Motu River

Map of River

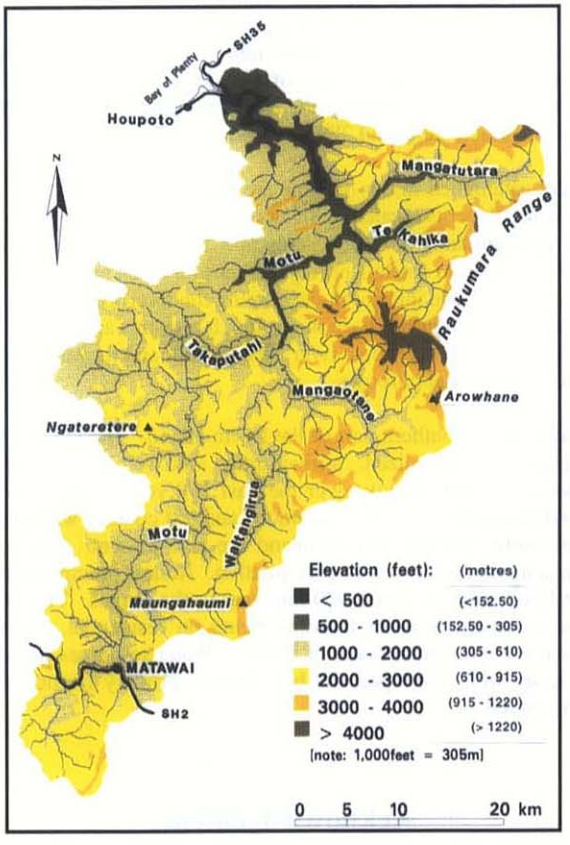
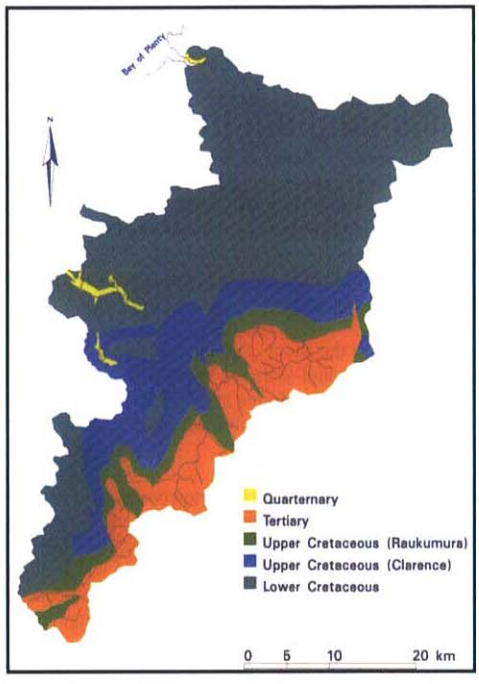


Table of Basic Data

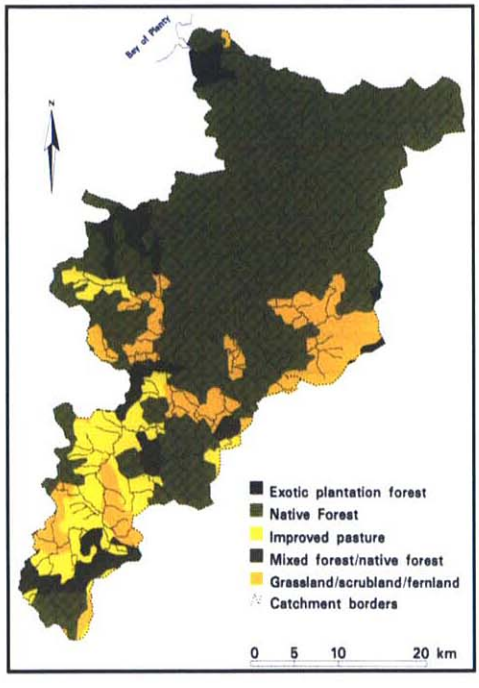
Name: Motu River		**Serial No. :** NZ-2
Location: North Island, New Zealand	S 37° 49' ~ 38° 27'	E 177° 2' ~ 177° 52'
Area: 1,393 km^2 at Houpoto gauging station	**Length of the main stream:** 159 km	
Origin: Matawai, Bay of Plenty district	**Highest point :** unnamed, Raukumara Ra. (1,486 m asl)	
Outlet: Bay of Plenty, South Pacific Ocean	**Lowest Pt. :** River mouth (0m)	
Main geological features : In the north and west, lower Cretaceous greywacke, sandstones and siltstones (Taitai Series) and Upper Cretaceous siltstones (Clarence Series); in the south and east, Upper Cretaceous to Oligocene siltstones and sandstones, and some rhyolitic tuffs. The rocks are extensively folded and faulted, especially towards the Raukumara Range in the east.		
Main tributaries: Takaputahi Stream (244 km^2), Mangaotane Stream (188 km^2), Te Kahika Stream (141 km^2)		
Main lakes: None		
Main reservoirs: None		
Mean annual precipitation: 2,600 mm estimated average for the catchment, 1961-1996		
Mean annual runoff: 91 m^3/s at Houpoto (1,393 km^2) (1957-1995)		
Population: 8,466 in Opotiki District, 1991, which includes the Motu catchment. In the Motu, population is only a few hundreds.	**Only significant settlement:** Matawai	
Land use (1980): Native forest (69.4%), Improved pasture (9.6%), Mixed pasture/fern/shrubland (13.3%), Exotic plantation forest (1.2%), Mixed pasture/native forest (6.5%),		

