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A STUDY ON
RIVER BANK EROSION ALONG
BATANG RAJANG
AND
ITS DISTRIBUTARIES

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By

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Summary

River bank erosion along Batang Rajang and its distributaries has caused increasing concern to the local population. A study made on the erosion which has occurred during the past 12 years shows that about 10 to 20 percent of the best alluvial soils which presently support a large agricultural population has been eroded during this period. At this rate of erosion, it is likely all the suitable alluvial soils of the Rajang River will be completely lost within 50 to 100 years. It is thought that fast passenger boats as well as other similar vessels are largely responsible.

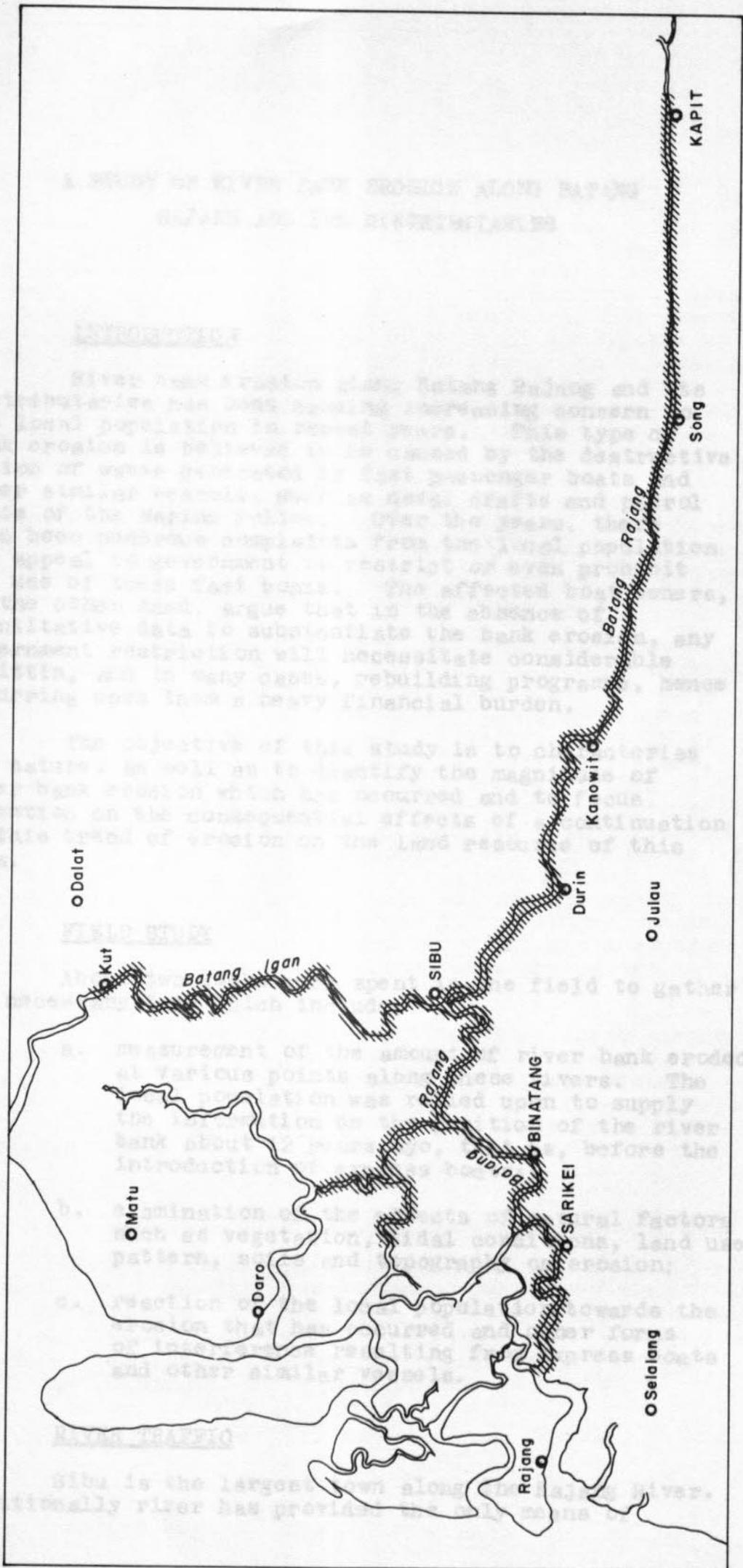


FIG. 1: LOCATION

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A STUDY ON RIVER BANK EROSION ALONG BATANG
RAJANG AND ITS DISTRIBUTARIES

1. INTRODUCTION

River bank erosion along Batang Rajang and its distributaries has been causing increasing concern to the local population in recent years. This type of bank erosion is believed to be caused by the destructive action of waves generated by fast passenger boats and other similar vessels, such as naval crafts and patrol boats of the Marine Police. Over the years, there have been numerous complaints from the local population and appeal to government to restrict or even prohibit the use of these fast boats. The affected boat owners, on the other hand, argue that in the absence of quantitative data to substantiate the bank erosion, any government restriction will necessitate considerable refitting and in many cases, rebuilding programme, hence incurring upon them a heavy financial burden.

