
Culicicapa ceylonensis	Grey-headed Flycatcher
Terpsiphone paradisi	Asian paradise Flycatcher
Philentoma pyrrhopterum	Rufous-winged Flycatcher
Motacilla cinerea	Grey Wagtail
Lanius cristatus	Brown Shrike
Acridotheres tristis	Common myna
Gracula religiosa	Hill Myna
Hypogramma hypogrammicum	Purple-naped Sunbird
Anthrepes simplex	Plain Sunbird
Nectarinia jugularis	Olive-backed Sunbird
Arachnothera longirostrata	Little Spiderhunter
A. chrysogenys	Yellow-eared Spiderhunter
A. affinis	Grey-breasted Spiderhunter
Prionochilus maculatus	Yellow-breasted Flowerpecker
Dicaceum trigonostigmum	Orange-bellied Flowerpecker
Zosterops everetti	Everett's White-eye
Z. palpebrosa	Oriental White-eye
Passer montanus	Tree Sparrow
Lonchura striata	White-rumped Munia

Source: Pergau Hydroelectric Project
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Table VII.2.13 **Population and Family Number in the Orang Asli Settlements**

Name of Settlement	Population	Family
1.Blau	217	47
2.Kuala Betis	1,050	315
3.Tohoi	144	34
4.Gemalah	35	24
5.Wias	288	40
6.Pulat	73	12
7.Lebir	376	52
8.Aring	145	38
9.Pasik	351	80
10.Gob	421	80
11.Simpor	321	70
12.Bihai	348	52
13.Hau	308	72
14.Hendrop	381	91
15.Brooke	783	149
16.Belatim	391	106
17.Sg. Rual	240	70
18.Kuala Lah	73	23
Total	5,945	1,355

Source: The Department of Orang Asli Affairs (JOA)

Table VII.2.14 Generalized Biological Information Concerning the Vectors of Malaria

Disease	Vector or intermediate host	Reproductive potential: Number of eggs	Egg-to-egg cycle	Number of broods	Life-span
Malaria	Anopheles	200	10-14 days	6-10	20 weeks

Preferred behaviour

Feeding time	Resting place	Source of blood	Flight of dispersal range
Night	Indoors and outdoors	Man and animals	1.5 km

Source : WHO reports

Table VII.3.1 Supposed Resettlement Population

Name of Contemplated Dam	Supposed Reservoir Area	Population	Family
Dabong	310 km^2	361	52
Kemubu	200 km^2	361	52
Nenggiri	120 km^2	1,512	397
Lebir	250 km^2	401	52

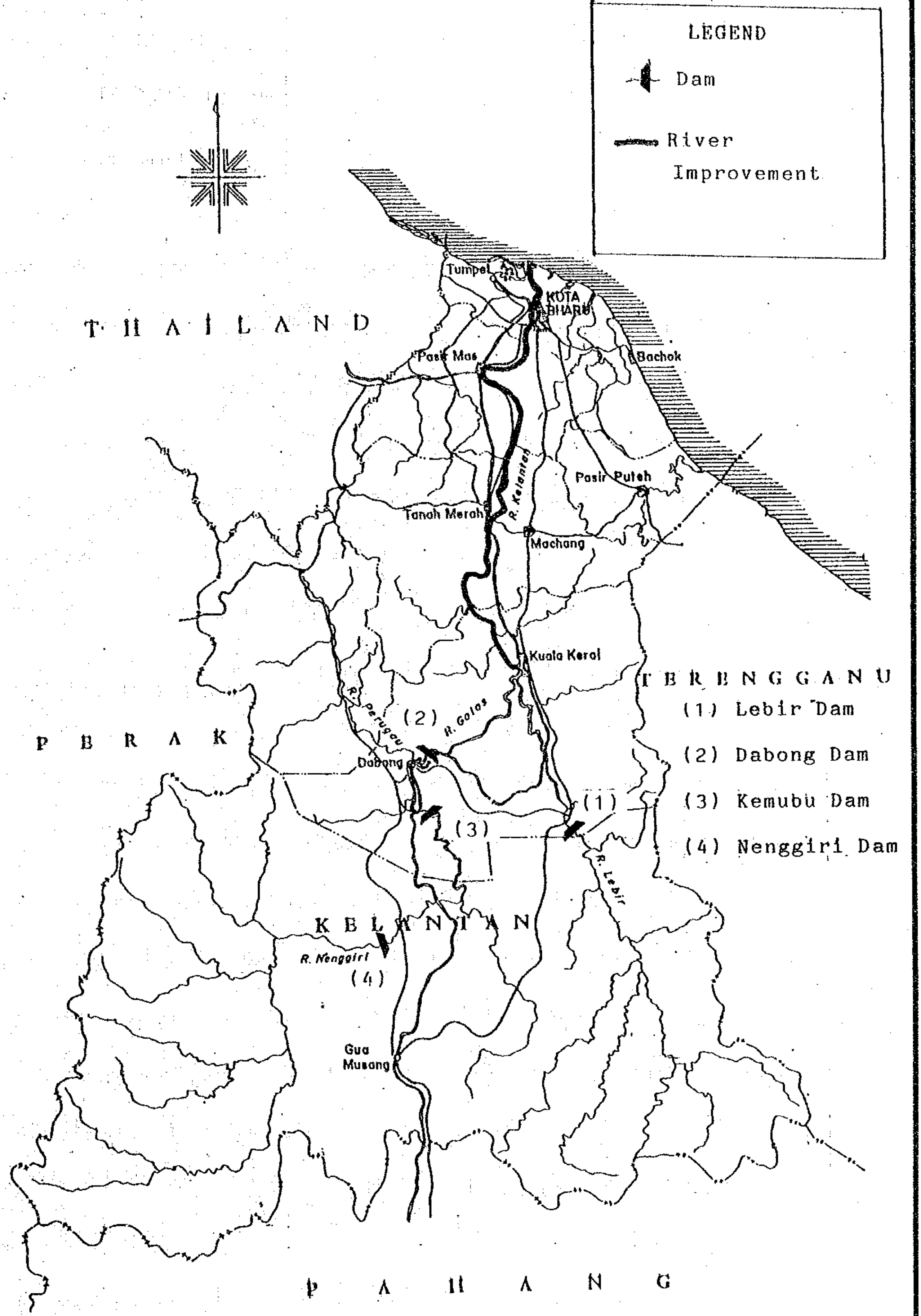

Fig.VII.1.1

Supposed Flood Mitigation Plan

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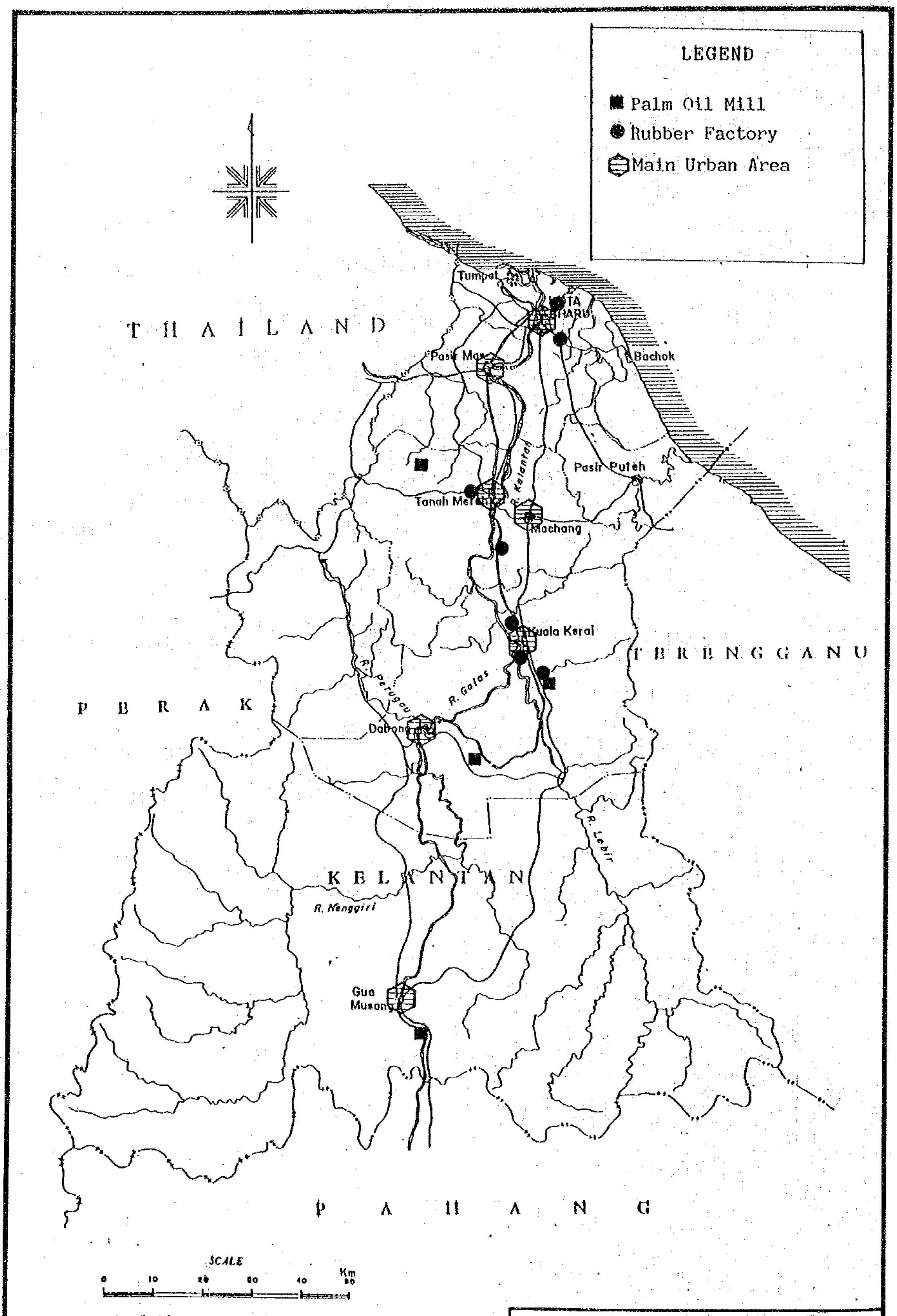