2. Geographical Information

2.1 Geological Map



2.2 Land Use Map



1. General Description

The Motu River is one of the few remaining major rivers in the North Island whose catchment is in a relatively undisturbed state. It represents a major undeveloped water resource, and has been seriously investigated with a view to developing its hydroelectricity generating potential. However, the decision was made, after exhaustive analysis and public debate, to set it aside from development, in recognition of its considerable scenic value. A National Water Conservation Order was gazetted in 1984, under the "wild and scenic river" provisions of the National Water and Soil Conservation Act (1981 amendment).

The Motu River drains northwestwards from the flanks of the Raukumara Range, one of the axial greywacke ranges of New Zealand. The length of the river along its main stem is 147 km (with a straight-line distance of 70 km); the average slope over much of its course is 0.004 to 0.007, with frequent rapids and three main gorges. With a catchment area of 1,393 km^2 at Houpoto gauging station, near the mouth, the river has a mean annual discharge of about 91 m^3/s, equivalent to a catchment runoff of 2,060 mm/year. Mean annual precipitation is estimated to be 2,600 mm, with a range from 1,400 mm at the coast to 4,000 mm at the top of the ranges, but there are only very sparse measurements on which to base these estimates.

The population of Opotiki District, in which the Motu catchment is located, is 8,646 (1991 census), but only a few hundred of those live in the small settlements and scattered farms of the Motu catchment itself. The catchment is predominantly forest covered - a variety of native forest types, with some exotic coniferous plantations near the coast - with improved pasture in the upper catchment around Matawai settlement. The water resource has not been developed.

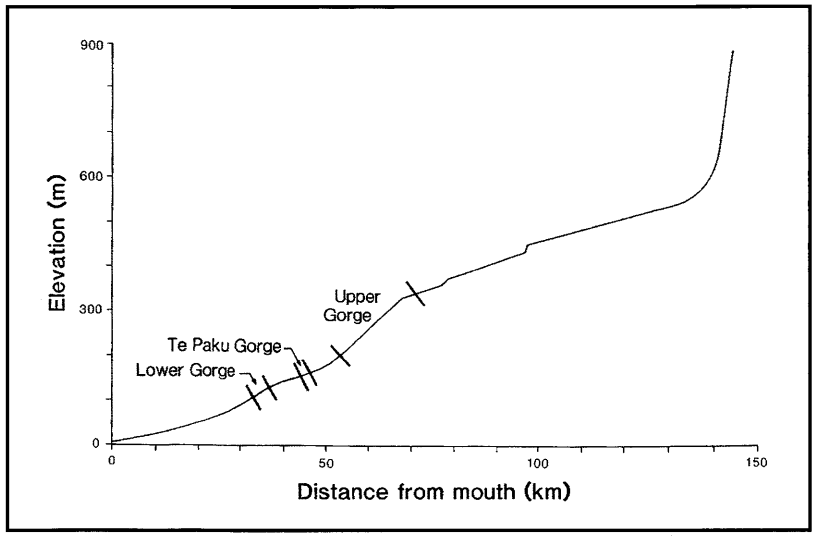
The principal water management issue in the past has related to competition for power generation and recreational purposes. This has effectively been resolved, by the decision to gazette a Water Conservation Order. In the process of investigating the river's power potential, the large flow range (2 year, 24 hour minimum flow of 13.4 m^3/s; 2 year, instantaneous maximum flow of 2,850 m^3/s at Houpoto gauging station) was a significant design issue. The ability of the river to rise rapidly from very low flow to very high flow is a significant risk to recreational users, and a number of deaths have occurred by drowning of people unable to find refuge in the river gorges during a rapidly rising flow.

