

CONFIDENTIAL

**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

DATA REPORT No. 11
MPAMBANYONI NS 40

SEDIMENT DYNAMICS DIVISION
COASTAL ENGINEERING AND HYDRAULICS
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

NRIO DATA REPORT D8302

Stellenbosch, South Africa
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NS 40

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Booklet layout

Details of the classification of the lower reaches of the Mpambanyoni river for 1937; 24.2.69; 6.6.59; 1967; 1973 and 1976 are given in Tables NS 40/I - VI. River widths and details of lateral stability appear in Tables NS 40/VII and VIII. Simulated run-off for the period 1921 - 75 is given in Table NS 40/IX and an abstract of results in Table NS 40/X. Thalweg displacement from 1937-76 is shown in Figure NS 40/1. Open water areas appear in Figure NS 40/2. Photograph NS 40/1 shows the 1937 river course superimposed on a 1976 photograph from the orthophoto series the remaining photographs used for classification are reproduced in Photographs NS 40/2-7.

Hydro data

The MAR from a catchment area of 562 km² is $71,29 \times 10^6 \text{ m}^3$ (Table NS 40/IX). The run-off is very erratic. Monthly run-off may be well below the mean for long periods which are broken by violent floods (Figure NS 40/4). A major flood with an estimated peak discharge of 1 228 cumecs occurred on the 17th/18th May 1959 : the northern approach embankments of both the rail and road bridges near the mouth were swept away and buildings were damaged at the Renishaw sugar mill. (Meineke 1960). Flooding of a similar magnitude was again experienced in March 1976.

For classification purposes, consideration must be given as to when the photographs were taken with regard to run-off. The following important facts emerge regarding the six photographs studied and antecedent run-off conditions:

- I) 1937 : below-average run-off; previous four months below-average fifth month high run-off
- II) 24.2.59 : below-average run-off and previous eight months below-average
- III) 6.6.59 : above-average run-off following a major flood of 17/12 May 1959
Prior to major flood, 12 months of below-average run-off
- IV) 1967 : near-average run-off within a dry phase
- V) 1973 : below-average run-off within a dry phase and following a very dry month
- VI) 1976 : near-average run-off following a four month period of major flooding.
- ...

River mouth

The river mouth stays open throughout the year. The river is diverted at the mouth by a southerly-extending sandspit and discharges into the ocean alongside rocks on its right bank. During major floods the sandspit is washed away.

Land use

The left valley side and left bank of the floodplain are mainly under sugar cane cultivation (in some cases up to the channel edge). The lower part of the right valley side is bushy, whereas the upper part is mainly built-up. A rail/road bridge is situated at the head of the reach and confines the river flow. The National Road bridge and the railway bridges (old and new) with their embankments across the left flood plain near the mouth, restrict the natural flow of the river during times of flood.

Siltation

There is apparently an abundant source of silt upstream of the reach which is an indication of agricultural malpractices in the catchment. This is clearly seen in the increase in bar areas, following the floods of May 1959 and March 1976. During drier phases, the river adopts a braided course through thick silt deposits. Embankments for the NR and railways bridges nearer the mouth have caused severe siltation on the L.B. By 1976 only 11% of the reach under review could be considered estuarine (based upon Begg 1978).

Stability

The Mpambanyoni has shifted its course laterally to a marked degree during the period 1937 - 76 (Figure NS 40/1). This is quantified by a high average lateral displacement of 96,4 m with a high average coefficient of variation of 37,0% (Table NS 40/VIII). Sinuosity has been fairly constant from 1937 - 1976 because the river course has had to adapt to bridges and their embankments for the whole period under review.

...

The longer thalweg and higher sinuosity for the 6 June 1959 is at first sight confusing. It is due to the fact that at that time three weeks after the devastating May 1959 flood, the main river flow ran round large mid-channel bars and a temporary causeway built to reach the Renishaw mill. (Photograph NS 40/4). From the same photograph the peak flood course can be deduced. The road and rail bridge embankments could not withstand the flood and the river adopted a more direct course to the ocean. It is interesting to note that the sinuosity under such conditions was reduced to 1,03. The varying average river widths (Table NS 40/VII) and open water areas (Figure NS 40/2) reflect the influence of the floods.

The Mpambanyoni shows instability for the period under review.

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NS 40/4	6-6-59 at 13h00
NS 40/5	18-6-67 at 11h31
NS 40/6	12-8-73 at 14h26
NS 40/7	6-7-76 (orthophoto)

REFERENCES

- BEGG G.W. 1978 The estuaries of Natal
- MEINEKE E.N. 1959 Floods in the south eastern coastal area May 1959.
Die Siviele Ingenieur in Suid-Afrika Sept. 1960.
- PITMAN W.V. MIDDLETON B.J. and MIDGLEY D.C. 1981
Surface water resources of South Africa Vol. VI.
Hydrological Research Unit Report No. 9/81.

ABBREVIATIONS/SYMBOLS USED IN THE TABLES

M.A.R.	Mean annual run-off
L.B.	Left bank
R.B.	Right bank
P	Perimeter
\bar{x}	Arithmetic mean
s	Standard deviation
V	Coefficient of variation $\frac{s}{\bar{x}}$
MSL	Mean sea level
R	River
d/s	Downstream
—	Maximum value
....	Minimum value
N.R.	No record

TABLE NS 40/I

CLASSIFICATION OF THE LOWER REACHES OF NATAL RIVERS

NRIO NS 40

RIVER Mpambanyoni ? ESTUARINE, REACH from Renishaw to mouth, 2.4 km from mouth. REF. DEA # 4804a
 AERIAL PHOTO DATE 30-4-37 SCALE 1:10000 CATCHMENT AREA 562.0 km², M.A.R. 71,29 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (Not Well-defined)			
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	✓ none	none		
✓ hilly	grass	scattered cultivation	occasional	grass		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	✓ trees	<u>20</u>	<u>28</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		✓ cultivated	<u>75</u>	<u>72</u>
	heavily forested (75-100%)	scattered settlement		✓ built-up	<u>5</u>	
	swamp/bog	✓ partly built-up urbanised				

Comments From HRLI Report 9/81

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	✓ not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope	✓ fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head of reach <u>5</u> m to MSL	continuous	entrenched	entrenched	aeolian
		aggrading		sand covered <u>2</u> % area

Comments _____

River Mouth

Characteristics	Measurements	Comments
open/closed	right bank breakwater length _____ m	
natural/artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
✓ sandy	cliffs on right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>187</u> °	
outer bar	length of spit/bar <u>188</u> m	
silt plume (fluvial)	length stabilized _____ m	
✓ suspended sediment (marine)	width <u>79</u> m	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain		Vegetation	Forest Type	Land-Use
Presence	Extent			
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓ cultivated <u>43</u> % area
fragmentary	maximum width <u>4100</u> m	reed swamp _____ % area	main channel	✓ crops <u>sugar cane</u> mixed
✓ continuous	aerial length <u>2182</u> m	✓ sparsely forested	✓ tributaries (very little)	✓ partly built-up
	area <u>74</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		Comments _____

Channel Description N.B. Estimate of flow stage: LOW/NEAR LOW-TERM-MEAN/HIGH

Pattern	Measurements	Islands/Sheets	Type of Flow	Bar Type
straight	thalweg <u>2371</u> m	none	stagnant/still	none
✓ sinuous	*sinuosity <u>1.09</u>	occasional	uniform water surface	✓ channel side bars
irregular	*open water area <u>9.6</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5225</u> m	split	✓ irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	✓ braided (no. <u>11</u>)	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	✓ diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____ m s = <u>39.5</u> m			Comments *whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	✓ none	✓ road/rail	Renishaw River confined	0 (at head)
logs	minor	✓ road bridges	" River confined	1.2 km
boulders	major	✓ rail bridges	" "	1.7 km
vegetation		causeway		
		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments _____

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	✓ alluvium (silt/sand)	✓ none	stable	
downstream progression	natural levées	weak	slightly unstable	
progression & cut-offs	rock/boulders	good	✓ moderately unstable	
mainly cut-offs	protected/stabilized	very strong	highly unstable	
entrenched loop development	✓ cultivation to channel edge	left bank <u>33</u> %		
✓ irregular lateral activity		right bank <u>26</u> %		
avulsion				