Fig.VII.2.1

Location of Main Pollution Sources

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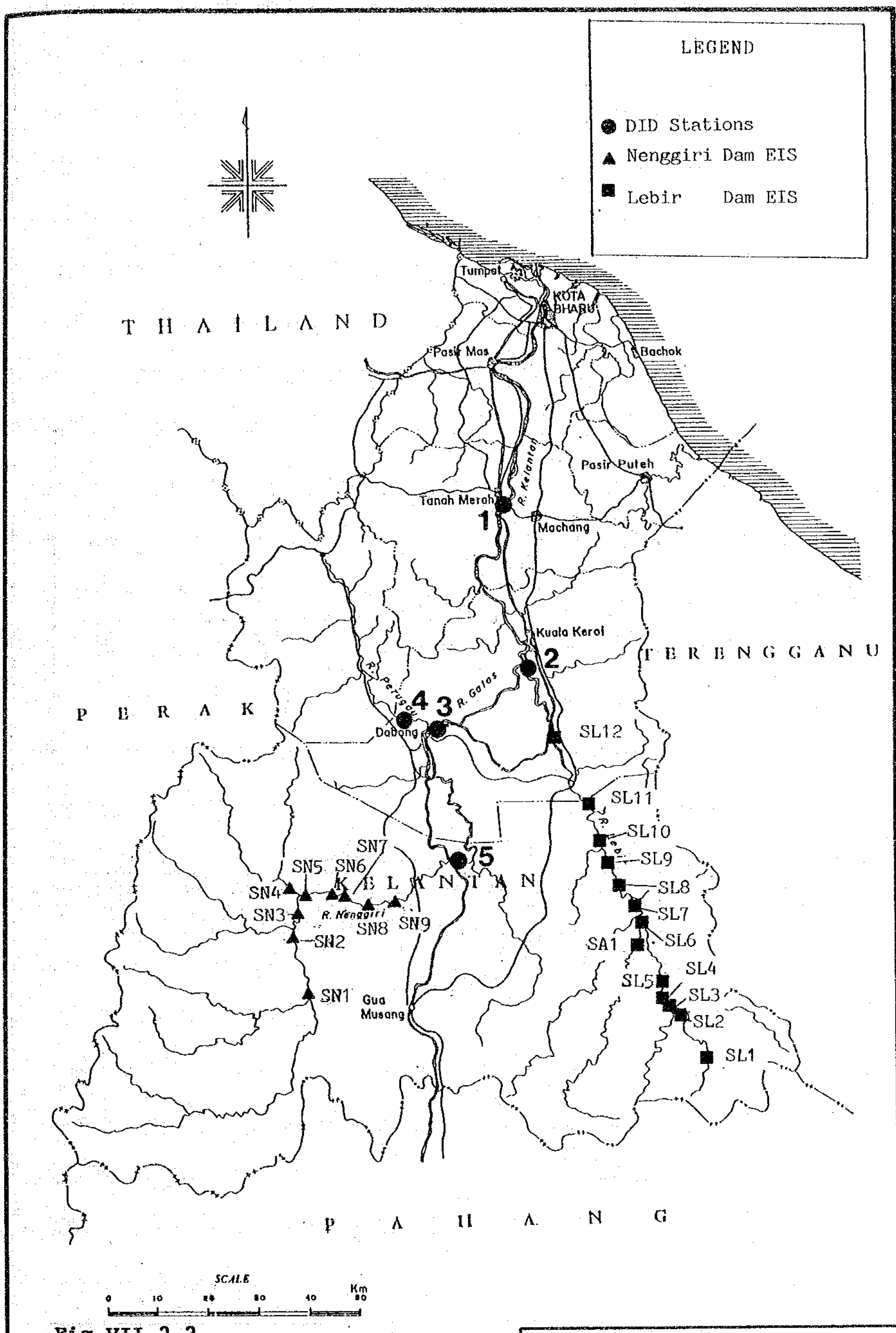

Fig.VII.2.2

Location of Water Quality Monitoring Stations

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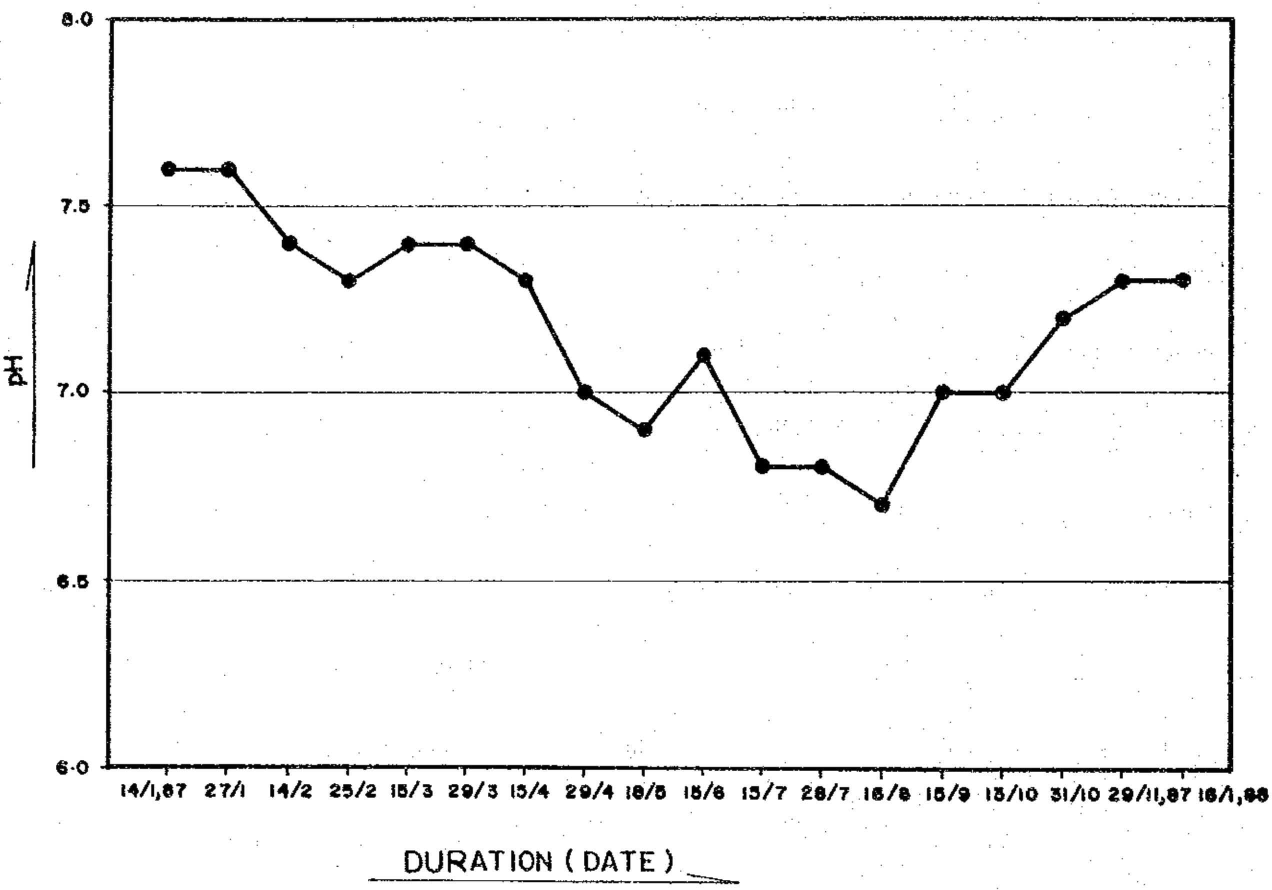

Fig.VII.2.3

pH in the Kelantan River
(Guillemard Bridge)

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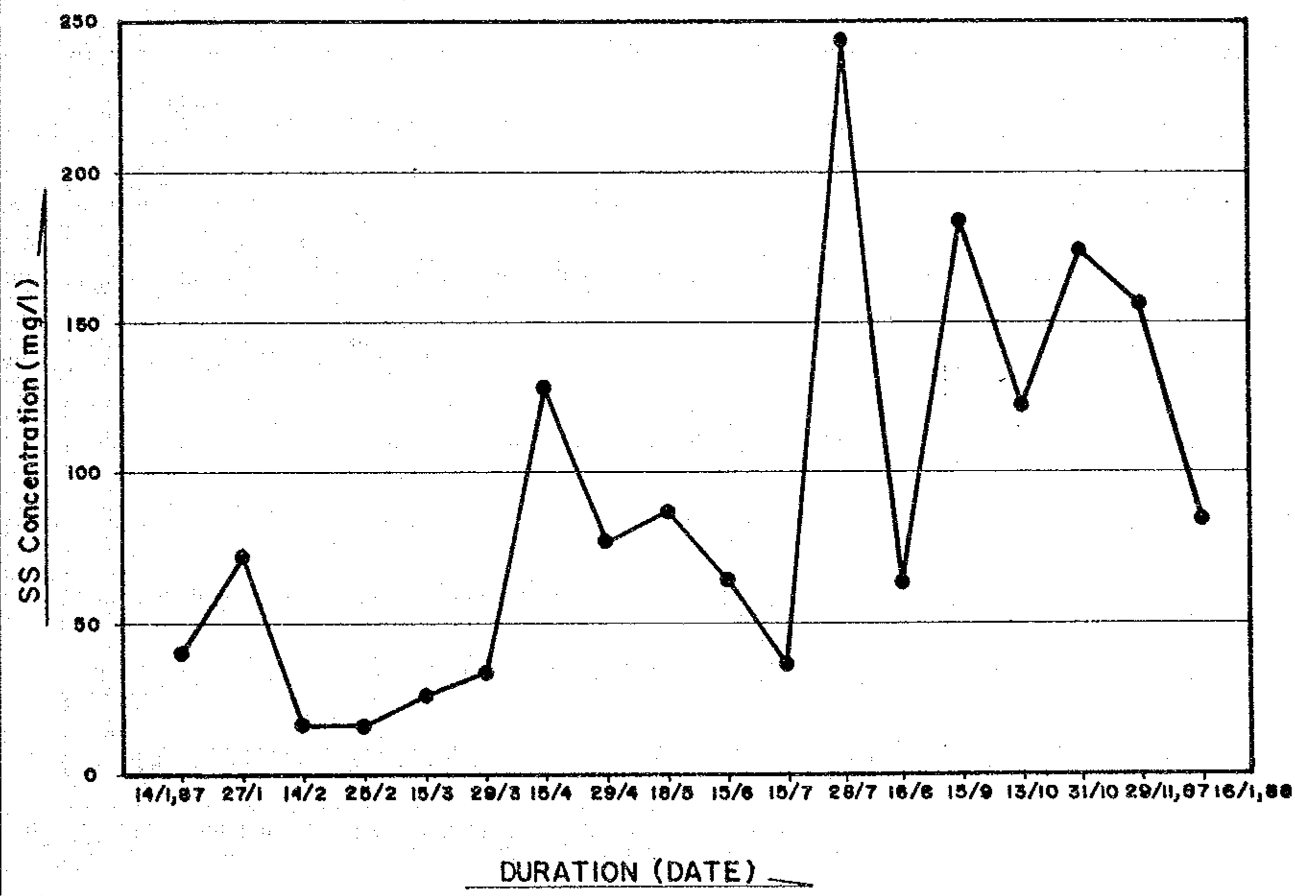