2.3 Characteristics of the River and Main Tributaries

Name of river	Catchment area [km^2]	Highest peak [m] Lowest point [m]	Settlements (Population in 1991)	Land use (%) (1981)				
				N	P	F	S	M
Motu (main river)	1,463.2	Unnamed, 1,486	Matawai (no data)	69.4	9.6	1.2	13.3	6.5
Mangaotane Stream (tributary)	187.9	Arowhana, 1,439		58.9	0	2.2	38.9	0
Mangatutara Stream (tributary)	112.7	unnamed, 1,486		100.0	0	0	0	0
Takaputahi Stream (tributary)	244.5	Ngateretere, 985		67.7	6.0	0	12.9	13.5
Te Kahika Stream (tributary)	141.3	Unnamed, 1,387		100.0	0	0	0	0
Waitangirua Stream (tributary)	76.4	Maungahaumi, 1,213		61.8	8.9	0	19.4	9.9

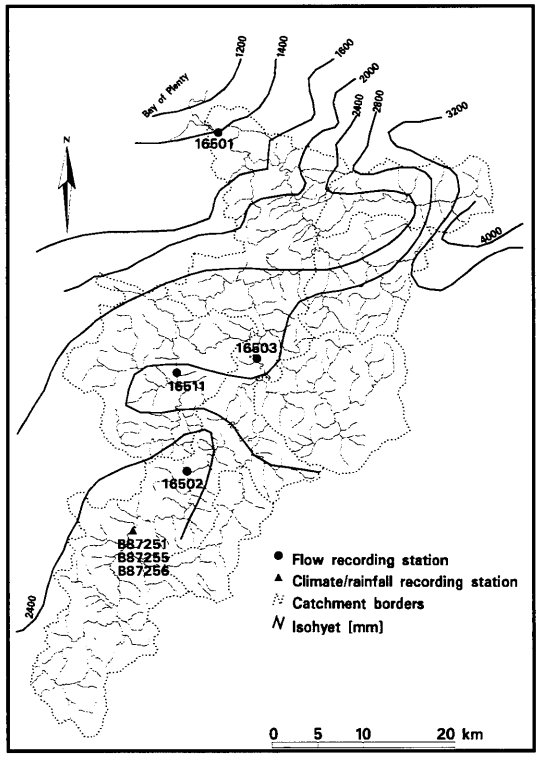
N: Native forest
F: Exotic forest
P: Improved pasture
S: Mixed pasture/fern/shrubland
M: Mixed pasture/forest