The objective of this study is to characterise the nature, as well as to quantify the magnitude of river bank erosion which has occurred and to focus attention on the consequential effects of a continuation of this trend of erosion on the land resource of this area.

2. FIELD STUDY

About two weeks were spent in the field to gather the necessary data which include:

- a. measurement of the amount of river bank eroded at various points along these rivers. The local population was relied upon to supply the information on the position of the river bank about 12 years ago, that is, before the introduction of express boats;
- b. examination of the effects of natural factors such as vegetation, tidal conditions, land use pattern, soils and topography on erosion;
- c. reaction of the local population towards the erosion that has occurred and other forms of interference resulting from express boats and other similar vessels.

3. RIVER TRAFFIC

Sibu is the largest town along the Rajang River. Traditionally river has provided the only means of

communication between Sibul and other towns up or down river. During the last decade, increase in prosperity in this region, brought about largely by the growth in timber industry, has triggered off revolutionary changes in river transport. Fast passenger boats, locally known as express boats or just expresses, were introduced some 12 years ago. These boats are powered by engines of 300-700 horse powers and are capable of travelling more than 20 miles per hour. The travelling time between Sibul and other riverine towns has been greatly reduced. It took nearly ten hours to travel from Sibul to Kapit in the past and now it takes less than four hours.

The largest number of these passenger boats operates between Sibul and Sarikei where one boat leaves every hour. There are three or four boats operating between Sibul and Kanowit, two up to Kapit and the same number to Daro and Oya via the Kut Canal.

It has been generally believed that these passenger boats have been providing a useful communication service to the local population living along these rivers. However, our interviews from a reasonable large number of people showed otherwise. The local people who are largely farmers still prefer the old, slower launches because the fares are about half of those of the express boats and more important, these slow launches can also carry their farm produce. Although the journey takes twice as long, time is an endless element which the local people can well afford. It would appear that these express boats exist mainly to provide service for communities living at the terminal points like Binatang, Sarikei and Kapit and the majority of the farming population along these rivers are not dependent on it for communication.

Other fast boats operating along these rivers include naval crafts, marine police patrol boats, trawlers and ocean-going ships. All these vessels, generate waves which are equally, if not more destructive than the passenger boats except that they travel less frequently on these rivers.

4. CHARACTERISTICS OF RIVER BANK EROSION OBSERVED

Based on the field observation and a consideration of the soil and land use pattern, the rivers studied may be divided into five sections, each being characterised by having similar association of vegetation and land use, soils, terrain, tidal conditions and erosion pattern. In the following, the important features of each section are briefly described.

4.1. Lower River Section

This section corresponds to the river downriver from Binatang on the Rajang River or downriver from Rantau Panjang on the Igan River. The river section is characterised by having a dominantly nipah and mixed swamp forest vegetation, which gives way to mangrove forest downriver. The soils along these rivers consist of a narrow strip of poorly drained, weakly to strongly saline clay backed by extensive deep peat swamp. Padi with some coconut are the important crops grown along the river bank but a large part of the river bank is still covered by the natural vegetation types mentioned. This section of the river is subjected to daily tidal fluctuation. During high tide, the river water is almost level or may even overtop the bank and during low tide, the river level is some five feet below the river bank. In this river section, bank erosion is partly influenced by the fluctuating river level and on the protective action of vegetation. During high tide wave erosion is considered to be most severe only in areas devoid of vegetation, while the presence of vegetation such as nipah, mangrove and 'rangas' offers adequate protection against wave action. Along Batang Lebaan, erosion is severe only along those parts exposed by padi cultivation or settlements, elsewhere where there is vegetation cover, very little erosion is observed. The erosion is caused mainly by ocean-going ships which used this river since 1961. At low tide, wave action is concentrated at the zone below the normal rooting depth, and causes collapse of the vegetation and rooted soil. The presence of vegetation like nipah provides no protection to wave erosion during low tide. In this river section, the usefulness of vegetation against wave erosion is greatest during the high tide and becomes ineffective during low tide. To fully exploit this condition, it would be ideal if boats could be regulated to operate during high tide and more trees to be planted along unprotected river bank.