Fig.VII.2.4

SS Concentration in the Kelantan River (Guillemard Bridge)

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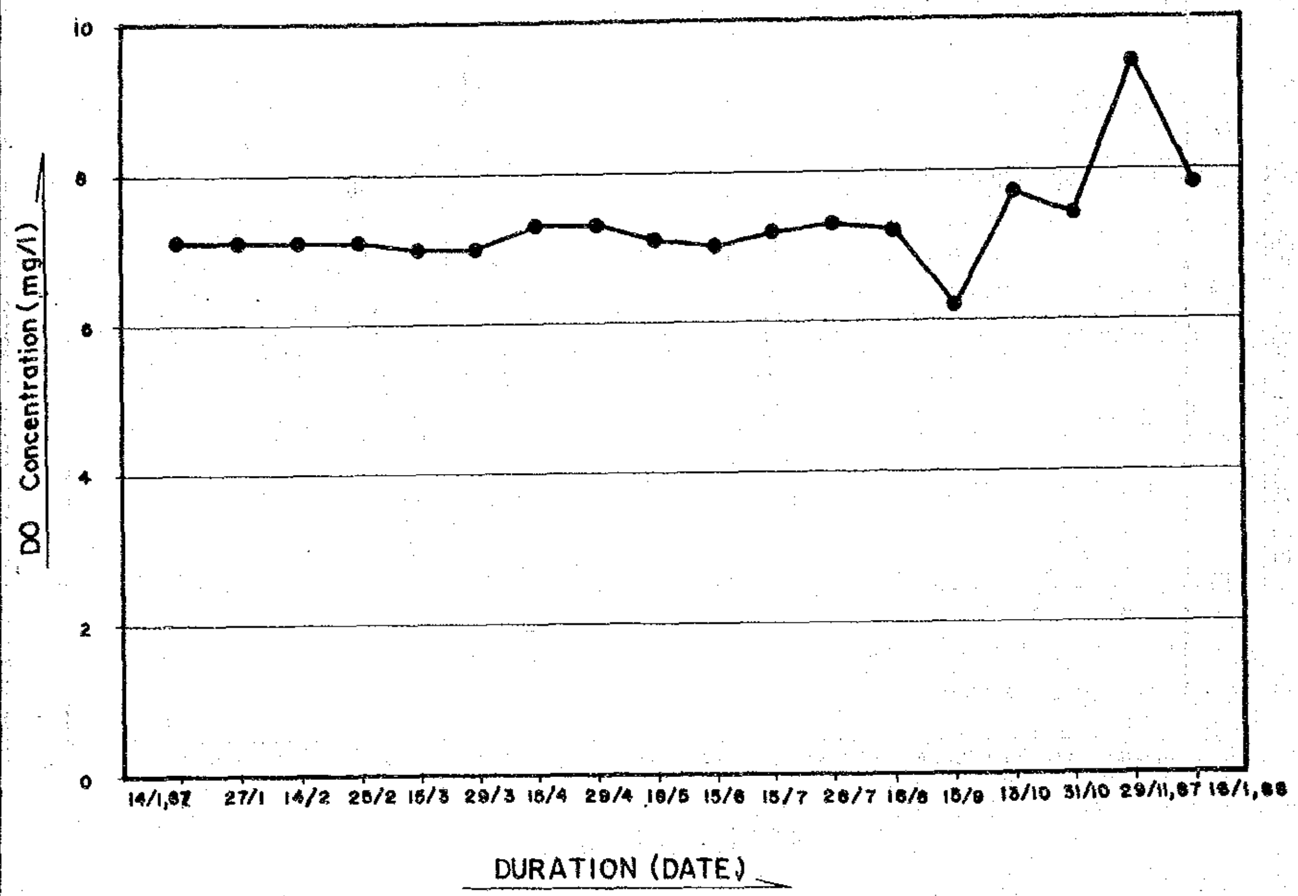

Fig.VII.2.5

DO Concentration in the Kelantan River (Guillemard Bridge)

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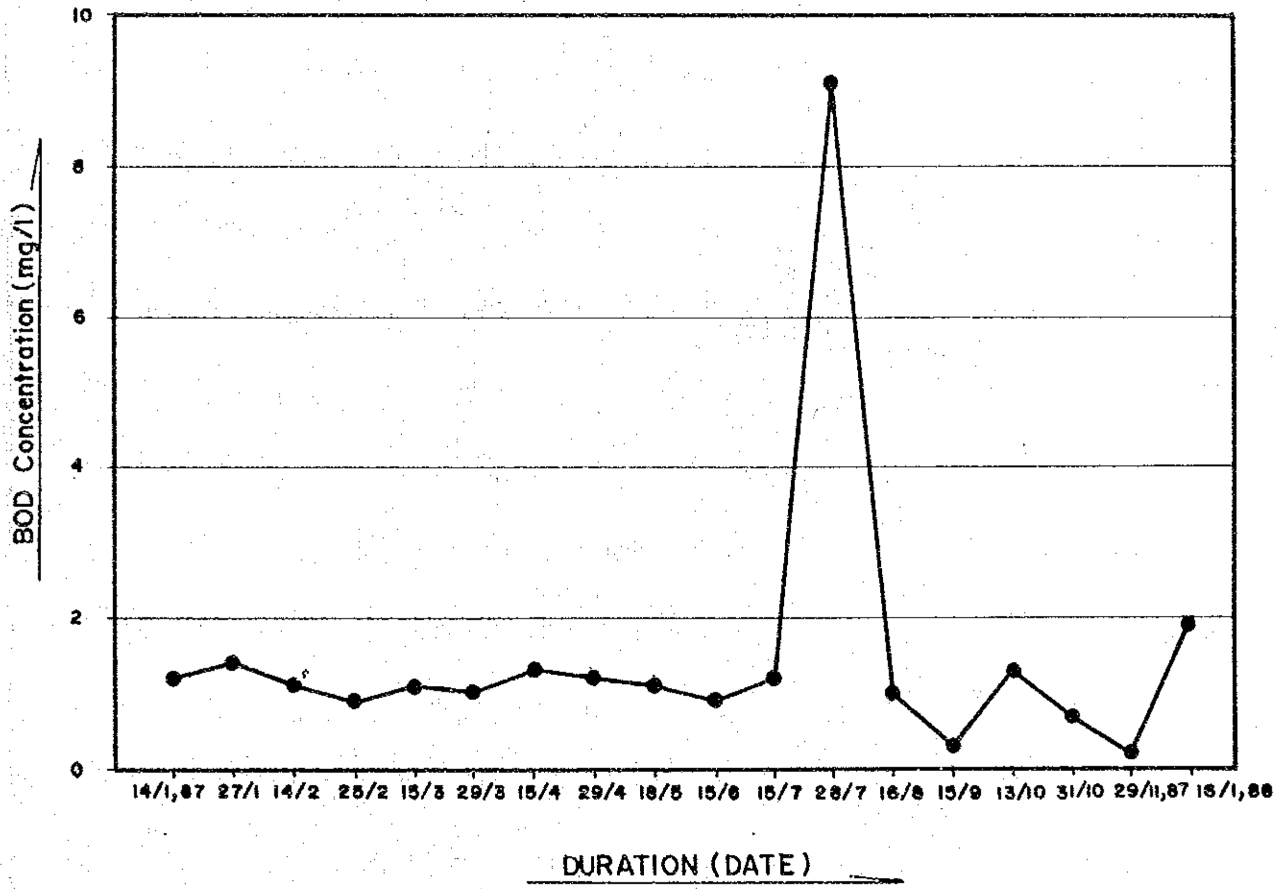

Fig.VII.2.6

BOD Concentration in the Kelantan River (Guillemard Bridge)