2.4 Longitudinal Profiles



3. Climatological Information

3.1 Mean Annual Isohyetal Map and Observation Stations



3.2 List of Meteorological Observation Stations

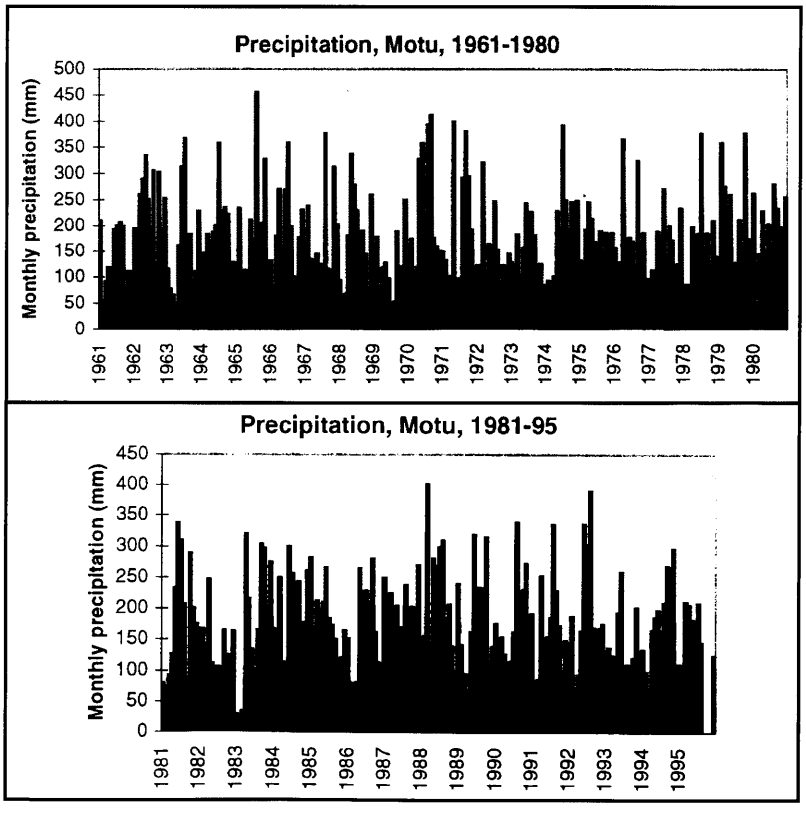
No[1]	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [mm]	Observation items
B87251	**Motu, Te Miro**	463	S 38° 25' E 177° 57'	1920 ~1960	2,104 (1920-60)	Rainfall
B87255	**Motu**	488	S 38° 27' E 177° 55'	1961 ~ present	2,044 (1961-96)	Rainfall
B87256	**Motu AWS**	488	S 38° 28' E 177° 52'	1990 ~ present	2,344 (1995-96)	Automatic Weather Stn

[1] Meteorological Service of NZ code number

3.3 Monthly Climate Data

Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	Motu AWS (B87256)	16.0	15.8	13.3	11.2	8.6	6.0	6.2	6.0	7.9	10.3	12.1	15.2	11.3	1990~1996
Precipitation [mm]	Motu B87255	139	114	139	158	185	205	197	220	194	168	168	168	2,044	1961~1996
Mean daily solar radiation [MJ/m^2/d]	Motu AWS (B87256)	20.8	16.7	14.6	9.48	7.37	5.57	5.78	8.55	11.6	15.7	18.8	22.3	13.0	1990~1996

3.4 Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.2 List of Hydrological Observation Stations

No.[1]	Station	Location[2]	Catchment area (A) [km^2]	Observation period	Observation items (frequency)[3]
16501	**Motu at Houpoto**	X15:181609	1,393	1957 ~ present	Q(15min), S (periodic), WQ(m)
16502	**Motu at Waitangirua**	X16:147233	295	1960 ~ present	Q(15min), S (periodic), WQ(m)
16503	**Motu at Mangaotane**	X16:211354	651	1961~ 63, 1979 ~ 84	Q(15min), S (periodic)
16511	**Takaputahi at Ngawhakatatara**	X16:124338	142	1978 ~ 1984	Q(15min), S (periodic)

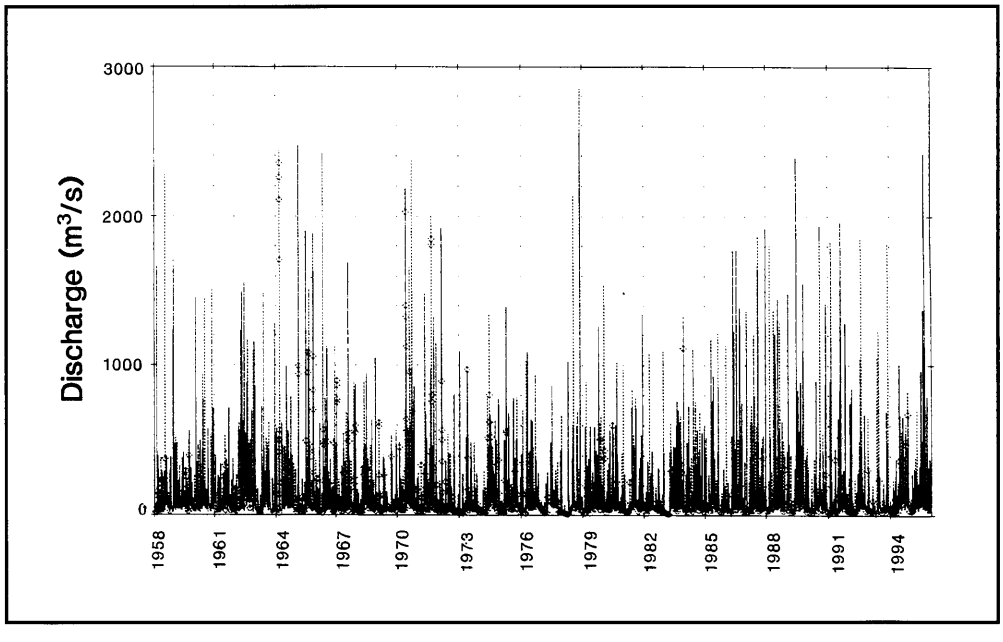
[1]National Institute of Water & Atmospheric Research code number. [2]New Zealand metric map reference.
[3]"Periodic" measurements are taken irregularly, commonly during flood events.
Q(15 minute): discharge recorded at 15 minute intervals; S: sediment concentration; WQ(m): monthly water quality