4.2. Lower to Mid-River Section

This section corresponds approximately to that part of the Rajang River between Binatang and Durin. The levee alluvium in this section is more extensive with average width of 1,000-1,500 feet along both river banks and backed by extensive peat swamps. A large part of this area is under rubber with some smaller areas under fruit trees, padi, pepper and annual crops. The land use of this part is much more intensive than the lower river section, because of the better soils, which are dominantly imperfectly drained to moderately well drained deep clay loam or clay. The tidal condition is similar to that of the lower section, but with slightly greater daily tidal fluctuation of 5-10 feet. The intensity of wave erosion is considered to be much greater than

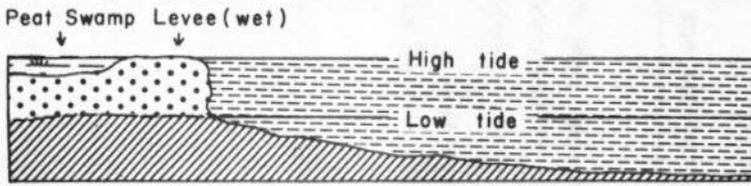


FIG. 2a. Lower river section : flood plain
Narrow levee alluvium, permanently wet;
bank subjected to daily erosion between low and high
tides. (Section corresponds approximately to Binatang
and downriver)

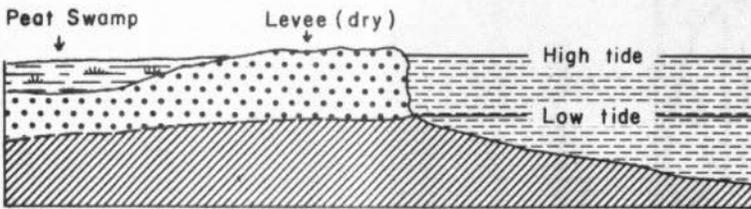


FIG. 2b. Lower - middle river section : flood plain
Extensive levee alluvium, mainly dry and highly erodible;
bank subjected to daily erosion between low and high
tides (Section corresponds approximately to
Durin - Binatang)

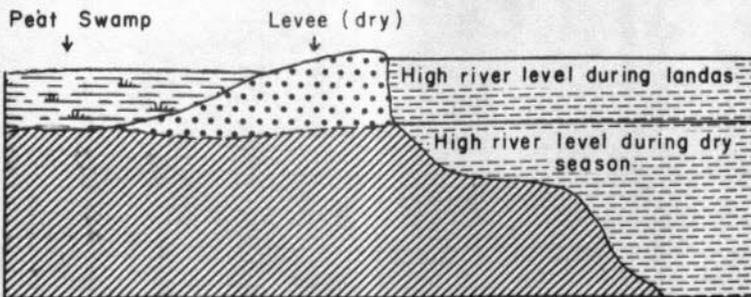


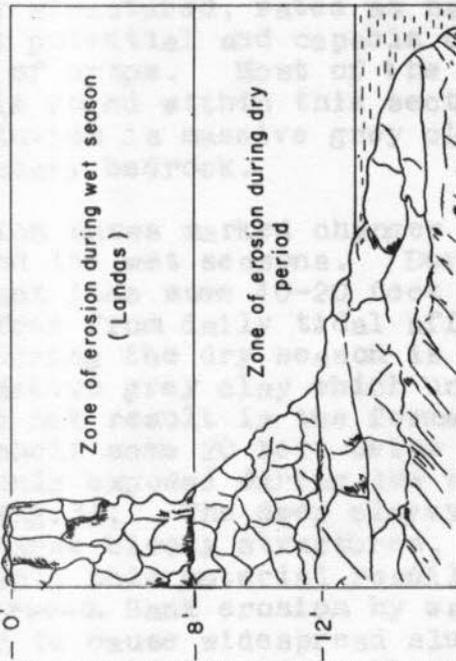
FIG. 2c. Middle river section : flood plain
Deep narrow levee alluvium backed by peat swamp;
river bank erosion is seasonal and occurs mainly
during landas. (Section corresponds approximately
to Durin - Song)

The lower river section in this section is made up of individual bars and channels. Front and vegetation are conspicuous. The improve or almost all the instead of permanently and are therefore soon replaced by shallow shelf for sand.

4.3. Mid-Delta

This section covers plain between the river levee that is less than 1,000 feet wide on both banks, and the levees are well-irrigated, with the highest agriculture supporting a wide range along the Rajahmundry. Underlying this deep alluvium is hard granite.

This river section level between the dry and wet seasons, the river level and the action of wave erosion to undermind of the deep alluvium. The wide, gently sloping River bank, and in some during the dry season alluvium probably the river level during the action of the waves and is undermind of the deep alluvium.



Weakly structured deep clay loam to clay above tidal zone during dry period but severely eroded during landas when river level is high.

Massive clay, permanently wet, erosion occurs mainly during dry period when river level is low.

Eroded shelving bank partly submerged and steepened by river current.