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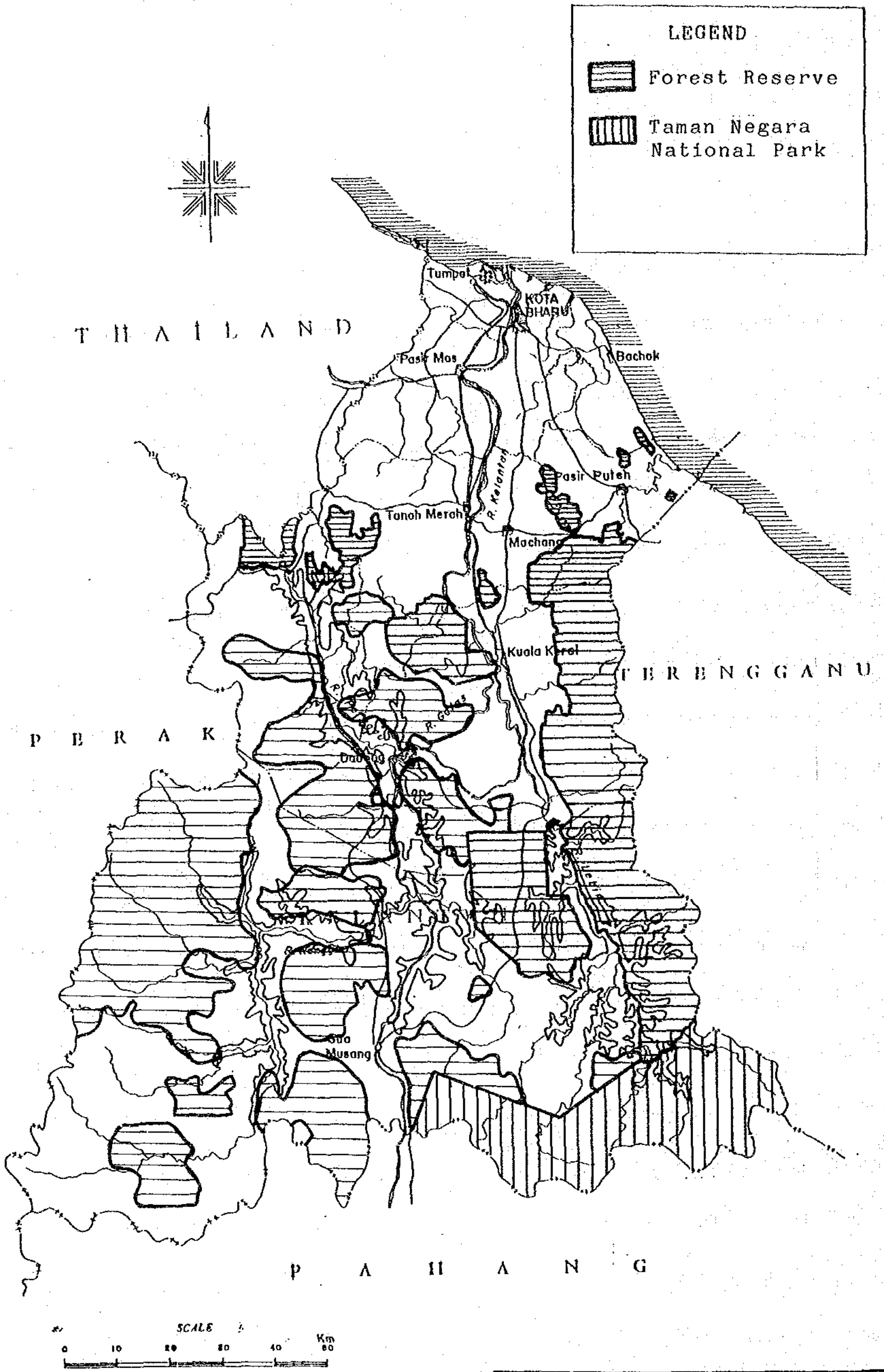

Fig.VII.2.7

Forest Reserve Area Map

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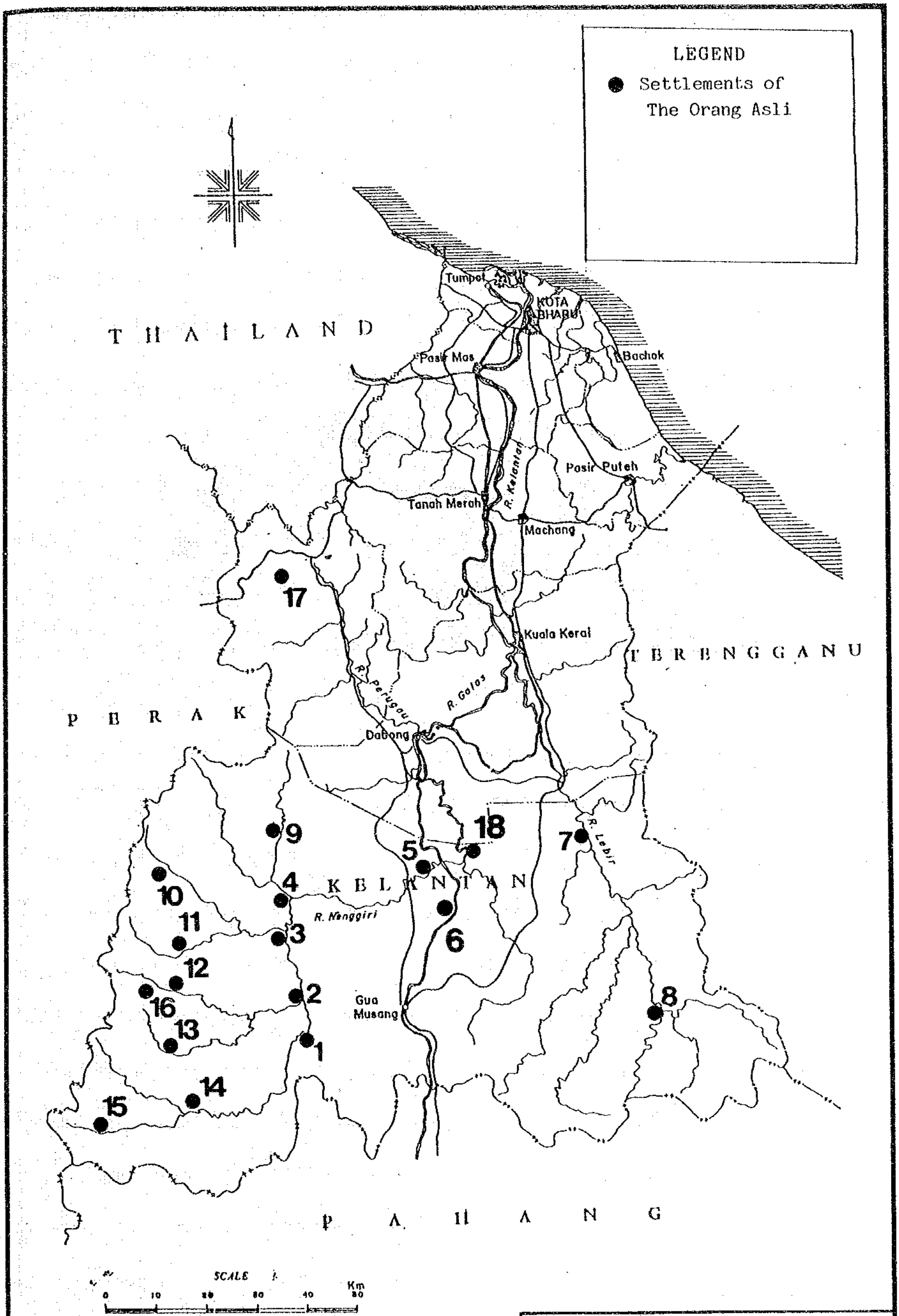

Fig.VII.2.8

Distribution Map of Orang Asli Settlements

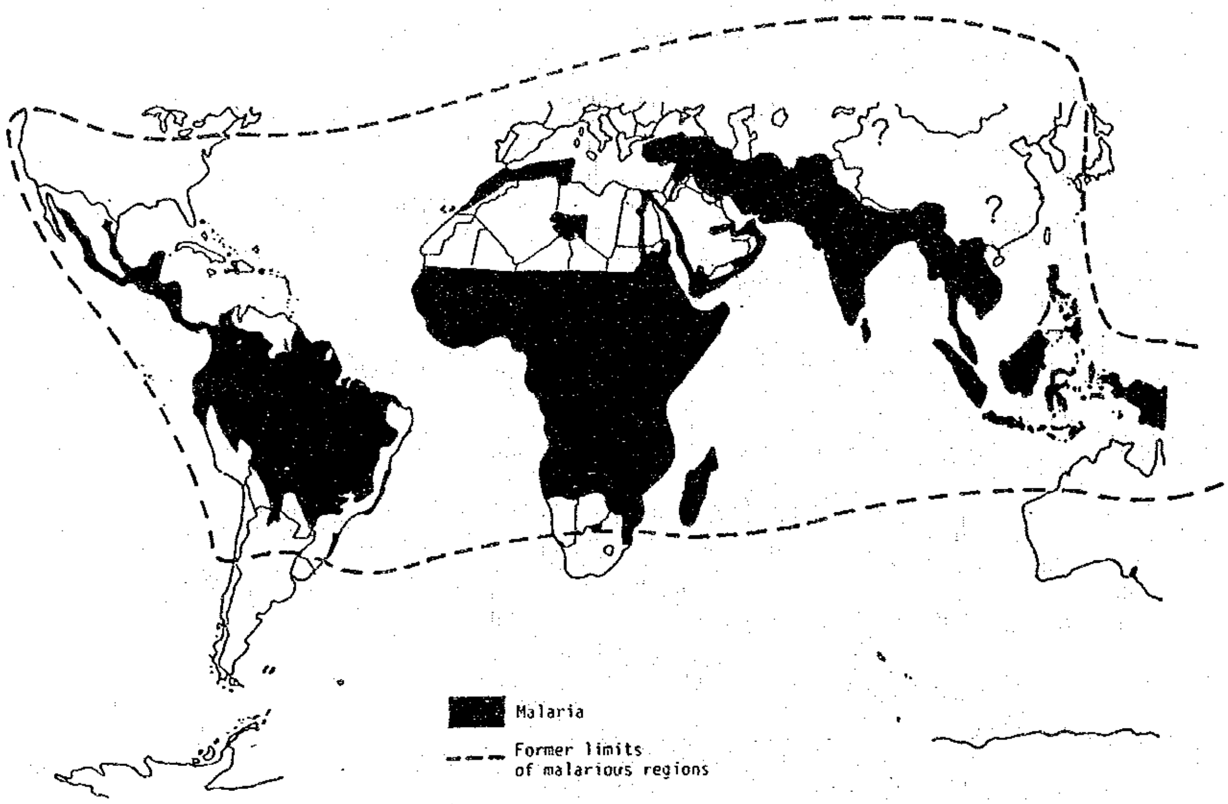

Fig.VII.2.9

Distribution of Malaria, Past and Present
(Source : WHO and Busvine (1975))