No.	Q [m^3/s]	Q_{sd} [m^3/s]	Q_{ma} [m^3/s]	Q_{max} [m^3/s]	Q_{min} [m^3/s]	Q/A [m^3/s/ 100 km^2]	Q_{ma}/A [m^3/s/100 km^2]
16501	91.1	130	1,600	2,850	13.4	654	115
16502	13.0	22.0	263	598	1.28	439	89.2
16503	35.6	44.7	459	742	5.14	546	70.5
16511	8.67	14.4	146	343	1.72	611	103

Q: Mean discharge; Q_{sd}: standard deviation of 15-minute discharges; Q_{ma}: mean annual flood; Q_{max}: maximum instantaneous discharge; Q_{min}: mean annual minimum discharge; Q/A: specific mean discharge; Q_{ma}/A: specific mean annual flood

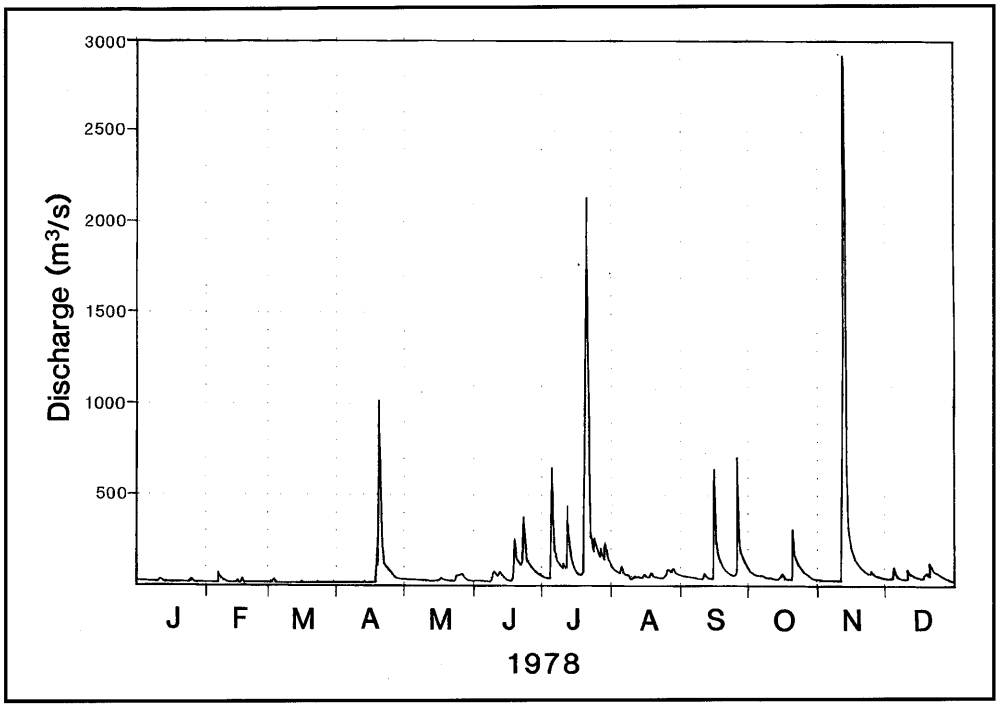
4.3 Long-term Variation of 15-minute Discharge