Fig. 3 : Riverbank section near Durin showing the zones of erosion during the dry and wet seasons.

the lower river section for two reasons: firstly, this section is under more intensive cultivation, with individual farm holdings spreading out along the river front and vegetation consisting mainly of rubber trees are considered less effective against erosion than mangrove or nipah and secondly, the soils are moist instead of permanently saturated, and less massive, and are therefore more erodible. The eroded bank is replaced by shallow shelf which is partly exposed during low tide.

4.3. Mid-River Section

This section covers the important mid-river flood-plain between Durin-Kanowit. Deep levee alluvium of less than 1,000 feet wide occurs as a narrow belt along both banks, and this is backed by peat swamp. The soils are well-drained, weakly structured, rated as having the highest agricultural potential and capable of supporting a wide range of crops. Most of the pepper along the Rajang River is found within this section. Underlying this deep alluvium is massive grey clay which in turn overlies sedimentary bedrock.

This river section shows marked changes in the level between the dry and the wet seasons. During the dry season, the river bank lies some 10-20 feet above the river level and is free from daily tidal affect. The action of wave erosion during the dry season is confined to undermining of the massive grey clay which underlies the deep alluvium. The net result is the formation of a wide, gently sloping shelf some 20 feet below the river bank, and is commonly exposed during low water during the dry season (Fig.3). The deep clayey alluvium commonly has coarse blocky structures, and as the river rises during 'landas', this material readily crumbles and is easily eroded. Bank erosion by wave action has been reported to cause widespread slumping and river bank retreat during landas. Depth measurements taken during low water from the eroded shelf some 20 feet from the river bank shows that the river bed steepens very rapidly. In this mid-river section, all eroded material is removed and transported downriver. The outline of the river bank is extremely smooth and contrasts with the slightly indented bank of the lower river section. This feature illustrates that the uniform material and river current have resulted in parallel bank retreat. If one were to examine the river bank at high water level, the absence of indentation may convey the impression that little or no erosion has taken place.

4.4 Mid-Upper River Section

This section is characterised by low hilly terrain with narrow stretches of deep alluvium formed along small tributaries. The water level fluctuation is entirely seasonal. During the dry season, the river is some

Shallow soil and deeply weathering rock material

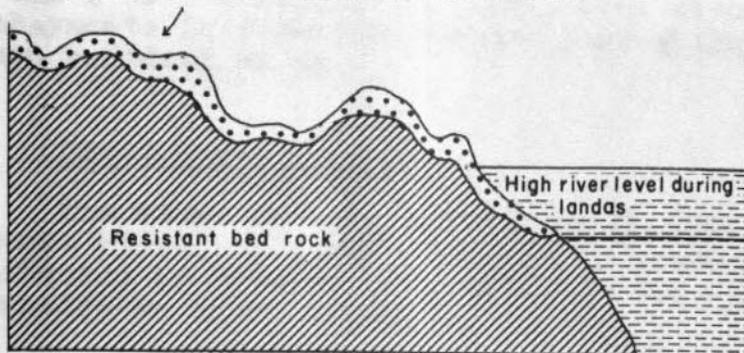


FIG. 2d. Middle-upper river section : low hilly

River bank erosion occurs only during landas and results in slope steepening and slope retreat.

(Section corresponds approximately to Song-Kapit)

Very shallow soil and weathering rock material

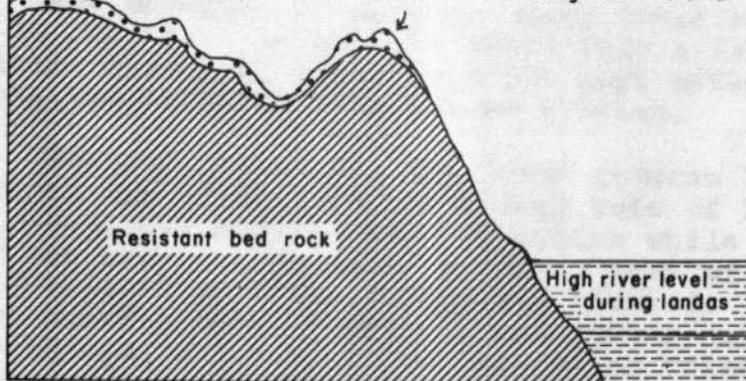


FIG. 2e. Upper river section : steep hilly

Very little erosion as river bank is bedrock controlled and not affected by seasonal river level changes.

(Section corresponds to Kapit - Pelagus and upriver)

15-30 feet below the river bank and wave erosion at this time is confined to the steepening of the footslope or base of the alluvium. Some of this eroded material is deposited as rock debris at the footslope (Plate 10) but when the river rises during the landas, this material is removed and results in slope steepening and slope or river bank retreat. The profile of the river bank has a more irregular outline, with strong indentations or embayments in stretches formed from alluvial deposits between residual hills.

4.5. Upper River Section

The river in this section is flanked by resistant bed rocks rising to steep hills of the interior, and is not affected by erosion although there is a great seasonal fluctuation in river level.