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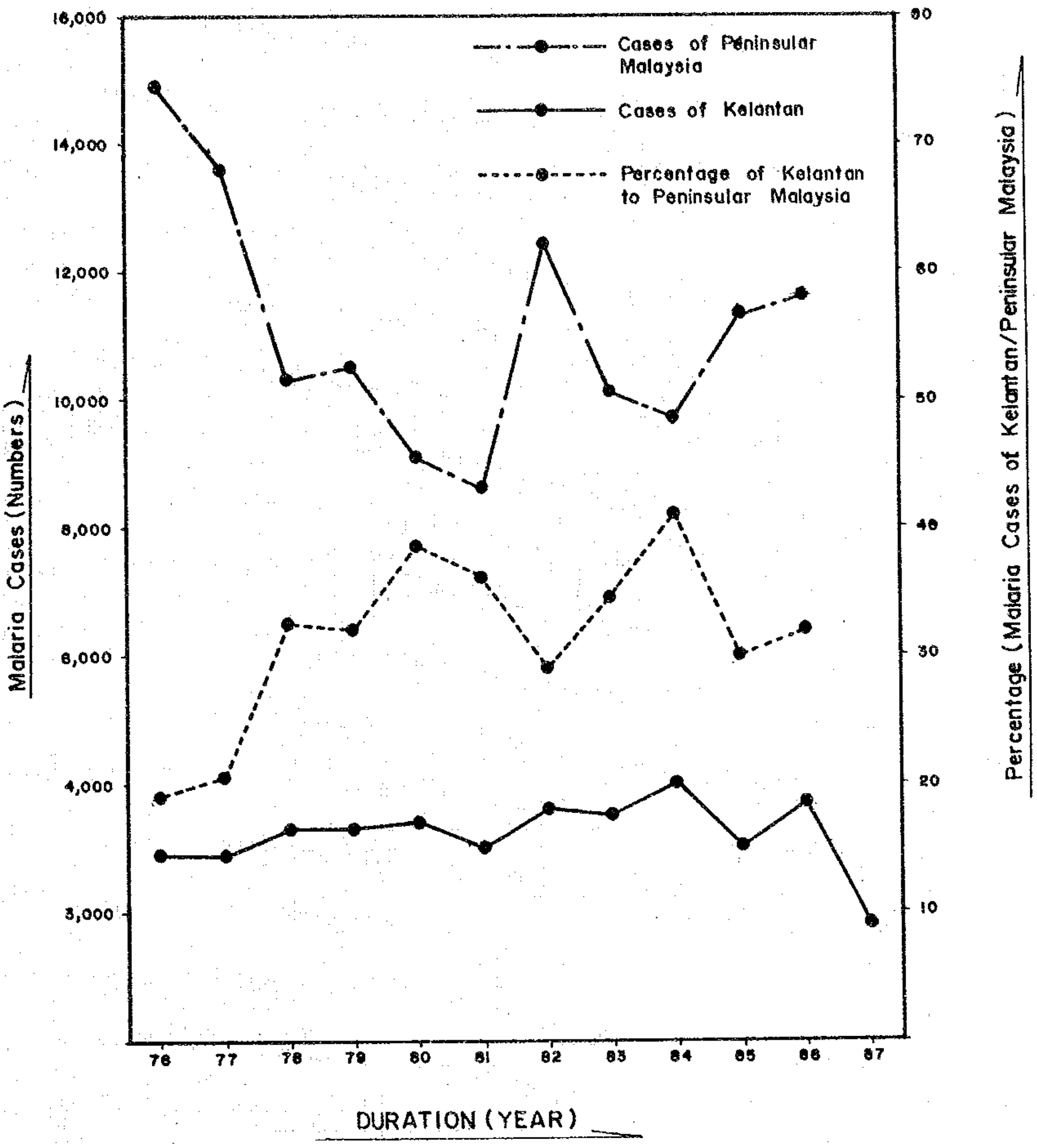

Fig.VII.2.10

Number of Malaria Cases at Peninsular Malaysia and the State of Kelantan

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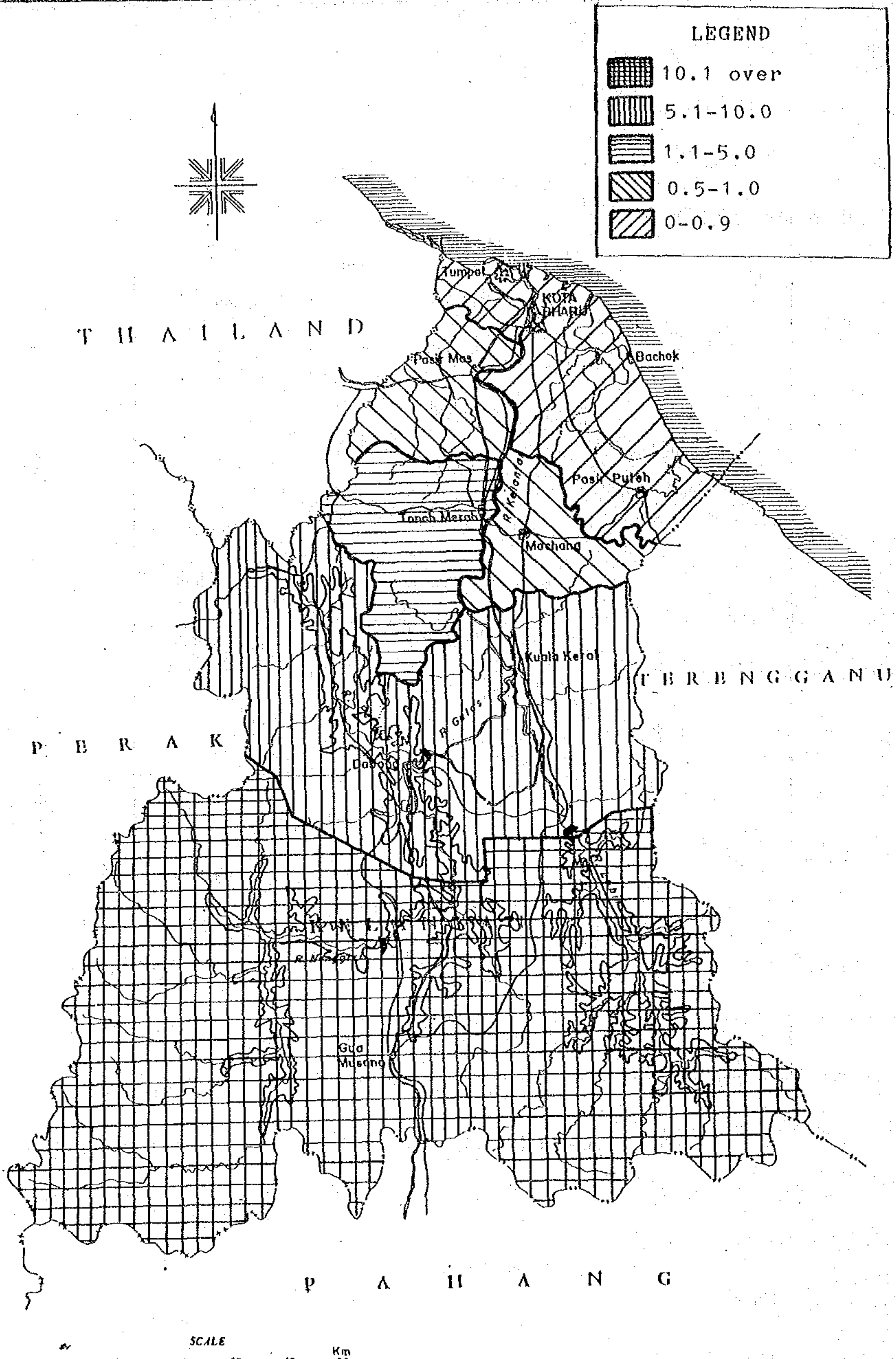

Fig.VII.2.11

Malaria Cases (per 1,000 population)

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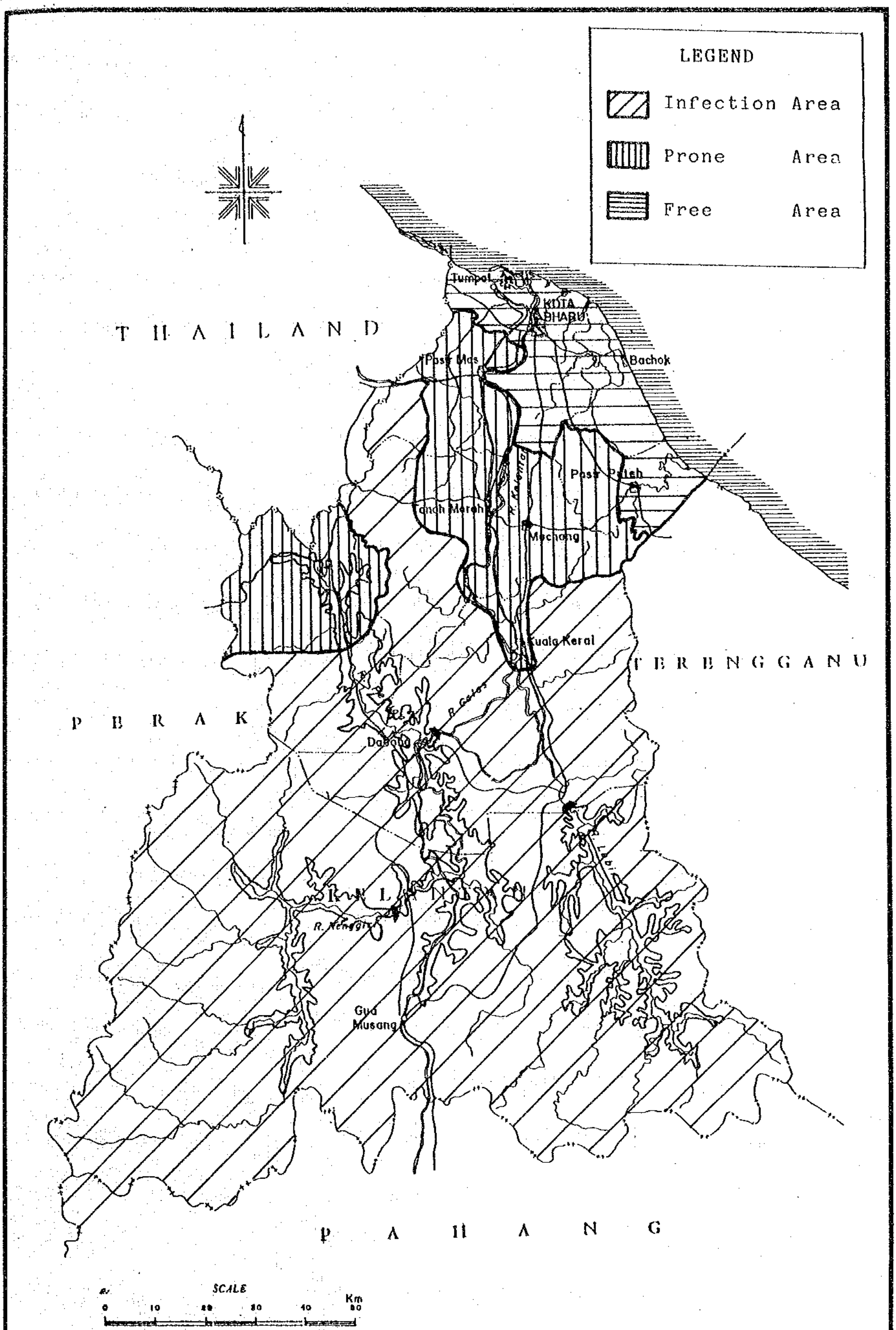