RIVER Mpambanyoni ? % ESTUARINE, REACH from Penishaw kg mouth, 2.4 km from mouth. REF. DEA 48049
 AERIAL PHOTO DATE 24-2-59 SCALE 1:10000 CATCHMENT AREA 562.0 km², M.A.R. 71,29 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	✓ none	none	—	—
✓ hilly	grass	scattered cultivation	occasional	grass	—	—
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	✓ trees	<u>46</u>	<u>100</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		✓ cultivated	<u>49</u>	—
	heavily forested (75-100%)	scattered settlement		✓ built-up	<u>5</u>	—
	swamp/bog	✓ partly built-up urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	✓ not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach <u>5</u> m to MSL		aggrading		sand covered <u>nil</u> % area

Comments _____

River Mouth

Characteristics	Measurements	Comments
✓ open/closed	right bank breakwater length _____ m	
✓ natural/artificial	left bank breakwater length _____ m	
canalized	rock sill level _____ m to MSL	
sandy	cliffs on right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>172</u> °	
outer bar	length of spit/bar <u>160</u> m	
silt plume (fluvial)	length stabilized _____ m	
✓ suspended sediment (marine)	width <u>48</u> m	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓ cultivated <u>37</u> % area
fragmentary	maximum width <u>4100</u> m	reed swamp _____ % area	main channel	✓ crops <u>sugar cane</u> & mixed
✓ continuous	aerial length <u>2195</u> m	✓ sparsely forested	✓ tributaries (very little)	✓ partly built-up
	area <u>74</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/NEAR LOW/NEAR HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2391</u> m	none	stagnant/still	none
✓ sinuous	*sinuosity <u>1.09</u>	occasional	uniform water surface	✓ channel side bars
irregular	*open water area <u>7.8</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5116</u> m	split	✓ irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	✓ braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available _____		turbid	✓ diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>28</u> m s = <u>11</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	✓ road/railway	Renishaw River confined	0 (at head)
logs	minor	✓ road/bridge/s	"	1600 m ; 2100 m
boulders	major	✓ rail bridge/s	"	2300 m
vegetation		causeway		
		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	cultivation to channel edge	left bank <u>57</u> %	
✓ irregular lateral activity		right bank <u>67</u> %	
avulsion			

Comments _____

RIVER Mpambanyri, ? % ESTUARINE, REACH from Renishaw br. to mouth, 2.4 km from mouth. REF. DEA U8049
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10000 CATCHMENT AREA 562,0 km², M.A.R. 71.29 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Not Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
✓ hilly	grass	scattered cultivation	✓ occasional	grass		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	✓ trees	<u>8</u>	<u>100</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		✓ cultivated	<u>87</u>	
	heavily forested (75-100%)	scattered settlement		✓ built-up	<u>5</u>	
	swamp/bog	✓ partly built-up urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope _____	✓ fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach <u>5</u> m to MSL		✓ aggrading		sand covered <u>14</u> % area

Comments _____

River Mouth

Characteristics	Measurements	Comments
✓ open/closed	right bank breakwater length _____ m	
✓ natural/artificial	left bank breakwater length _____ m	
canalized	rock sill _____ level _____ m to MSL	
sandy	cliffs on right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>190</u> °	
✓ outer bar	length of spit/bar <u>45</u> m	
✓ silt plume (fluvial)	length stabilized _____ m	
suspended sediment (marine)	width <u>60</u> m	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓ cultivated <u>17</u> % area
fragmentary	maximum width <u>400</u> m	reed swamp _____ % area	main channel	✓ crops sugar cane & mixed
✓ continuous	aerial length <u>2203</u> m	✓ sparsely forested	tributaries	✓ partly built-up
	area <u>74,2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: ~~LOW/NEAR-LONG-TERM-MEAN~~/HIGH (following flood)

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2463</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,12</u>	occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>21,8</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>6564</u> m	✓ split	✓ irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	✓ mid-channel bars
tortuous meanders	river X-sections available _____		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width \bar{x} _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width \bar{x} <u>87</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	*road/railway br.	Renishaw River confined	0 (at head)
logs	minor	**road bridge/s <u>2</u>	old road br.; national rd. br.	1600 m; 2100 m
boulders	major	**rail bridge/s _____	railway br.	2300 m
vegetation		causeway _____		
		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others _____		

Comments * Renishaw br. swept away during floods
 ** L.B. embankments of national rd. br. and railway br. swept away

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	cultivation to channel edge	left bank <u>17</u> %	
✓ irregular lateral activity		right bank <u>24</u> %	
avulsion			

Comments _____

RIVER Mpambanyoni, ? % ESTUARINE, REACH from Penishaw ^{br} to mouth, 2.4 km from mouth. REF. DEA U3049
 AERIAL PHOTO DATE 18-6-67 SCALE 1:10000 CATCHMENT AREA 562.0 km², M.A.R. 71,29 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Height
mountainous	almost none	none	✓none	none	-	-
✓hilly	grass	scattered cultivation	occasional	grass	-	-
undulating	✓sparsely forested (0-25%)	partly cultivated	frequent	✓trees	<u>8</u>	<u>100</u>
plains	moderately forested (25-75%)	✓mainly cultivated		✓cultivated	<u>87</u>	-
	heavily forested (75-100%)	scattered settlement		✓built-up	<u>5</u>	-
	swamp/bog	✓partly built-up urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	✓not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	✓not obviously degrading	occasionally confined	lacustrine deposits
valley slope _____	✓fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head _____	continuous	entrenched	entrenched	aeolian
of reach <u>5</u> m to MSL		aggrading		sand covered <u>3</u> % area

Comments _____

River Mouth

Characteristics	Measurements
✓open/closed	right bank breakwater length _____ m
✓natural/artificial	left bank breakwater length _____ m
canalized	rock sill level _____ m to MSL
sandy	cliffs on right bank: height _____ m to MSL
✓rocks on right bank	cliffs on left bank: height _____ m to MSL
rocks on left bank	spit/bar: direction of growth <u>179</u> °
outer bar	length of spit/bar <u>110</u> m
silt plume (fluvial)	length stabilized _____ m
✓suspended sediment (marine)	width <u>53</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓cultivated <u>34</u> % area
fragmentary	maximum width <u>4100</u> m	reed swamp _____ % area	main channel	✓crops/sugar cane + mixed
✓continuous	aerial length <u>2237</u> m	✓sparsely forested	tributaries	✓partly built-up
	area <u>74,2</u> ha	moderately forested	✓coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/NEAR LONG-TERM MEAN/HIGH

Pattern	Measurements	Islands/Sheals	Type of Flow	Bar Type
✓straight	thalweg <u>2366</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,06</u>	occasional	uniform water surface	✓channel side bars
irregular	*open water area <u>14,4</u> ha	frequent	uniform with rapid in reach	✓point bars
regular meanders	perimeter <u>5272</u> m	split	✓irregular	✓channel junction bars
irregular meanders	lake/lagoon area _____ ha	✓braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available _____		turbid	✓diamond bars
bifurcated	channel slope _____			✓diagonal bars (mostly)
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>65,5</u> m s = <u>27,0</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓none	none	✓road/bridge	Penishaw River confined	0 (at head)
logs	minor	*road bridge/s	old rd. br.; nat. rd. br.	1,6 km; 2,0 km
boulders	major	✓rail bridge/s	"	2,1 km
vegetation		causeway	"	
		✓weir/dam	bldg. constriction	
		fish traps	"	
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments * Old rd. br. swept

away in flood.