5. SEVERITY OF EROSION

From measurements of river bank eroded, it is possible to draw up tentative severity erosion classes for the rivers studied. These classes are as follows:

<u>Class</u>	<u>Severity</u>	<u>Amount of river bank eroded within 12 years</u>
1	slight	less than 25 feet
2	moderate	25-50 feet
3	severe	50-100 feet
4	very severe	more than 100 feet

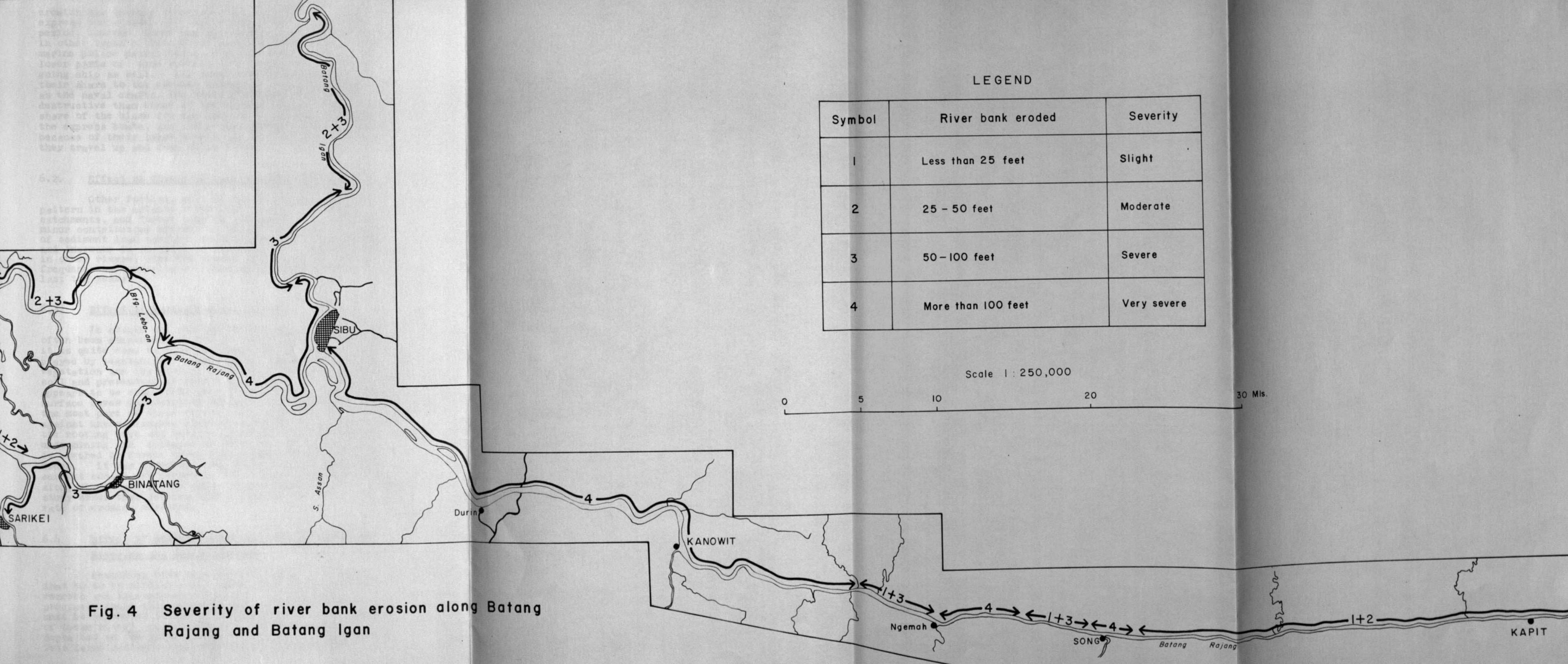
The severity of erosion along these rivers is shown in Fig. 4. It will be noted that a large part of the rivers examined, especially the part between Sarikei and Song has suffered very severe erosion.

The definition for the lower erosion limit requires some knowledge of what is the normal rate of bank erosion under relatively undisturbed conditions while other factors remain the same. For this purpose, part of the Rajang River sheltered by Pulau Dudong was studied. This bank is also under pepper, vegetable and rubber cultivation but no express boats or other fast motor vessels use this channel. It was found that the rate of erosion is less than 2.5 feet per year, and this figure is considered as the lowest limit of bank erosion and probably represents the value for most part of the river before express boats and other vessels came into operation.