Motu River at Houpoto



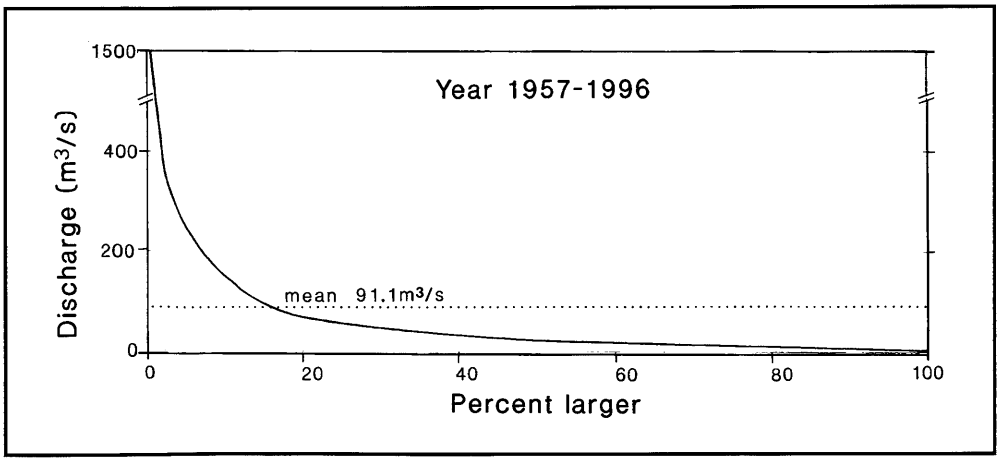
4.4 (a) Annual Pattern of Discharge

Motu River at Houpoto



4.4 (b) Flow Duration Curve

Motu River at Houpoto, 1957-1996



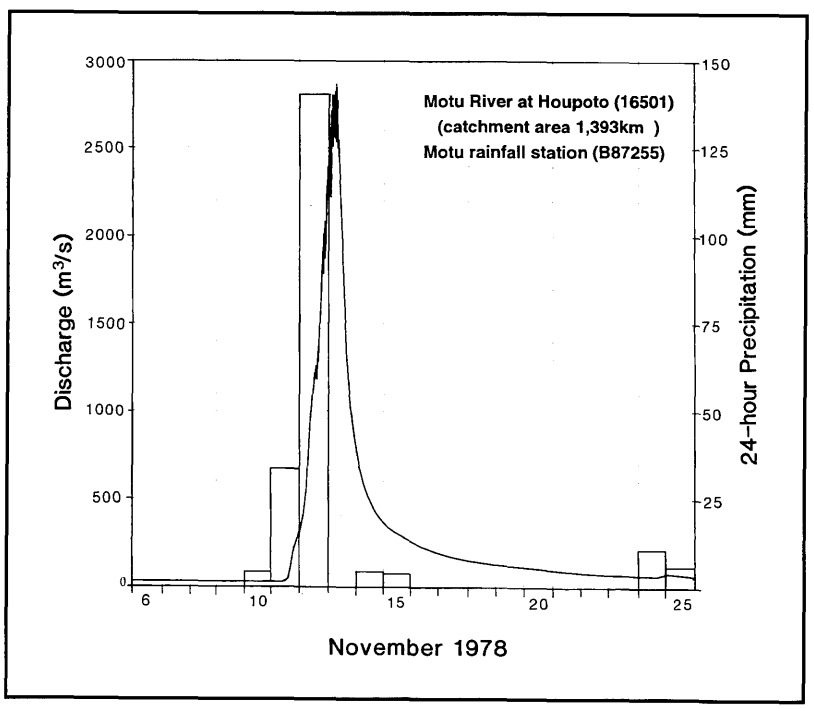
4.6 Annual Maximum and Minimum Discharges

Motu River at Houpoto [1,393 km^2]