Work constructed immediately

upstream

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	✓moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	cultivation to	left bank <u>15</u> %	
✓irregular lateral activity	channel edge	right bank <u>25</u> %	
avulsion			

Comments _____

RIVER Mpambanyoni, ? % ESTUARINE, REACH from Renishaw br. to mouth, 2.5 km from mouth. REF. DEA 48049
 AERIAL PHOTO DATE 12-8-73 SCALE 1:10000 CATCHMENT AREA 562,0 km², M.A.R. 71.29 m²x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Not Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	✓none	none	-	-
✓hilly	grass	scattered cultivation	occasional	grass	-	-
undulating	✓sparsely forested (0-25%)	partly cultivated	frequent	✓trees	11	100
plains	moderately forested (25-75%)	✓mainly cultivated		✓cultivated	84	-
	heavily forested (75-100%)	scattered settlement		✓built-up	5	-
	swamp/bog	✓partly built-up urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	✓not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope _____	✓fragmentary	✓partly entrenched	frequently confined	fluvial deposits
height at head of reach <u>5</u> m to MSL	continuous	entrenched	entrenched	aeolian
		aggrading		sand covered <u>2</u> % area

Comments _____

River Mouth

Characteristics	Measurements
✓open/closed	right bank breakwater length _____ m
✓natural/artificial	left bank breakwater length _____ m
canalized	rock sill level _____ m to MSL
sandy	cliffs on right bank: height _____ m to MSL
✓rocks on right bank	cliffs on left bank: height _____ m to MSL
rocks on left bank	spit/bar: direction of growth <u>187</u> °
outer bar	length of spit/bar <u>150</u> m
silt plume (fluvial)	length stabilized _____ m
suspended sediment (marine)	width <u>58</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓cultivated <u>33</u> % area
fragmentary	maximum width <u>4100</u> m	reed swamp _____ % area	main channel	✓crop/ sugar cane + mixed
✓continuous	aerial length <u>2199</u> m	✓sparsely forested	tributaries	✓partly built-up
	area <u>74.2</u> ha	moderately forested	✓coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/NEAR LONG TERM MEAN/HIGH

Pattern	Measurements	Islands/Sheets	Type of Flow	Bar Type
straight	thalweg <u>2294</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,04</u>	occasional	uniform water surface	✓channel side bars
✓irregular	*open water area <u>6,6</u> ha	frequent	uniform with rapid in reach	✓point bars
regular meanders	perimeter <u>5372</u> m	split	✓irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	✓braided	pool & riffle sequence	✓mid-channel bars
tortuous meanders	river X-sections available _____		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>24.6</u> m s = <u>8,8</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Non-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓none	none	✓road/rail br.	Renishaw River confined	0 (at head)
logs	minor	✓road bridges	rd. rd. br.	2,0 km
boulders	major	* ✓rail bridges	2 dd br. new br.	2,1 km ; 2,2 km
vegetation		causeway		
		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments * new bridge under construction.

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	✓moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
✓entrenched loop development	cultivation to channel edge	left bank <u>15</u> %	
irregular lateral activity		right bank <u>62</u> %	
avulsion			

Comments _____

RIVER Mpambanyoni, 11 % ESTUARINE, REACH from Renishaw ^{br.} to mouth, 2.5 km from mouth. REF. DEA U8049
 AERIAL PHOTO DATE 6-7-76 SCALE 1:10 000 CATCHMENT AREA 562,0 km², M.A.R. 71,29 m³x10⁶, No. of DAMS NIL

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Not Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	none		
✓ hilly	grass	scattered cultivation	✓ occasional	grass		
undulating	✓ sparsely forested (0-25%)	partly cultivated	frequent	✓ trees	<u>13</u>	<u>79</u>
plains	moderately forested (25-75%)	✓ mainly cultivated		✓ cultivated	<u>82</u>	<u>21</u>
	heavily forested (75-100%)	scattered settlement		✓ built-up	<u>5</u>	
	swamp/bog	✓ partly built-up urbanised				

Comments _____

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>2300</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>268</u> m	indefinite	not obviously degrading	✓ occasionally confined	lacustrine deposits
valley slope <u>1:460</u>	✓ fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head of reach <u>5</u> m to MSL	continuous	entrenched	entrenched	aeolian sand covered <u>10</u> % area

Comments _____

River Mouth

Characteristics	Measurements
✓ open/closed	right bank breakwater length _____ m
✓ natural/artificial	left bank breakwater length _____ m
canalized	rock sill level _____ m to MSL
sandy	cliffs on right bank: height _____ m to MSL
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL
rocks on left bank	spit/bar: direction of growth <u>183</u> °
outer bar	length of spit/bar <u>145</u> m
✓ silt plume (fluvial)	length stabilized _____ m
suspended sediment (marine)	width <u>35</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>268</u> m	grass	riverine:	✓ cultivated <u>20</u> % area
fragmentary	maximum width <u>400</u> m	reed swamp _____ % area	main channel	✓ crop/✓ sugar cane + mixed
✓ continuous	aerial length <u>2233</u> m	✓ sparsely forested	tributaries	✓ partly built-up
	area <u>74,2</u> ha	moderately forested	✓ coastal dune/evergreen mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: ~~LOW~~/NEAR LONG-TERM MEAN/~~HIGH~~ (Previous 4 months floodflows)

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2375</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1,06</u>	occasional	uniform water surface	✓ channel side bars
✓ irregular	*open water area <u>17,9</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>5451</u> m	split	✓ irregular	channel junction bars
irregular meanders	lake/lagoon area _____ ha	✓ braided	pool & riffle sequence	✓ mid-channel bars
tortuous meanders	river X-sections available _____		turbid	✓ diamond bars (L-shaped)
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>68,5</u> m s = <u>28,7</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	✓ road bridge/s	Nat. road bridge	river confined <u>20</u> km
logs	minor	✓ rail bridge/s	New railw. bridge	" <u>2,2</u> km
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments _____

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	✓ moderately unstable
mainly cut-offs	protected/stabilized	very strong	highly unstable
entrenched loop development	cultivation to channel edge	left bank <u>9</u> %	
✓ irregular lateral activity		right bank <u>26</u> %	
avulsion			

Comments _____

TABLE NS 40/VII

RIVER WIDTHS

MPAMBANYONI NS 40

Station	Approx. distance along 1976 R. course from Renishaw Bridge (m)	River widths (m)						\bar{x}	s	V%
		Date								
		30-4-37	24-2-59	6-6-59	18-6-67	12-8-73	6-7-76			
1	0	20	37	77	100	35	67	56	30,3	54,1
2	250	31	48	50	65	26	65	47,5	16,5	34,6
3	500	19	35	55	70	17	74	45,0	25,0	55,6
4	750	12 (5+7)	33	35	50	25	88	40,5	26,4	65,2
5	1 000	14	25	80	40	22	40	36,8	23,5	63,9
6	1 250	25 (12+5+7)	15	125	55	16	64 (27+37)	50,0	42,1	84,2
7	1 500	13	17	110	60	40	46	47,7	35,3	74,1
8	1 750	55	30	50	45	25	100	50,8	26,7	52,6
9	2 000	115	25	110 (70+40)	85 (10+75)	34	105	79,0	39,8	50,3
10	2 250	112	35	145	120	11	95	86,3	52,2	60,5
11	2 500	5	10	120	30 (15+15)	20	10	32,5	43,8	134,8
\bar{x}		38,3	28,2	87,0	65,5	24,6	68,5	52,0		
s		39,5	11,1	36,8	27,0	8,8	28,7			
V%		103,1	39,5	42,3	41,2	35,9	41,8			

Station	Approx. distance along 1976 R. course from Renishaw Bridge (m)	Distance from maximum observed L.B. position to mid-river (m)						Max-Min	\bar{x}	s	V%
		Date									
		30-4-37	24-2-59	6-6-59	18-6-67	12-8-73	6-7-76				
1	0	80	74	52	50	50	35	58,5	14,6	25,0	
2	250	40 ..	50	75	50	45	35	54,2	13,2	24,3	
3	500	155 ..	205	78,6 ..	120	137	126,4	131,9	45,1	34,2	
4	750	196,7	197	116,2 ..	100	145	153	133,2	59,3	44,5	
5	1 000	173	195	92,6	110	125	153	119,3	62,1	52,1	
6	1 250	45 ..	45	62,5	80	100	55	69,0	22,1	32,0	
7	1 500	10 ..	25	75	95	115	115	74,2	47,4	63,8	
8	1 750	67 ..	25	75	135	125	110	92,8	44,2	47,7	
9	2 000	190	110	76,8 ..	169,4	187	113,2	147,7	45,3	30,7	
10	2 250	125	125	82,8 ..	90	173	90,2	121,5	32,6	26,8	
11	2 500	110	120	60 ..	87,5	110	75	103,8	26,4	25,5	
\bar{x}		108,3	106,5	77,0	98,8	119,3	96,4	100,6		37,0	
s		64,8	69,0	17,2	34,9	43,9	42,3			13,2	
V%		59,8	64,8	22,3	35,4	36,8	43,9			35,6	