Fig.VII.2.12

Malaria Infection Area

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ANNEX VIII

STUDY
ON
FLOOD MITIGATION PLAN
WITH MULTIPURPOSE DEVELOPMENT

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VIII. STUDY ON FLOOD MITIGATION PLAN WITH MULTIPURPOSE DEVELOPMENT

1. INTRODUCTION

The Kelantan River basin with a catchment area of 13,100 km^2 lies in the northeastern part of Peninsular Malaysia, occupying more than 85% of the Kelantan State. The basin area is bounded by the State of Perak and Thailand on the west, by the State of Pahang on the south and by the State of Terengganu on the east. The northern part of the basin faces the South China Sea. A location map of the Kelantan River basin is shown in Fig. VIII.1.1.

The Kelantan River is divided into the Galas and Lebir rivers just at the upstream reach of Kuala Krai, about 100 km upstream from the river mouth. The Galas River is further divided into the Nenggiri and Pergau rivers. The Nenggiri River originates from the central mountain range in the southwestern part of the State of Kelantan, and flows down northeastward collecting many tributaries and changing its name to the Galas River.

The Galas River joins the Pergau River near Dabong, flows down eastward and joins with the Lebir River which originates from the Taban mountain range. After joining the Lebir River with the Galas River, the river changes its name to Kelantan and flows down northward passing along such major towns as Kuala Krai, Tanah Merah, Pasir Mas and Kota Bharu, finally debouching to the South China Sea near Kota Bharu. A total river length is about 360 km.

The topographic features of the Kelantan River basin are characterized by geological strata from north to south direction and it is formed by high mountaneous ranges in the eastern and western zones, which are extending from north to south direction, hilly area in the middle zone and flat area in the downstream reaches.

High mountains situated in the eastern and western parts of the basin consist mainly of granites which are intruded during the Palaeozoic-Tertiary period. They are massive and sound and shape the steep mountain slopes.

The hilly area in the middle zone is predominated by the Palaeozoic-Mesozoic rocks comprising sandstones, shales, limestones, tuffs and volcanics, which are very often regionally metamorphosed into phyllites and slates and further into crystalline schists. Particularly, phyllites, slates and schists are deeply weathered because of plenty of developed cracks and foliations. Limestone having strong resistance to weathering forms high pinnacles which are visually recognized easily.

Geological structure trends strongly north-south or northwestward. The axes of folding and major faults are also oriented in these directions.

The flat area of downstream reaches situated in about 40 km long endmost river stretches consists of the alluvial deposits comprising mainly sand, silt and clay and forms the soft ground. Coarse sand carried by the westward littoral current forms the dunes around the mouth of the Kelantan River and along the coastal area within 10 km inland from the coastline.

The Kelantan River basin is characterized by much rainfall. The annual rainfall in the basin is about 2,700 mm. Especially, much rainfall occurs in the northeastern part of the basin in the period from October to December due to the northeast monsoon which brings about a half of the annual rainfall amount.

The annual mean temperature is about 27^{o}C. There exists little seasonal variation around the annual mean, in spite of having 28^{o}C of the maximum temperature in May and 25^{o}C of the minimum temperature in December to January. The average relative humidity in the basin is about 81%. The mean annual discharge in the Kelantan River is about 570 m^3/sec at Guillemard Bridge.

Population of the Kelantan State is estimated at 1,091,800 as of 1988. North Kelantan comprising six Districts of Bachok, Kota Bharu, Machang, Pasir Mas, Pasir Puteh and Tumpat occupies 20% of area and 80% of population in the whole state. Whereas, South Kelantan consists of four Districts of Tanah Merah, Jeli, Kuala Krai and Gua Musang, covering 80% of the state area and 20% of the state population.

There are four major towns in the Kelantan River basin which are important in terms of location, population and population density; Kota Bharu, Pasir Mas, Tanah Merah and Kuala Krai. Their respective population in 1988 is estimated at 224,719, 23,145, 15,641 and 16,273. Also, their respective density of population in same year is calculated at 1,782, 1,165, 182 and 61 per km^2. They are all located in the flood prone area.

The total land area of the Kelantan State is 14,943 km^2 and the average density of population is 73 persons per km^2. The average growth rate of population for the past 8 years is estimated at 2.5%.

Total employees are 327,700 with 158,300 (48.3%) in the primary industry, 50,700 (15.5%) in the secondary industry and 118,700 (36.2%) in the tertiary industry. The GDP of Kelantan State for 1988 is estimated to be M$2,684.4 million. Thus, per capita GDP works out at M$2,459. The State economy has grown at the average annual rate of 6.1% during the past 8 years.

Out of the total land use area of 1,504,009 ha, 1,119,076 ha (74.4%) is covered with forest, while 320,583 ha (21.3%) for agriculture, 5,365 ha (0.4%) for urban and associated areas and 58,985 ha (3.9%) for other areas. Out of the total area of the agricultural land, 129,413 ha (40.4%) is used for rubber, 71,248 ha (22.2%) for paddy, 61,261 ha (19.1%) for oil palm and 58,661 ha (18.3%) for other crops.

The downstream lowland area in the basin has suffered from severe flood damages every year. The flood data show that the downstream area of more than 200,000 ha inundated up to the maximum depth of 6 m and about 540,000 of inhabitant has suffered from inundation at the flood time in 1967. It is reported that the duration of inundation lasted about 3 to 4 weeks in the longest period.

The flood mitigation facilities such as levee, revetment, groyne and so on to cope with such repeating inundation have only been constructed by JPT partly in the downstream stretches of the Kelantan River. These facilities are, however, insufficient to decrease flood damages.

In this Annex VIII, the following items are presented:

(1) Present river conditions,

(2) Basic concept for the formulation of flood mitigation plan in the basin, and

(3) Formulation of flood mitigation plans incorporating water resources and hydropower development.

The formulation of the flood mitigation plan in the Kelantan River basin is discussed stressing on water resources development as well.

2. RIVER CHARACTERISTICS AND FLOOD DAMAGE

2.1 Present River Conditions and Characteristics

The longitudinal profile of the river system in the Kelantan River basin is illustrated in Fig. VIII.2.1.

About 30 km long Nenggiri River stretches with an altitude of higher than EL.300 m have a steep slope of 1 to 30 to 1 to 40. The Nenggiri River flows down northward to northeastward in a V-shaped river channel passing through the mountaneous zones and joins the Galas River at about 180 km upstream from the river mouth. The river bed slope gradually changes from 1:100 to 1:1,000 in this river stretch. The river width in this stretch is less than 100 m.

After joining the Nenggiri River with the Galas River, the river changes its name to the Galas River, flows down northward and joins with the Pergau River at about 140 km upstream from the river mouth. The river bed slope in the stretch varies from 1:1,000 to 1:3,000. The river width is around 100 m. Afterward, the Galas River changes its direction to northeast, debouches to plain area changing the river channel from V-shape to U-shape and joins with the Lebir River at about 103 km upstream from the river mouth. The river bed slope in this stretch is around 1:4,000. The river width gradually increases from around 100 m to 400 m.

The Lebir River which originates from the southeastern mountaneous range flows down northwestward to the confluence with the Galas River and changes its river bed slope from around 1:200 to 1:4,000. The V-shaped river channel changes to U-shape after debouching to plain area at about 30 km upstream from the Galas confluence. The river width changes from less than 100 m to around 300 m.

After the confluence of the Galas and Lebir rivers, the river changes its name to the Kelantan River and flows down northward. The river bed slope in this stretch is about 1:6,000. The river channel forms a single cross-section with the width of about 300 m to 900 m and bankful depth of about 5 m to 15 m as shown below and further details are given in Fig.VIII.2.2:

Section	River width, m	Bankful depth, m
Estuary to Pasir Mas (25 km upstream from the estuary)	600 to 900	5 to 10
Pasir Mas to Tanah Merah (55 km upstream from the estuary)	500	10 to 12
Tanah Merah to Kuala Krai (101 km upstream from the estuary)	300	10 to 15

After the Kelantan River passes along the Kota Bharu town, it flows down about 8 km long stretch and divides into the main river channel to northern direction and several mesh-like river channels to northwestern direction to Tumpat. Large scale sand dunes are being developed at the river mouth from the east to west direction causing closure of the river mouth especially in the dry season.

The variation of the river bed in the Kelantan River was evaluated by the following data:

(i) The variation of lowest river bed elevation at Guillemard Bridge, and

(ii) The comparison between the cross sectional data in this Study and those in 1975 by ENEX.

Fig. VIII.2.3 shows the variation of lowest river bed elevation at Guillemard Bridge. The data show that the river bed elevation is quite stable. Although the degradation of river bed was caused by the flooding, the sediment deposits supplying from the upstream basin have gradually aggraded the river bed.

The variation of the river bed in the Kelantan River was also tried to see by comparing the river cross-sections surveyed with an interval of 1 km in this study with the ones prepared by ENEX in 1975 with an interval of 5 km. It was clarified in the comparison of these river cross-sections that the variation of the river bed was little observed in the further upstream reaches.