6. GENERAL OBSERVATIONS AND CONCLUSIONS

6.1. River Traffic as Agent of Bank Erosion

Field evidence and information provided by the local population have shown that the severity of river bank



LEGEND

Symbol	River bank eroded	Severity
1	Less than 25 feet	Slight
2	25 - 50 feet	Moderate
3	50 - 100 feet	Severe
4	More than 100 feet	Very severe

Scale 1 : 250,000

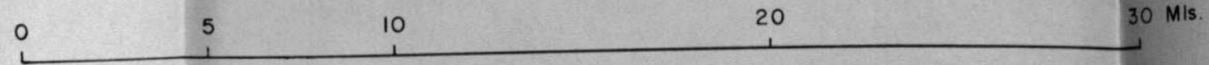


Fig. 4 Severity of river bank erosion along Batang Rajang and Batang Igan

erosion has greatly increased over the past 12 years since express boats came into operation. During the same period, however, there has also been a marked increase in other types of fast river boats, namely, naval crafts, marine police patrol boats, fishing trawlers and in the lower parts of some rivers, like Batang Lebaan, ocean-going ship as well. All these vessels contribute their share to the erosion observed. In some cases, such as the naval crafts, the waves generated are far more destructive than those of the express boats. The major share of the blame for the erosion is presently placed on the express boats, and this may appear fairly justified because of their large number and the frequency in which they travel up and down these rivers.

6.2. Effect of Change in Land Use and Forest Logging

Other factors, such as the change in land use pattern in the uplands - the upper Belaga and Balui catchments, and forest logging operations, may also have minor contributory effects on the river regime, in terms of sediment load carried, erosive power of river current and increase in severity of flooding. It has been noted in other rivers, like the Sadong and the Baram, that the frequency and severity of flooding has increased over the last ten years.

6.3. Effect of Vegetation and Jetties

In nearly all studies on erosion, vegetation has often been considered as one of the most vital factors and it is quite easy to draw erroneous conclusion of the role played by vegetation. Under normal undisturbed conditions, vegetation and its rooting are very effective in binding soil and preventing it from disintegration. However, this appears to be completely ineffective against high-energy surface waves generated by the powerful river boats. For the most part of these rivers, such waves are directed against unconsolidated alluvial material which lies below the rooting zone and results in widespread tunnelling, undermining and collapse of river bank even though it is covered by forest trees like nipah, rubber and fruit trees. It has sometimes been suggested that localised current eddies are formed by jetties and their presence along river bank is the cause of increased erosion. The study shows that jetties have little or no effect on the rate of erosion observed.

6.4 Effect of Sediment Load on River Siltation and Riverine and Marine Ecology

Resulting from this erosion, it is estimated that 10 to 15 million cubic yards of material have been removed and transported downriver. No one knows precisely where this material goes to but part of it must be deposited in the river beds in the lower section of these rivers and a large part is transported and deposited in the river estuaries or shallow coastal shelf. This large sediment load released within this short

period is expected to give rise to serious siltation of the important river channels which we now depend on for communication, and to upset the equilibrium of the riverine and marine ecology. The study of these effects lies outside our field but it is felt that they should be subjected to some detailed monitoring if we are to show any concern for our environment and to preserve it for our long-term benefit.

6.5. Effect of Bank Erosion on Property

Although our study is unable to provide quantitative data on the actual amount of property lost or affected, it is possible to convey some impression of the damage done. Farm holdings and long houses along these rivers, like elsewhere in Sarawak, are traditionally sited on the better drained and higher levee alluvium close to the river bank. This means that most of the houses were found within a narrow strip of 100 to 300 feet along the river. The erosion of more than 100 feet of this river bank, as has been shown above, means that at least 50 percent of the houses have been affected. Our survey has shown that in nearly every kampung and longhouse, some major reconstruction has been undertaken during the last ten years. In many cases, whole longhouses and kampung have to be rebuilt further inland. Between Kanowit and Kapit, it was noted that nearly all the longhouses along the river banks are presently endangered and will have to be shifted inland in the next few years. In addition, extensive damage is also done to jetties and long boats. The total sum of property destroyed and lost by the thousands of local people may in fact far exceed the financial outlay of all the express boats.

6.6. The Significance of Bank Erosion to Land Resources

The deep alluvial soils of the Rajang River stretching from Binatang to Song forms a very important land unit because these free draining soils are rated as the best soils in Sarawak and capable of supporting a wide range of crops. This narrow belt of alluvial soils, with average width of about 1,000 feet, was formerly planted with rubber in many places but in recent years some of this rubber is replaced by pepper and other annual crops. Also, the population density of this area is about the highest of all the riverine floodplains in the State.

The field study has shown that about 10 to 20 percent, or approximately 1,000 acres, of the best land in this floodplain were irreparably lost during the last 10 years. Considering the soil distribution pattern, it is important to note that the agriculture viability of the area hinges solely, if not entirely, on the presence of this high-potential alluvial land along the river, as behind this alluvial soils are found deep peat and small pockets of poorly drained clays which, by themselves can hardly support the population or the range of

agricultural crops that are found at present. If the current rate of river bank erosion is to continue unabated, it is likely that all the alluvial land along this river will be completely lost within a period of 50 to 100 years.