Average lateral displacement 1937 - 76 = 96,4 m
 Average coefficient of variation 1937 - 76 = 37,0%

TABLE NS 32/IX SIMULATED RUN-OFF FOR MPARAMBANYONI CATCHMENT AREA= 562.050 KM. SM.A.R.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APH	MAY	JUN	JUL	AUG	SEP	TOTAL	SM.A.R.
1921	3.90	4.67	18.44	3.09	2.01	1.52	1.86	2.37	2.14	1.98	2.02	88.22	123.75	
1922	2.19	12.87	6.76	4.02	16.33	9.25	2.32	1.41	1.41	1.43	1.15	69.47	97.46	
1923	1.16	1.25	1.56	2.16	3.12	3.02	2.10	1.41	1.41	1.43	1.06	19.29	27.07	
1924	1.33	1.94	3.50	26.05	12.85	106.44	38.98	3.52	2.05	1.54	1.37	200.52	281.28	
1925	1.36	1.56	1.36	1.22	1.49	3.35	3.72	2.46	2.04	1.32	1.33	89.78	125.94	
1926	2.40	2.94	2.57	1.83	1.63	50.04	19.98	2.92	1.73	1.18	1.01	23.75	33.31	
1927	1.79	1.90	2.20	2.69	3.50	3.58	1.49	1.49	1.18	1.63	5.38	103.74	145.52	
1928	1.50	2.13	2.30	2.21	2.05	3.58	4.96	4.36	38.18	27.89	2.40	40.91	57.39	
1929	6.83	6.32	4.57	4.82	4.53	3.05	2.17	1.64	1.47	1.54	2.40	100.02	140.31	
1930	3.77	4.10	4.31	4.83	4.07	4.19	4.25	2.85	1.60	42.92	14.74	35.30	49.52	
1931	3.48	3.04	2.73	2.88	3.86	4.62	3.78	3.21	2.87	1.48	1.22	25.44	35.69	
1932	1.74	3.70	5.07	3.86	2.22	1.76	1.62	1.56	1.12	2.33	2.44	75.00	105.20	
1933	1.54	2.24	11.60	28.12	11.99	4.25	3.74	3.22	2.31	29.88	5.37	169.16	237.30	
1934	1.70	1.96	17.26	3.57	2.69	3.37	3.42	4.01	4.74	3.43	1.69	33.73	47.32	
1935	2.79	1.97	1.15	1.22	6.90	5.52	3.13	1.80	1.16	1.97	1.26	87.30	122.66	
1936	1.70	1.96	2.64	3.83	27.12	11.74	3.74	3.41	2.42	2.07	1.48	64.11	89.93	
1937	1.87	3.52	3.75	3.75	15.67	9.26	4.30	2.92	2.11	1.83	1.91	53.20	74.63	
1938	5.26	6.02	27.07	11.14	1.93	1.33	1.38	3.29	5.01	4.01	2.52	70.74	99.24	
1939	1.41	8.41	6.83	4.03	2.30	1.93	2.05	1.53	1.01	1.85	1.03	32.20	45.16	
1940	1.43	1.84	1.83	3.11	3.78	4.36	4.69	3.65	2.36	1.49	1.47	31.91	44.76	
1941	2.87	5.15	17.94	9.48	4.02	11.88	34.46	15.00	5.00	4.06	4.87	119.46	167.57	
1942	12.04	23.63	11.03	4.66	3.35	3.36	3.17	2.19	1.60	1.43	1.21	69.61	97.64	
1943	4.50	4.47	2.54	1.63	1.78	3.57	3.61	2.77	1.93	1.41	1.09	30.15	42.30	
1944	1.36	1.59	1.16	1.09	1.53	2.37	2.58	1.92	1.25	1.88	1.61	17.02	23.87	
1945	1.61	2.12	2.02	2.02	2.24	12.91	8.57	4.91	5.37	5.55	2.76	52.97	74.30	
1946	2.12	28.77	14.69	7.74	5.96	6.13	5.91	4.55	2.75	1.65	1.13	87.32	122.49	
1947	3.54	3.54	2.74	1.92	1.68	2.27	2.78	2.34	1.53	1.05	1.91	24.25	34.02	
1948	2.65	60.83	30.92	4.94	4.60	4.05	3.24	3.04	2.59	2.21	3.26	146.29	205.22	
1949	3.54	3.28	31.00	39.81	13.58	5.16	4.53	2.78	1.62	1.06	1.50	2.78	110.64	155.20
1950	4.94	4.80	3.99	9.26	6.82	4.60	5.22	6.00	4.90	3.29	2.23	1.70	57.75	81.01
1951	1.54	1.77	2.25	3.37	5.96	4.79	2.67	1.59	1.06	1.78	1.23	2.33	29.36	41.19
1952	3.37	4.44	3.61	4.54	3.40	3.15	2.65	2.27	2.15	1.77	1.43	1.91	36.31	50.94
1953	53.98	22.15	3.61	12.24	8.08	18.60	9.59	3.58	2.34	1.76	1.27	1.69	138.92	194.88
1954	2.62	3.45	3.37	2.00	2.51	51.87	21.93	4.90	3.41	2.67	2.44	2.64	103.81	145.63
1955	3.44	4.54	24.75	12.71	4.11	5.35	15.19	9.65	3.29	1.98	1.50	2.41	96.99	136.05
1956	12.04	8.53	4.35	3.74	16.98	9.31	36.33	15.19	2.94	1.82	1.31	1.25	113.84	159.70
1957	1.77	3.36	3.97	3.53	3.20	2.43	1.70	58.86	23.58	4.08	3.54	3.08	113.10	156.66
1958	3.01	3.04	2.52	1.89	1.67	2.14	3.32	3.60	2.63	1.81	1.41	1.43	28.47	39.94
1959	1.92	2.79	4.54	5.14	3.94	4.17	51.86	20.94	3.90	2.93	2.25	1.98	106.37	149.21
1960	2.09	2.59	2.54	2.53	3.27	10.62	6.89	3.34	2.07	1.33	1.36	2.68	40.15	56.32
1961	1.89	3.41	3.64	25.50	11.47	42.82	17.33	2.85	1.82	2.87	3.53	2.68	119.82	168.08
1962	2.91	3.72	19.01	28.07	10.92	3.43	2.54	1.96	2.18	2.59	2.18	1.89	81.40	114.19
1963	45.60	12.63	4.90	4.72	4.45	3.08	1.79	1.43	2.26	3.00	3.40	4.43	71.69	100.57
1964	13.43	11.63	0.16	4.95	4.55	2.88	1.90	2.45	2.96	2.28	1.84	1.62	56.80	79.68
1965	1.43	1.68	1.84	2.16	3.20	4.57	13.06	7.37	3.06	2.28	1.84	1.32	43.80	61.45
1966	1.56	3.05	3.30	2.67	2.24	2.29	2.25	4.24	4.30	3.18	1.16	1.92	24.09	33.80
1967	2.61	2.63	1.98	1.16	1.05	2.37	3.24	4.24	1.87	2.18	2.54	2.41	31.71	44.48
1968	4.30	6.14	6.82	5.06	3.07	1.66	3.90	1.05	1.87	3.77	5.39	3.01	38.53	54.05
1969	10.04	8.04	6.14	4.72	3.79	3.67	3.63	4.51	4.28	2.28	2.15	5.85	63.82	89.53
1970	5.27	4.80	5.22	5.15	12.73	7.34	2.99	2.14	2.14	2.28	1.14	1.57	53.78	75.45
1971	3.03	3.03	4.19	3.46	2.58	2.11	2.16	1.86	1.21	1.86	1.14	2.06	25.95	36.40
1972	2.74	3.35	3.65	3.85	4.17	4.21	3.60	4.45	4.99	3.74	2.41	1.65	42.83	60.09
1974	1.46	1.81	3.62	13.10	11.45	6.42	3.75	2.25	1.42	1.97	1.21	1.21	48.19	67.60
1975	1.88	1.83	2.64	4.16	36.86	114.04	63.78	15.07	6.15	4.76	3.87	3.63	258.68	362.87
MEAN	4.63	7.23	7.04	7.05	6.29	11.10	8.60	5.10	4.91	3.84	2.43	2.15	71.29	
S	7.97	12.58	4.70	6.20	6.64	22.15	13.04	8.38	7.47	7.47	2.72	1.22	47.99	
V	172.10	173.93	122.19	116.29	106.10	199.54	151.56	184.18	231.09	194.60	111.62	56.93	67.32	