As for the river bed material, the samples were collected at Kuala Krai, Pasir Mas and the river mouth. As shown in Fig. VIII.2.4, the results of sieve analysis show that the river bed material consists of the coarse sand with a median grain size of about 1.2 mm at the river mouth and Pasir Mas and of about 1.8 mm at Kuala Krai.

The comparison of the topographic map prepared in 1955 to 1967 and aerial photograph shot in 1974 to 1976 shows that the sand dune in the river channel varies remarkably in the downstream stretch from Pasir Mas. This comparison also shows that the river channel of the Kelantan becomes wider at the river mouth, the direction of the river mouth shifts westward probably due to the effect of the littoral current, and the original river mouth is being closed by the littoral sand dune.

An island called P. Dollah located at the endmost of the Kelantan River bifurcates its main channel into two; one channel toward Kuala Besar and the other toward Kuala Suri as shown in Fig. VIII.2.5. According to the topographic maps prepared in 1955 to 1967, both channels flow in the South China Sea separately. It is observed that sand dunes are not developed in front of both channels and that the channel toward Kuala Besar has a wider channel than that of Kuala Suri. Furthermore, the flow direction of the Kelantan River goes toward Kuala Besar.

Taking into consideration the above facts, the channel toward Kuala Besar is judged to have had a larger function to release flood water than that toward Kuala Suri.

Aerial photographs shot in 1974 to 1976 show such drastic change that the sand dunes developed from the right bank of Kuala Besar extend upto the front of Kuala Suri passing behind P. Dollah. Furthermore, aerial photographs shot in 1980 to 1985 depict further development of sand dunes toward west.

The reconnaissance to the estuary in 1988 observes that the sand dunes in front of Kuala Besar are opened to the South China Sea in spite of narrow width and that the remaining split sand dunes are connected with P. Dollah. Although the endmost of the Kelantan River returns to the condition with two channels toward Kuala Besar and Kuala Suri as observed in the map of 1955 to 1967, clogging of the river channel is still serious.

The 1988 floods occurred on November and December flushed away the sand dunes developed in front of Kuala Besar, resulting in the wider channel at the endmost reaches of the Kelantan River. The formation of sand dunes is however expected to develop at the estuary by the force of westward littoral current in near future, unless the Kelantan River flow with strong tractive force, flood, will arise.

Flow capacity of the Kelantan River by means of non-uniform flow calculation was computed using the cross-sectional maps with an interval of 1 km newly prepared in this study. There are several places where the present bankful flow is less than 5,000 m^3/sec in the downstream reaches of Pasir Mas as illustrated in Fig. VIII.2.6, and the present bankful flow at several major points is summarized as follows:

River stretch	Flow capacity (m^3/sec)
Kota Bharu	4,500
Pasir Mas	6,600
Tanah Merah	10,200
Guillemard Bridge	11,000
Kuala Krai	10,500

It is noted that the bankful flow at Kuala Krai shows the capacity of opposit river bank of town area, since inundation takes place at the opposit bank of Kuala Krai at first. Thus, Kuala Krai is free from the bigger flood than 10,500 m^3/sec.

According to the frequency analysis of flood discharges recorded at Guillemard Bridge, flood with peak discharge of greater than 5,500 m^3/sec occurs almost once in two years. It can therefore be said that the Kelantan River inundates more frequently than once in two years.

2.2 Existing Flood Mitigation Facilities and Plans

2.2.1 General

The flat areas in the downstream reaches of the Kelantan River have suffered from habitual inundation mainly due to overtopping of flood water from the Kelantan River channel. To cope with such repeating inundation, JPT has worked out several flood mitigation plans and implemented the flood mitigation works at several places in the downstream stretches of the Kelantan River. This section presents the situation of the flood mitigation works and plans promoted by JPT.

2.2.2 Existing flood mitigation facilities

The existing flood mitigation facilities executed by JPT are shown in Fig. VIII.2.7.

To prevent the flood flow in the Kelantan River from overflowing to the Kemubu irrigation area, an about 10.5 km long trapezoidal levee of 4 to 5 m in crest width and 1.5 to 2 m in height was constructed in the right bank downstream from the Kemubu pumping station in 1971. Although the levee is cut in several places to make access roads to the Kelantan River, the levee structure is still in a good condition at present. Following this work, an about 1.8 km long revetment comprising sheet piling and foot protection by concrete and stone piling was constructed to protect the left river bank where the river sharply meanders along the Pasir Mas town in 1972. It seems that this work is effective for the prevention of bank erosion in this sharply bent river channel, but a part of the revetment is falling down to the river side at present.

In order to prevent flood water in the Kelantan River from overflowing into the Lemal irrigation scheme, an about 3 km long and 2 to 3 m high levee was constructed in 1984 just at the opposite side of the Kota Bharu town.

In 1986, Kedai Buloh river protection work comprising the stone pitching groyne and revetment with stone piling was constructed for about 800 m long stretches to protect the river bank against bank erosion in Kedai Buloh village at about 3 to 4 km upstream from the river mouth. Besides, tendering work to construct an about 1.2 km long revetment in this stretch is being carried out by JPT.

Temporary river bank protection work by means of sand bag piling was executed in 1987 to protect sandy river bank from severe erosion in the left river bank at about 3 to 4 km downstream from Kota Bharu and tendering work to construct the permanent bank protection work is being carried out.

The river mouth of the Kelantan River is shifting westward due to the closure by sand bar. In order to improve the navigation condition at the river mouth portion, JPT executed about 200 m long open cut work with the trapezoidal shape of about 5 to 6 m in bottom width in 1983 to cross this sand bar to the South China Sea. However afterward, this open cut channel was buried by a littoral current and the river mouth is shifting westward at present.

To prevent the flood flow in the Golok River from overflowing to the Malaysian side, an about 17 km long levee was constructed in 1960 in the stretch upstream from river mouth. However, a road with higher embankment, which has a function of the levee, was thereafter constructed in the Thailand side, and consequently flood water overflowed the levee flows into the riparian area of Malaysian side at present.

2.2.3 Flood mitigation plan

Several flood mitigation plans were proposed for the Kelantan River basin in past. The basin-wide flood mitigation study was carried out by ENEX in 1977. In this study, conceivable damsites for flood mitigation were selected and flood mitigation effect was studied by combining several promising dams. To mitigate flood damages in the downstream plain area of the basin, it was recommended to implement the Dabong multipurpose dam scheme and about 60 km long levee embankment work in the upstream stretches from the river mouth. However, a concept for the design flood scale and a relation between the dam and river improvement on the flood mitigation effect are not made clear.

In 1982, National Water Resources Study, Malaysia was carried out by JICA aiming mainly at utilization of river water for irrigation use, hydroelectric power generation, municipal and industrial demands and so on. In this planning, a flood mitigation study in the Kelantan River basin was preliminarily carried out and implementation of the Dabong and Lebir dam schemes was recommended for the flood mitigation of the downstream reaches.

On the other hand, the hydroelectric power development study was performed for the Galas and Lebir rivers. In the Galas River, a feasibility study on Nenggiri dam project was made in 1986 by NEB incorporating flood mitigation effect to the downstream stretches. In the Lebir River, the feasibility study on the Lebir dam project including flood mitigation is being performed by JICA. However, flood mitigation effect for the river stretches up to Kota Bharu is not yet made clear in the study on the Nenggiri and Lebir dam projects as well as the Dabong dam project by ENEX.

In order to protect the Kota Bharu town from flood water overtopping the river bank of the Kelantan, a 44 km long levee embankment plan is being worked out by JPT. The design concept of this plan is as follows:

Design flood	:	10,000 m^3/sec
Location of levee	:	Kg. Semut Api (the Kelantan delta) to Kemubu

Type of levee	:	Earth embankment
Dimension	:	Trapezoid with the slope of 1:2 to 1:3 on both sides and top width of 3m to 10.7 m
Freeboard	:	0.9 m
Construction cost	:	M$77.3 million (1981 price).

It is noted that this works is based on the premise that the Dabong and Lebir dams proposed by ENEX will be constructed in an early stage.

2.3 Past Large Floods and Damage

2.3.1 Past large floods

Floods with a magnitude of more than 5,500 m^3/sec occur almost once in two years in the downstream stretches. Among them, the floods occurred in 1967 and 1983 have relatively sufficient data, including hourly rainfall records and data for inundation phenomena.

On 2nd January 1967, heavy rainfall occurred and lasted up to 7th January in the entire Kelantan River basin. The recorded maximum daily rainfall was 585 mm at JPT store, Kota Bharu and 420 mm at Machang P.S. Flood peak discharges at the major gauges were 3,400 m^3/sec at Chegar Atas, 8,700 m^3/sec at Dabong, 4,200 m^3/sec at Tualang and 16,000 m^3/sec at Guillemard Bridge. On 4th January, flood water overtopped the bank of the Kelantan River and the entire coastal plain was inundated. Most of the Kota Bharu town was under water at night time on 4th January.

On 1st December 1983, rain started and lasted up to 15th December in the entire basin area. The maximum rainfall occurred during 3th to 5th December. The recorded maximum daily rainfall was 290 mm at Machang and 270 mm at Kuala Krai. Flood water overtopped the river bank, and the Kota Bharu town inundated on 5th December. Flood peak discharges were about 1,900 m^3/sec at Chegar Atas, 6,000 m^3/sec at Dabong, 4,000 m^3/sec at Tualang and 12,000 m^3/sec at Guillemard Bridge.

The floods with double peaks hit the downstream area on November and December of 1988, causing considerable damage. A detail survey for these floods is discussed in the separate Volume (Part III).

2.3.2 Flood damage

A large magnitude flood in 1967 caused heavy flood damages in the downstream plain areas of the Kelantan River basin. The flood damages exert not only to the destruction of houses, losses of properties and damages to the social infrastructures but also to the loss of lives especially in the riparian areas.