Year	Maximum		Minimum		Year	Maximum		Minimum	
	Date	[m^3/s]	Date	[m^3/s]		Date	[m^3/s]	Date	[m^3/s]
1957	6.24	964	5.15	27.7	**1976**	4.30	1,090	3.20	13.7
1958	7.19	2,270	2.17	13.0	**1977**	6.29	870	3.20	10.7
1959	10.06	565	9.18	24.6	**1978**	11.13	2,850	4.17	6.7
1960	11.19	1,520	10.28	18.9	**1979**	10.14	1,260	2.04	11.3
1961	9.18	719	1.14	11.8	**1980**	1.23	1,540	2.23	20.5
1962	6.23	1,560	1.01	17.9	**1981**	12.08	1,350	4.11	12.9
1963	6.06	1,490	4.15	1.2	**1982**	12.12	1,090	9.01	13.1
1964	3.11	2,440	2.27	12.3	**1983**	12.10	1,330	3.23	7.9
1965	2.13	2,470	4.24	14.8	**1984**	6.07	1,110	1.12	10.6
1966	4.26	2,420	3.30	15.4	**1985**	8.26	1,220	10.18	16.6
1967	8.12	1,690	10.29	11.4	**1986**	7.26	1,780	4.22	8.2
1968	12.07	1,050	3.06	12.6	**1987**	12.26	1,920	2.27	15.0
1969	2.07	610	4.18	12.0	**1988**	3.08	1,800	2.07	11.7
1970	9.26	2,380	4.27	17.1	**1989**	6.12	2,390	4.29	13.7
1971	9.07	2,010	4.06	18.0	**1990**	8.07	1,940	3.09	11.9
1972	3.05	1,920	12.24	14.2	**1991**	8.09	1,960	1.23	10.8
1973	1.11	1,090	3.07	11.7	**1992**	8.10	1,860	4.10	12.9
1974	7.03	1,360	2.16	12.2	**1993**	11.21	1,820	2.18	11.2
1975	4.23	1,400	2.14	14.1	**1994**	6.11	1,010	1.24	11.5

MINIMUM is 1.18 m^3/s at 15 April 1963 (This is the recorded value, which seems to be erroneous, and more likely should be approx 6 m^3/s)
MAXIMUM is 2,850 m^3/s on 13 November 1978

4.7 Hyetograph and Hydrograph of a Major Flood



5. Water Resources

5.1 General Description

The Motu River, with a catchment area of approximately 1,400 km^2, is located in the northeast of the North Island. It flows to the Bay of Plenty, part of the Pacific Ocean, and its headwaters are in the Raukumara Range, with a maximum elevation of 1,486 m. The catchment is exposed to winds from northerly quarters, and receives particularly heavy precipitation when warm and humid air streams come from the north and northeast. In general, however, the catchment has a winter (June-August) rainfall maximum, and this is when river flows are greatest. Mean annual rainfall varies from about 1,400 mm at the coast to about 4,000 mm at the top of the ranges.

Vegetation cover is modified over approximately 30% of the catchment, with nearly 70% in native forest (some of which is degraded by introduced browsing animals), 10% in improved pasture, and the remaining 20% in mixed grassland, forest, fernland and shrubland. It is unlikely that modification of the vegetation cover has had a significant impact on the hydrological behaviour of the catchment, however.

Flows at the mouth of the catchment (Motu River at Houpoto, catchment area of 1,393 km^2) range, during the period of record 1957-95, between 6 and 2,850 m^3/s (0.5 to 205 $m^3/s/100\ km^2$). Mean discharge is 91 m^3/s (6.54 $m^3/s/1000\ km^2$), and mean annual flood is 1,150 m^3/s (115 $m^3/s/1000\ km^2$); the specific mean discharge is among the highest for a medium-sized catchment in the North Island, although flood discharges are not extreme, on an island-wide scale. The probable maximum flood was estimated in 1980 to be 8,300 m^3/s at Houpoto, and the flood with a recurrence interval of 100 years is estimated at 3,160 m^3/s. The one-day flow with a recurrence interval of two years is 13.4 m^3/s; lowest flows normally occur in late summer (February and March).

The water resource is essentially undeveloped, and there are no water resource facilities or systems in the Motu River basin. The catchment has been thoroughly investigated for its hydro-electricity potential, but the decision to protect the catchment via a National Water Conservation Order has for the time being removed the possibility of development. The catchment is extremely lightly populated, so that floods and droughts have little significance in the normal way. Usage of the river is principally for recreation - rafting and kayaking. Floods present significant hazards to recreationists, because once they have embarked on a journey through the series of river gorges they have limited escape routes. On the other hand, low flows present a serious limitation on recreation. The optimal flow is 55-75 m^3/s at Houpoto, and there have been numerous periods during which flows have fallen below this level for several days. During March (a prime month for recreation), flows can be expected to exceed 45 m^3/s (50% of mean flow) only 33% of the time.

5.2 Major Floods and Droughts

There is no comprehensive record of major floods or droughts, other than at the hydrological recording stations, because practical impacts on human activity are negligible.