71.29 MILLION CUBIC METRES. COMPILED FROM HRU REPORT NO.9/81 DATA

ABSTRACT

HUMAN INFLUENCES

Within the Reach

1. Land-use
 - (a) Cultivation: Valley sides Sugar cane and mixed farming on left side
Flood plain Usually 30-40%. Less, only following major floods.
To channel edge Only some years.
 - (b) Bridge building and embankments
Rail/road bridge at head of reach (1940) swept away 1967 fixed
Old road bridge 1.6 km from head of reach (1940) swept away 1967 fixed
New NB bridge (1954) 2.1 km from head of reach
Railway bridge (1973) 2.3 km from head of reach
 - (c) Canals
nil
 - (d) Urbanization/Industry
Benishaw sugar mill on RB of floodplain
Built up area above RB of valley

2. Breaching of sandbar
Nil

3. Others
Nil

Upstream of Reach

(a) Dams in the catchment
Date of construction

(b) Building construction or canalization immediately upstream of reach
(Construction) of weir 100 m upstream of reach. (15-6-67)

(c) Land-use malpractices/silt supply
Sugar cane and mixed farming malpractice upstream cause severe siltation of river.

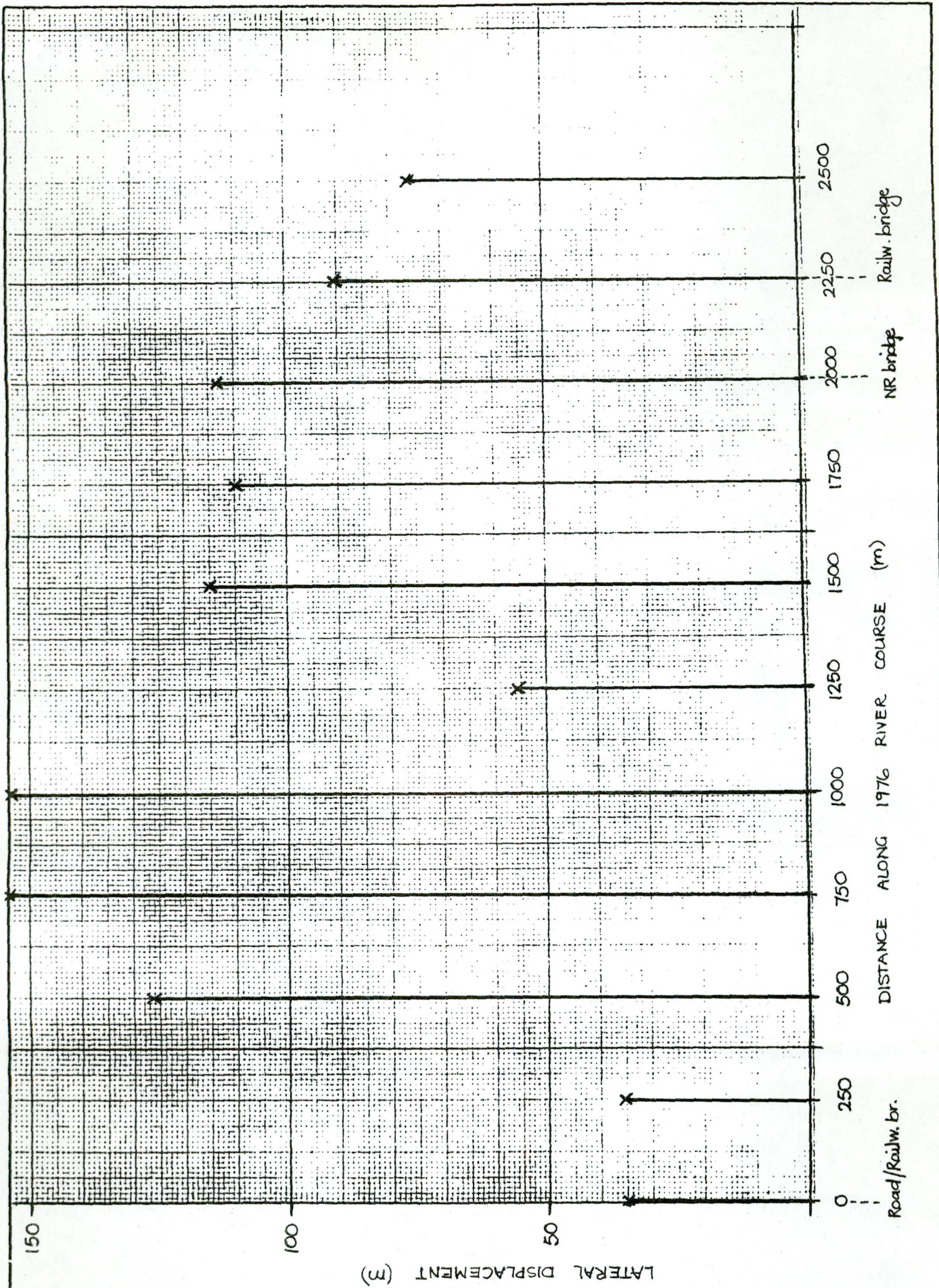
TABLE NS 40/X
BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1976)	\bar{x}	96.4	m
Relative lateral stability (1937 - 1976)	V	37.0	%
Area of catchment		562.0	km ²
Area of flood plain		74.2	ha
Area of envelope of mobility		3.8	ha
Simulated M.A.R. (1921 - 1975)	\bar{x}	71.3	x 10 ⁶ m ³
	S	48.4	x 10 ⁶ m ³
	V	68.0	%