Land as a physical entity has three dimensional attributes, with areal extent and depth. Land degradation in its worst possible form in many cases affects only one of these attributes, namely, a decrease in soil depth but the land surface still remains and offers possibilities for subsequent reclamation and room for human rehabilitation. The type of river bank erosion which we have just described leaves only a widened river, upon which it is practically impossible to reclaim for agricultural use. This alluvial land, which has taken tens of thousands of years to form through the complex geologic processes of weathering and deposition, is lost forever.

In the face of rapid population increase and a corresponding demand for land, we cannot feel unconcerned about the loss of our land resources at this alarming rate. The loss in terms of property is costly but can be replaced, but not the land resource. It is unfortunate that the long-term effects on the environments produced by the introduction of fast river boats have not been realised earlier, or have hitherto received so little official attention. It is hoped that this study can help to bring about an awareness of the catastrophic effects caused by recent changes in river transport system on the local environments, and to provide some basis to decide whether a precious part of our natural heritage - some of our best and most valuable land, must continue to be sacrificed for our short-term benefits, and probably very selfish interest.

6.7. Monitoring of Future Bank Erosion

As a follow-up to our present study, a number of bench-marks will be set up next year along these rivers so that the rate of bank erosion, whether annual or over a longer period, can be accurately determined.

Wave baselling into river bank which is subjected to daily tidal fluctuation, commonly seen between Durin and Biringang. Photograph shows Kg. Salama near Biringang. Most of the old kampong houses, together with fruit trees have been eroded.

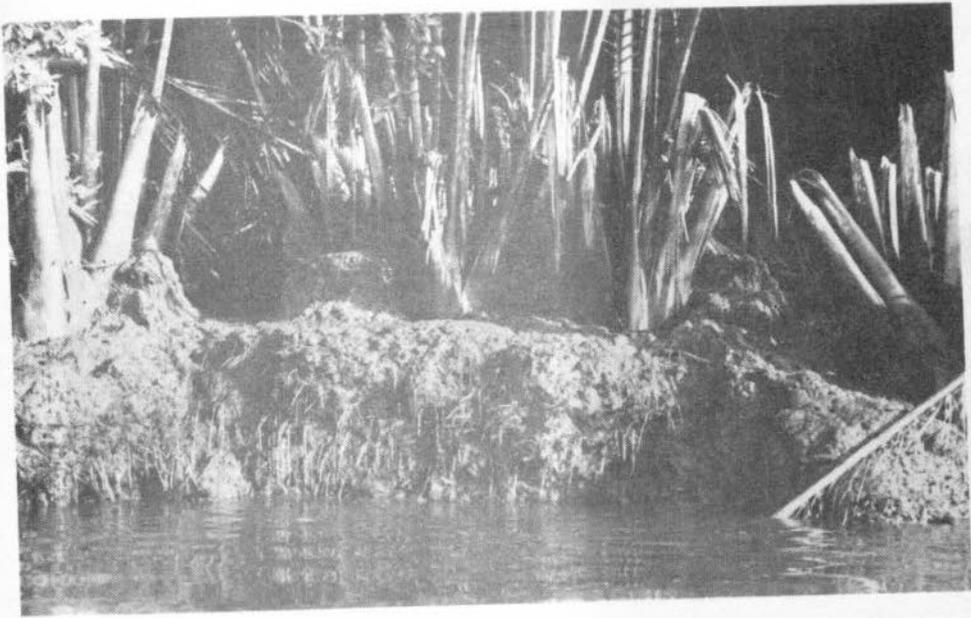


Plate 1. *Fig. 3.* River bank along Sarikei-Binatang with nipah palms (*Nipa fruticans*) being eroded.



Plate 2. *Fig. 4.* Wave tunnelling into river bank which is subjected to daily tidal fluctuation, commonly seen between Durin and Binatang. Photograph shows Kg. Selamas near Binatang. Most of the old kampong houses, together with fruit trees have been eroded.



Plate 3. Kampong Mauh along Batang Rajang, downriver from Sibul. Three years ago the river bank was at the tree trunk on the right of the photograph; more than 50 feet of river bank has been eroded during this period.



Plate 4. River bank at Bukit Lan along Batang Rajang, downriver from Sibul. Before express boats came into operation, the river bank was at landing raft, 120 feet from the present bank.