Such major towns along the Kelantan River as Kuala Krai, Tanah Merah, and Pasir Mas were inundated at the beginning of January 1967. In the river stretches along Kota Bharu, flood water overtopped the Kelantan River bank on 4th January and inundated gradually the town area. The maximum inundation depth reached about 4 m in the lowest area on 6 to 7th January. The inundation lasted for about 4 to 5 days in the most of the town area and 3 to 4 weeks in the lowest area.

The inundation area at the flood time in 1967 was about 297,900 ha. The flood report, January 1967 states that about 537,000 persons were affected by the flood, about 125,000 persons evacuated from the lowland area and death toll went up to 38 persons in total. It is reported that flood damages in 1967 were about M$30 million in total in the State of Kelantan. Among them, the damage for agricultural crop is estimated at around M$14 million. Among about 17,400 ha of irrigation schemes, 2,800 ha of the acreage corresponding to about 16% of the scheme areas were damaged.

Since December 1966, the Golok River and its tributaries were already in a spate condition and river water partly overtopped the river bank. On 5th January 1967, flood water of the Golok River overtopped the river bank in its entire stretch and inundation depth reached 1.5 m at the Rantau Panjang town and 4.3 m at Kuala Jambu. Overtopped flood water flowed down to the South China Sea at the coast between Tumpat and the river mouth of the Golok River inundating the plain area in the right bank of the Golok River.

The flood occurred in December 1983 also caused damages in the downstream area of the basin. On 4th December, most of the towns along the Kelantan River stretches inundated due to overtopping of flood water. The maximum inundation depth reached about 1 m in Kuala Krai and Tanah Merah, 0.9 m in Pasir Mas and 2.6 m in Kota Bharu. The inundation lasted for about one week in the most of the area in Kota Bharu. The inundation area in the basin amounted to about 60,700 ha and about 27,000 persons in the riparian area along the Kelantan River were affected by the flood. The estimated flood damage in the basin is around M$11.4 million comprising M$3.5 million for agricultural crops, M$0.5 million for livestocks and poultry, M$1.0 million for houses, properties and business and M$6.4 million for public services and facilities.

2.4 Existing Structures along the River Stretches

The structures such as bridges, pumping stations, jetties for small fishing ships and so on are located along the Kelantan River and its tributaries as shown in Fig. VIII.2.8.

There are three roadway bridges crossing over the Kelantan and Lebir rivers, connecting with the national road networks. They are Sultan Yahya Putra Bridge crossing at Kota Bharu, Tanah Merah Bridge upstream of the Tanah Merah and a bridge crossing over the Lebir River at about 30 km upstream from the Galas confluence. The superstructures of these bridges are of concrete type and their substructures are constructed by concrete piles or concrete pier structures. A roadway bridge is under construction at Pasir Mas. Furthermore, JKR has a plan to build a roadway bridge at Dabong.

There are four railway bridges crossing over the Kelantan River and its tributaries. They are Guillemard Bridge crossing over the Kelantan River at 15 km upstream of Tanah Merah: Others are on the Galas, Lebir and Nenggiri rivers. The superstructures of these railway bridges are steel truss type and their substructures are concrete pier structures. The scouring at the bottom of the substructures and at both banks in the up and downstream sides of the bridges is not found at present. The features of these bridges are given in Table VIII.2.1.

To supply river water for irrigation use, four pumping stations connected with the main irrigation canals are provided in the downstream reaches of the Kelantan River (refer to Fig. VIII.2.8). They are Kemubu and Lemal pumping stations in the right bank upstream from the Pasir Mas, and Salor and Pasir Mas pumping stations in the left bank up and downstream of the Pasir Mas. There exists a pumping station for water supply of Tanah Merah. The features of these pumping stations are listed in Table VIII.2.2.

There are several wooden-made jetties on the downstream reaches near the estuary. Those are used for unloading the marine products carried by small ships. A jetty is under construction by the Fishery Development Board at Kg. Che Latiff near the estuary (refer to Fig. VIII.2.8). The dredging works with a scale of 5 m deep and 90 m wide is included as part of the project to ensure the access of fishing ships from the sea to the jetty. Dredging of the clogged river mouth will have not only the ensurance of navigation canal, but also advantageous effect for flushing flood discharge.

2.5 Existing Flood Forecasting and Warning System

Considering the current situation of flood mitigation facilities in the Kelantan River basin, one of the most effective means of flood-damage reduction is the emergency evacuation of the threatened area. A flood forecasting and warning system to make ease the evacuation of the threatened area was introduced for the entire Kelantan River basin in 1971, and was renewed in 1986.

Fig. VIII.2.9 depicts a flow chart of the flood forecasting and warning system established in the Kelantan River basin. Rainfall and water level data from the telemetric stations, six for rainfall and seven for water level, are sent to DID Flood Operation Room in Kota Bharu, a key station of the telemetric system, via a relay station at Bukit Bakar as shown in Fig. VIII.2.10.

In case that water level is higher than El.65 feet (Alert level of warning discussed hereinafter) at Kuala Krai and that rainfall occurs in the upper basin, a water level forecast is carried out using Tank Model and the correlation diagram of water levels as shown in Fig. VIII.2.11 by the hydrologist of DID Flood Operation Room in Kota Bharu. It is noted that water level forecasts were carried out by DID Flood Forecasting Centre in Kuala Lumpur by 1986 before a personal computer is mounted in DID Flood Operation Room of Kota Bharu. Data transfer between Kota Bharu and Kuala Lumpur was based on telex.

In case that the water level forecast shows the possibility of flood occurrence in the downstream reaches of the Kelantan River, information is transferred to the State Flood Warning Committee, which issues the warning of three levels to the threatened area according to the magnitude of flood; Alert (Water level is higher than El.65 feet at Kuala Krai), Warning (higher than El.75 feet) and Emergency (higher than El.85 feet).

According to the flood reports, the warning of emergency level was issued eight times after the installation of flood forecasting and warning system in 1971 including 1988 flood, and inhabitants in the threatened area of flood evacuated to safe places such as schools following the guide of police without chaos.

The telemetric system including the maintenance of stations is well operated, however, the current problem is that DID Flood Operation Room of Kota Bharu has only once carried out the water level forecast by themselves due to only one big flood since their task started.

The prediction of flood runoff in the existing flood forecasting and warning system relies on data from six rain gauges installed in the Lebir, Galas and Pergau river basins (refer to Fig. VIII.2.10). It is proposed in this circumstance to install new rain gauges in the Nenggiri River basin for enhancing the accuracy in predicting flood runoff.

The water level coming 6 hours later at Kuala Krai is estimated in the existing flood forecasting and warning system. Considering the travelling time of about 4 hours between Kuala Krai and Tanah Merah and 12 hours between Kuala Krai and Kota Bharu, 10 hours are only allowed for the evacuation of inhabitants in Tanah Merah, while 18 hours for Kota Bharu. In order to increase the security of evacuation, it is proposed to predict water levels at the Dabong and Kg. Tualang stream gauges besides those at Kuala Krai.

3. BASIC CONCEPT FOR THE FORMULATION OF FLOOD MITIGATION PLANS

3.1 General

Inundations take place over the vast plain in the downstream reaches of the Kelantan River basin. It is deemed impractical from the viewpoints of economic effectiveness and budgetary fund to realize perfect flood mitigation works for the entire stretches of the large river system. Therefore, it should be contemplated to mitigate flood damages to a practical extent by adopting structural and non-structural measures.

The structural measures will be adopted in due consideration of their economic effectiveness, safety of livelihood of the riparian people and social urgent requirement. In application of the structural measures, a high target level of protection as much as possible would be desirable to adopt for the safety of facilities, long term stability and livelihood of the riparian people concerned. However, a large amount of construction costs and a long construction period will be needed for realizing the high target level plan. In order to realize the flood mitigation plan as early as possible and to meet with the social urgent requirement, stage-wise flood mitigation plans have to be contemplated.

The non-structural measures will be contemplated to supplement the structural measures and/or to the flood prone areas where the structural measures are not adopted.

A pre-feasibility study to be carried out in the following stage will be made for the structural measures.

3.2 Protection Areas from Flood

3.2.1 General

It is contemplated to select the objective areas for flood mitigation by the structural measures by means of damage potential indicated by amount of flood damage and inundation population. The selection criteria for protective river stretches are presented as follows.

3.2.2 Division of flood analysis area by river stretch

In order to carry out the study on the flood analysis and the selection of flood protection priority areas, the Kelantan River stretches along the flood prone areas are divided as follows:

KL 1 : About 2.5 km long river stretch from the river mouth

KL 2 : 2.5 km from the river mouth to 5 km downstream of Kota Bharu

KL 3 : 5 km downstream of Kota Bharu to 4.4 km upstream of Kota Bharu

KL 4 : 4.4 km upstream of Kota Bharu to 3.2 km downstream of Pasir Mas

KL 5 : 3.2 km downstream of Pasir Mas to 3.2 km upstream of Pasir Mas

KL 6 : 3.2 km upstream of Pasir Mas to 18 km downstream of Guillemard Bridge

KL 7 : 18 km downstream of Guillemard Bridge to 5.7 km downstream of Guillemard Bridge

KL 8 : 5.7 km downstream of Guillemard Bridge to 3.8 km upstream of Guillemard Bridge

KL 9 : 3.8 km upstream of Guillemard Bridge to 13.9 km upstream of Guillemard Bridge

KL 10 : 13.9 km upstream of Guillemard Bridge to 9.5 km downstream of Kuala Krai

KL 11 : 9.5 km downstream of Kuala Krai to 1.9 km downstream of Kuala Krai

Kl 12 : 1.9 km downstream of Kuala Krai to the confluence of the Galas and Lebir rivers.

The river stretches thus divided are shown in Fig. VIII.3.1.

3.2.3 Selection criteria for priority protection areas

To know the degree or level of importance for the flood prone areas along the respective divided stretches, a preliminary selection of priority areas was made under the following criteria:

Area/place to be selected: Division by river stretch

Selection criteria : Priorities given by damage potential of each stretch (damaged value and population in the inundated area per km and per km^2)

Proposed structure : River improvement.

Increase of the population and flood damage potential due to future land use is considered for this preliminary selection. The river stretches classified as Level-1 are the most important protective area, followed by Level-2 and 3. Based on this classification, a protective river stretch was selected considering the degree of safety for the riparian area against