Dates of major floods: 17/15 May 1959 ; March 1976

MEASUREMENTS/CALCULATIONS from PHOTOGRAPHS

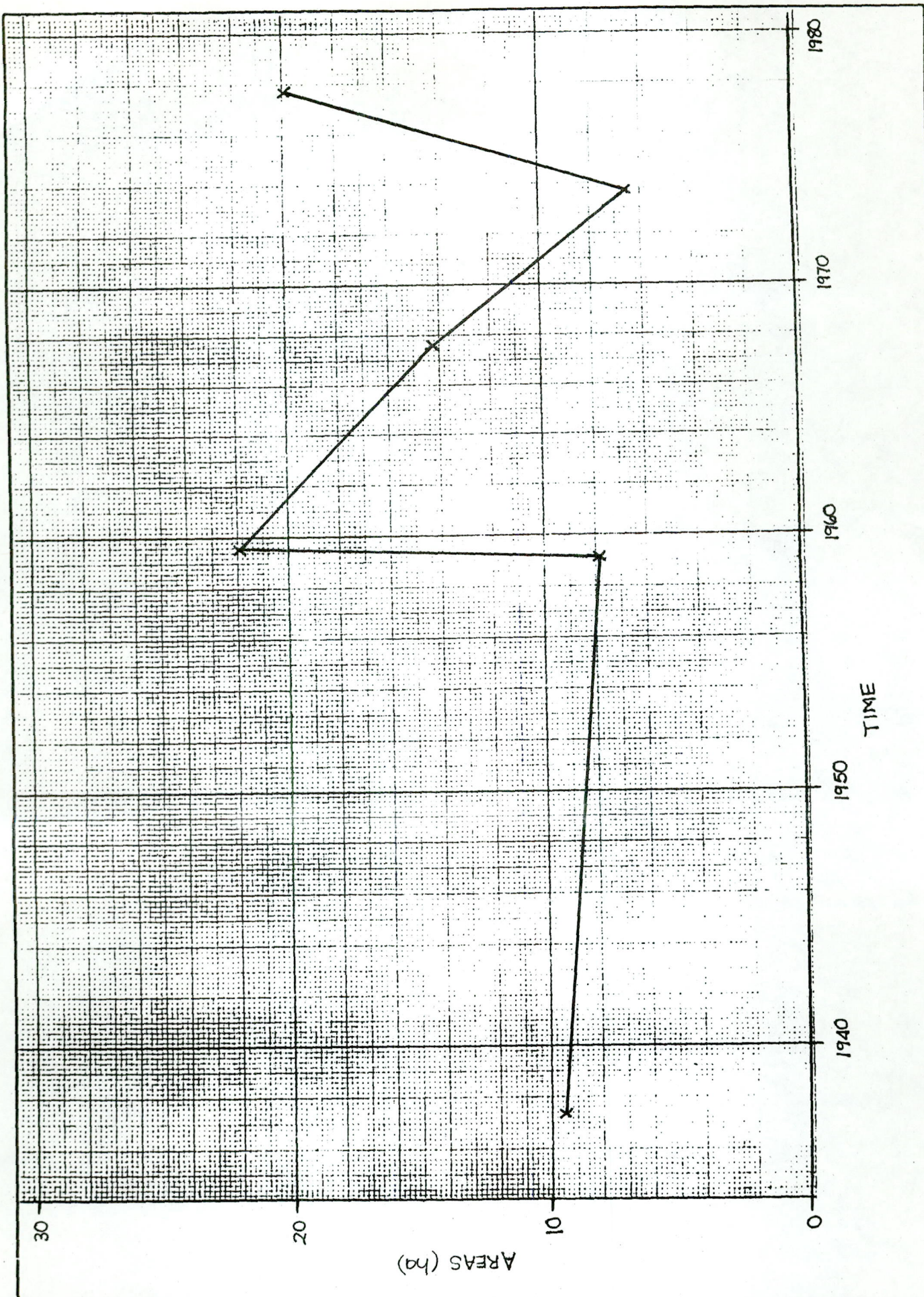
Date	30-4-37	24-2-59	6-6-59	18-6-67	12-8-73	6-7-76
Thalweg (m)	2371	2391	2463	2366	2294	2375
% Thalweg estuarine	?	?	?	?	?	11
Aerial D (m)	2152	2195	2203	2237	2199	2233
Sinuosity	1.09	1.07	1.12	1.06	1.04	1.06
\bar{x} River width (m)	35.3	28.2	27.0	65.5	24.6	68.5
Open water area (ha)	9.6	7.8	21.8	14.4	6.6	17.9
% envelope of mobility	25.0	20.5	57.4	37.9	17.4	47.1
Bar/island area (ha)	3.4	3.2	10.2	1.1	3.4	5
River braided	✓	✓	—	✓	✓	✓
% Flood plain cultivated	43.4	36.5	46.7	33.6	33.4	19.7
Left valley side:						
% grass	—	—	—	—	—	—
% trees	19.7	46.1	7.9	28.9	10.5	13.2
% cultivated	75	48.6	86.2	65.8	84.2	81.5
% built up	5.3	5.3	5.2	5.3	5.3	5.3
Right valley side:						
% grass	—	—	—	—	—	—
% trees	100	100	100	100	100	100
% cultivated	—	—	—	—	—	—
% built up	—	—	—	—	—	—
L.B. % vegetated	33	57	17	15	15	9
R.B. % vegetated	26	67	24	25	62	26
Mouth open/closed (o/c)	0	0	0	0	0	0
Spit/bar:						
Direction (°)	187	172	190	179	187	183
Length (m)	182	160	45	110	150	145
\bar{x} width (m)	78.8	47.5	60.0	52.5	57.5	35.0



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 DATE:
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NATAL ESTUARIES: MPAMPANYONI
 THALWEG DISPLACEMENT 1937-76

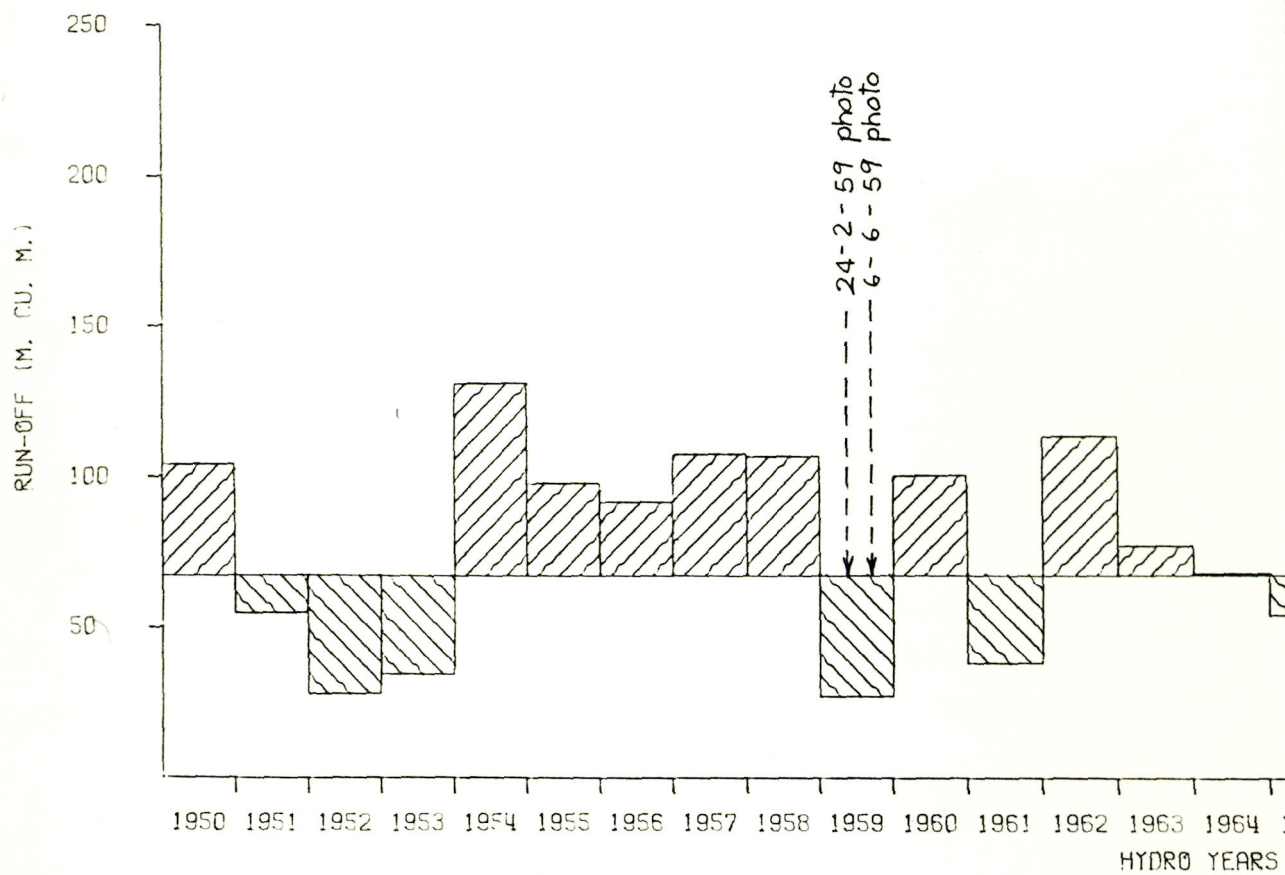
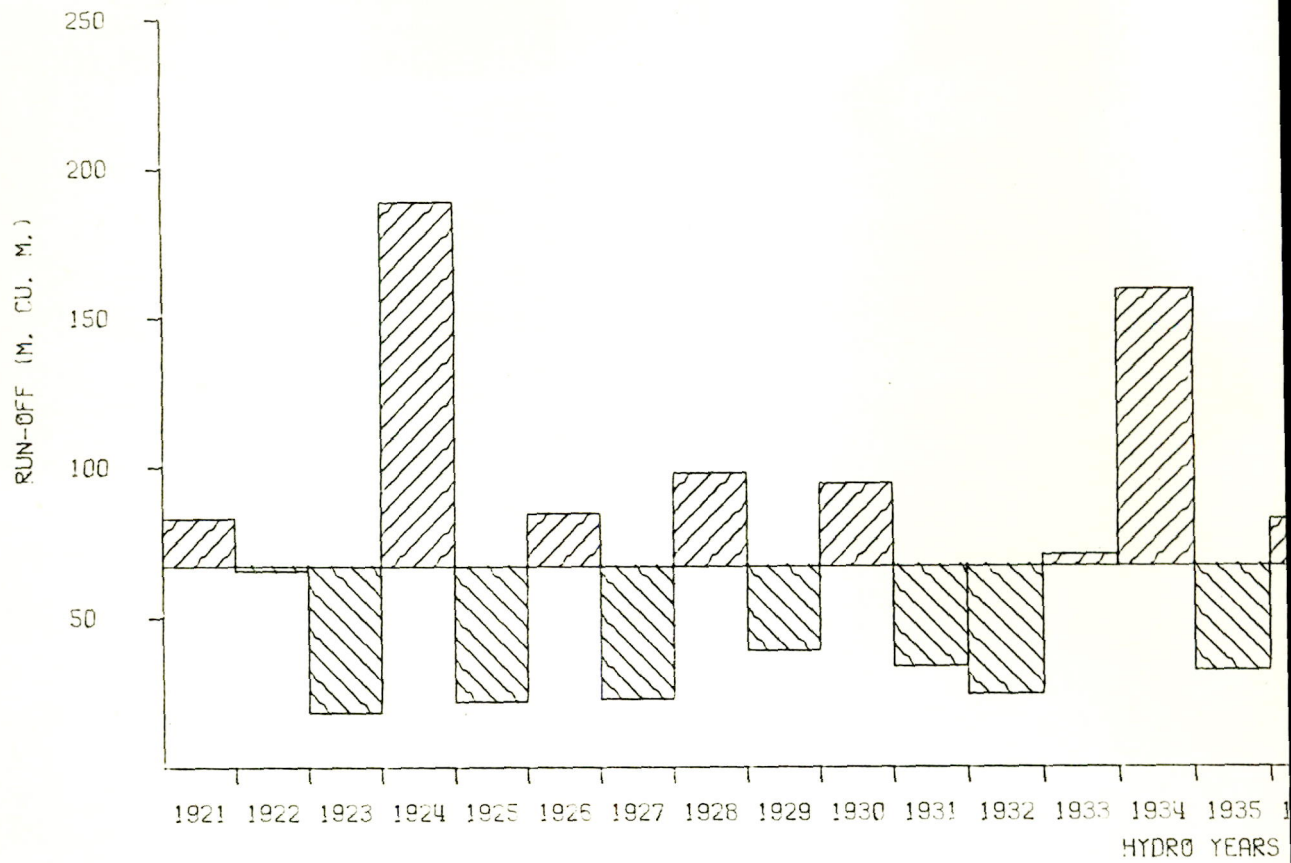
FIGURE
 NS 40/1