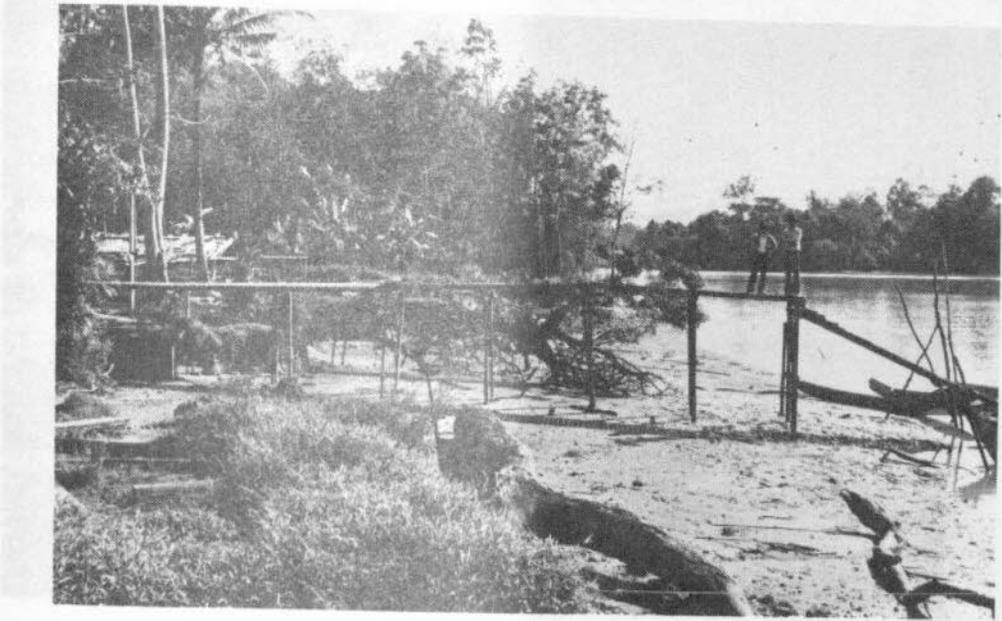


Plate 5. Eroded river bank at Rumah Janin along Batang Igan, downriver from Sibul. More than 100 feet of river bank eroded within 12 years.



Plate 6. Jetties of Kampong Banyok near Sibul, completely destroyed. More than 120 feet of river bank has been eroded and many houses in the kampong are already endangered by wave erosion.



Plate 7. Wave generated by a passing express boat during low tide near Sibou. Erosion is most active during high tide.

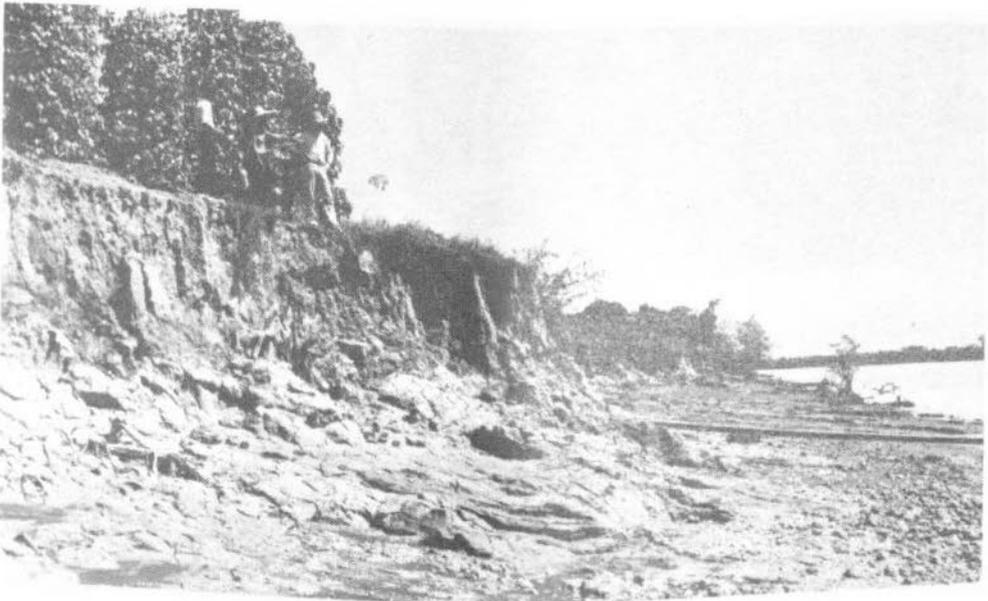


Plate 8. Eroded river bank near Durin. More than 120 feet of river bank eroded during the last 12 years. This farmer has lost most of his good land and pepper vines.



Plate 9.

Very severe erosion occurs on this deep but weakly consolidated alluvium commonly seen between Kanowit and Song along Batang Rajang. The base of this alluvial deposit is being undermined during the dry season and as the river rises during the Landas, wave erosion causes extensive vertical collapse.



Plate 10.

Colluvial fan of rock debris being built up at the footslope and low water mark during the dry season; this fan deposit will be completely removed during the Landas, resulting in steepening of the hill slopes flanking the river between Song and Kapit.