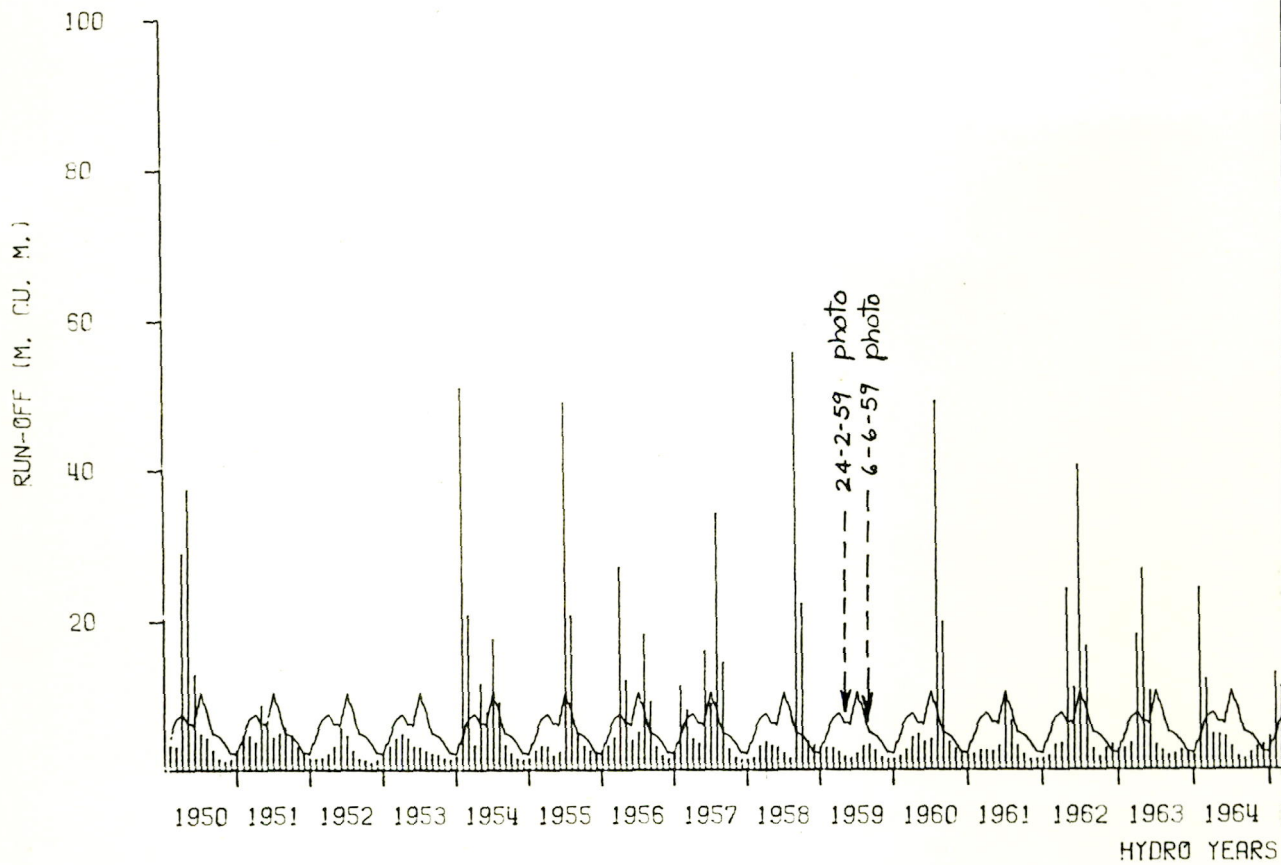
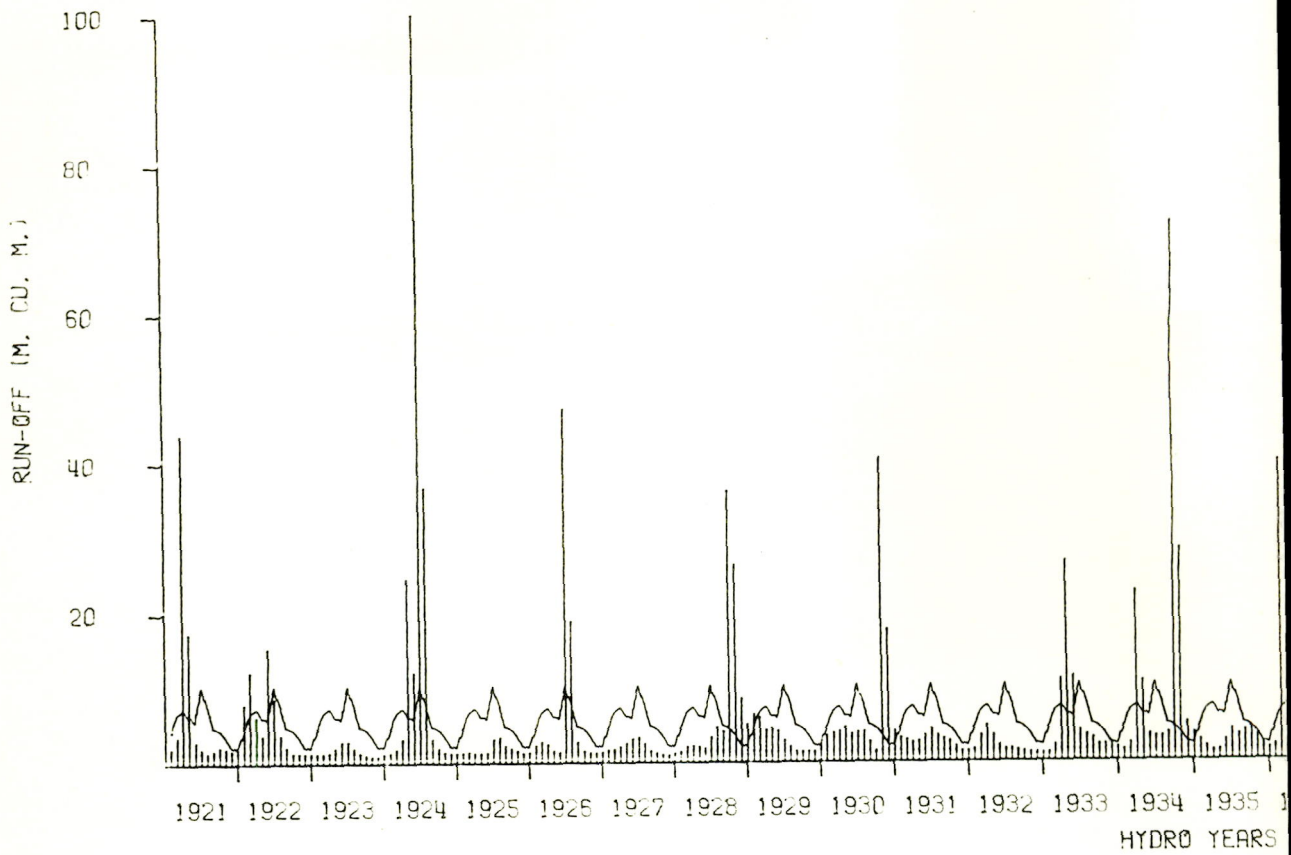
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NATAL ESTUARIES: MPAMPANYONI
 OPEN WATER AREAS 1937-76

FIGURE
 NS 40/2



TRACED : COMPLETE CHECKED : DATE : REF. :	NATAL ESTUARIES - MPAMBANYONI SIMULATED ANNUAL RUN-OFF 1921-1975	FIGURE NS40/3
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



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 REF. :

NATAL ESTUARIES : MPAMBANYONI
 SIMULATED MONTHLY RUN-OFF
 1921-1975

FIGURE
 NS 40/4



SCALE: 1 : 10 000 approx

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DATE
REF

NATAL ESTUARIES MPAMBANYONI
6-7-76 at 12h52
(30-4-37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH
NS 40/1

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SCALE 1:10 000 approx

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DATE
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NATAL ESTUARIES MPAMBANYONI

30-4-37 at 12h30

PHOTOGRAPH
NS 40/2

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SCALE 1:10 000 approx.

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DATE
REF

NATAL ESTUARIES MPAMBANYONI

24-2-59 at 11h07

PHOTOGRAPH

NS 40/3

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SCALE: 1:10 000 approx

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DATE
REF

NATAL ESTUARIES: MPAMBANYONI

6-6-59 at 13h00

PHOTOGRAPH

NS 40/4

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SCALE: 1:10 000 approx.

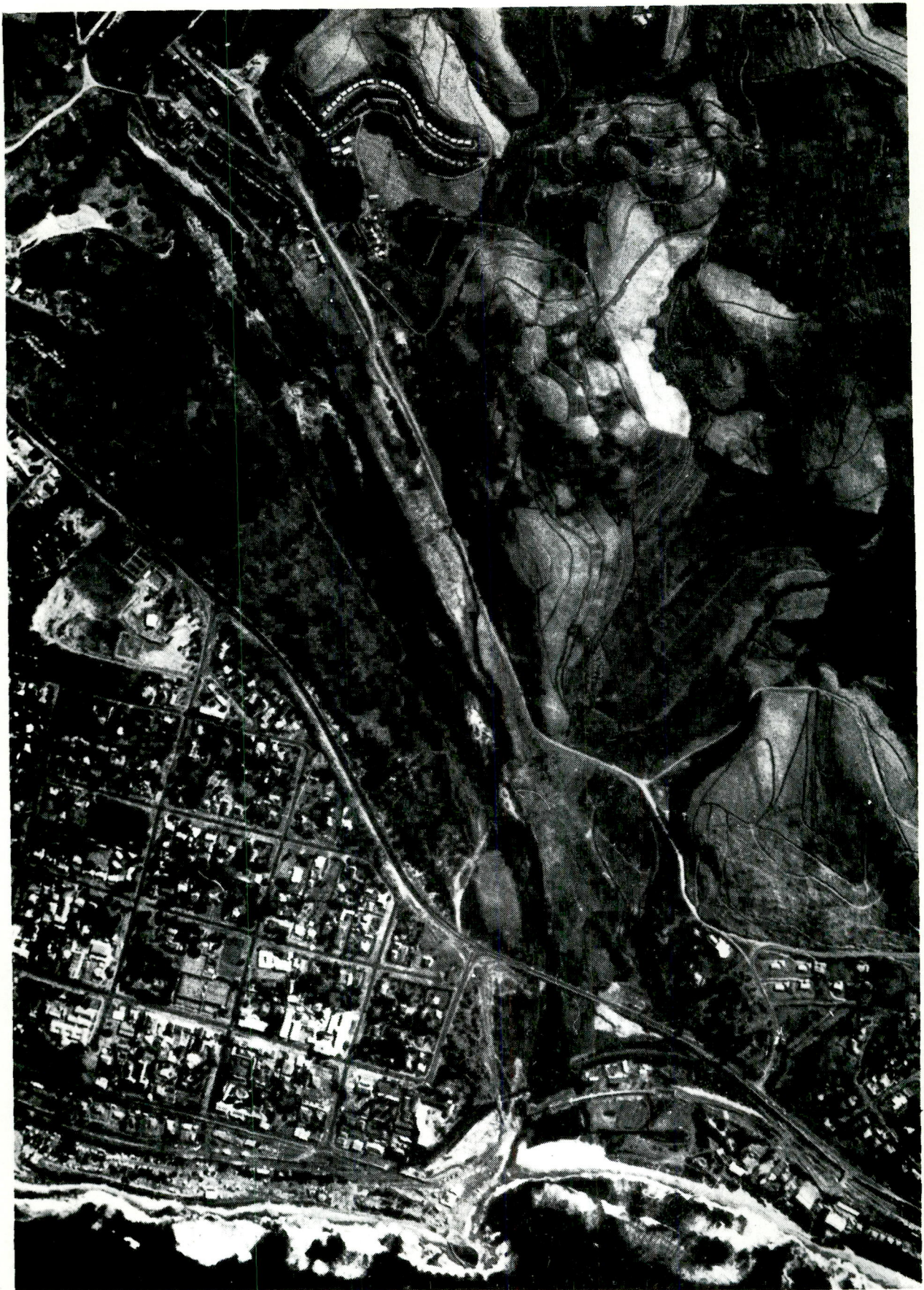
TRACED JGAN
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DATE
REF

NATAL ESTUARIES MPAMBANYONI

18-6-67 at 11h31

PHOTOGRAPH
NS 40/5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE 1 : 10 000 approx.

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES MPAMBANYONI

12-8-73 at 14h26

PHOTOGRAPH

NS 40/6

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx

TRACED JGAN
CHECKED
DATE
REF

NATAL ESTUARIES: MPAMBANYONI

6-7-76 (ORTHOPHOTO)

PHOTOGRAPH

NS 40/7

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