5.3 Water Quality

The waters of the Motu River are low in major ions and nutrients, and clear and well-oxygenated under normal flows. During normal low flows, water clarity is in the range 2-3 m; dissolved oxygen is normally in the range of 96-102% saturation. Algal populations are low in numbers, and the algal communities are indicative of oligotrophic conditions. During floods, water appearance deteriorates markedly because of high suspended sediment loads. Average annual suspended sediment yield (1958-78) was 766 m^3/km^2, or 1,067,000 m^3/year for the whole catchment.

River Water Quality, Motu River at Houpoto[1], 1993

Date	Jan 27	Feb 24	Mar 24	Apr 21	May 19	Jun 16	Jul 14	Aug 12	Sep 9	Oct 7	Nov 3	Dec 9
pH	7.81	7.73	7.91	7.91	8.13	7.62	7.78	7.71	7.65	7.94	8.05	7.72
BOD [mg/l]	0.3	0.5	0.2	0.4	0.05	0.05	0.25	0.15	0.15	0	0.1	0.35
Conductiv-ity µS/cm)	114	86	115	115	72	74	98	89	92	117	93	102
Turbidity [NTU]	0.9	125	2.7	1.0	300	180	8.8	23	15	0.6	5.0	3.2
Total N [ppb] [2]	60	245	55	65	400	270	190	110	85	50	90	85
Total P [ppb] [3]	12	200	10	13	450	245	26	35	25		21	32
Discharge [m³/s]	18.4	98.5	19.4	15.7	402	240	43.0	49.0	52.7	22.0	58.2	53.5

[1]Site 16501
[2]Alkaline persulphate digestion, cadmium column reduction, nitrite finish
[3]Persulphate digestion, manual ascorbic acid reduction

6. Socio-cultural Characteristics

The name of the river, Motu, means "an isolated place" in Maori, the language of the first colonists of New Zealand. The catchment is remote from the main population centres of the North Isalnd, and very lightly populated, with nearly 70% covered by native forest and only two roads crossing it. There is extensive pastoral land use in the upper catchment, in the vicinity of the settlement of Matawai, on the main inland highway from Whakatane to Gisborne. Forest plantations have been developed near the mouth of the river, where there is access to the coastal road from Whakatane to Gisborne. More extensive areas have, in the past, been developed for pasture, but much has been allowed to revert to shrubland and fernland, or is being converted to exotic forest (radiata pine) plantations.

The Motu River is very popular for recreation - fishing, rafting, and kayaking. A raft trip through the wilderness section of the river takes 3-4 days, so the river appeals to tourists who are not pressed for time, and the numbers involved would be considerably fewer than for rivers which offer shorter trips. The catchment, parts of which have high numbers of introduced deer and goats, is also popular for recreational hunting.

7. References, Databooks and Bibliography

McColl, R. H. S. (1986): *Motu River: a description of its catchment, channel, waters and sediments,* Water & Soil Miscellaneous Publication 92, Ministry of Works & Development, Wellington, 60 p (all sections).

McKerchar, A. I., and Pearson, C. P. (1989): *Flood frequency in New Zealand,* Publication 20 of the Hydrology Centre, DSIR, Christchurch, 87 pp (4.5, 4.6).

Mosley, M. P. (editor), (1992): *Waters of New Zealand,* New Zealand Hydrological Society, Wellington, 431 pp (1, 2.3).

Quayle, A. M. (1984): *The climate and weather of the Bay of Plenty Region,* N Z Meteorological Service Miscellaneous Publication 115 (1), 2nd Edition, 56 pp (1, 3.1 to 3.4).

Riddell, D. C. (1980): *Flood hydrology of the Motu River,* Journal of Hydrology (NZ), 19, 35-48 (4.5, 4.6).

Smith, D. G. (1994): *The National Water Quality Network,* Fifth annual report: 1993. Consultancy Report No. NIB400/1, National Institute of Water & Atmospheric Research, Hamilton, 6pp and 2 appendices (5.3).

Tomlinson, A. I. and Sansom, J. (1994a): *Temperature normals for New Zealand,* NIWA Science and Technology Series No. 4, National Institute of Water & Atmospheric Research, Wellington, 18 pp. (3.2, 3.3).

Tomlinson, A. I. and Sansom, J. (1994b): *Rainfall normals for New Zealand,* NIWA Science and Technology Series No. 3, National Institute of Water & Atmospheric Research, Wellington, 20 pp. (3.2, 3.3).

Young, D, and Foster B. (1986): *Faces of the river,* TVNZ Publishing, Auckland, pp 51-72 (1).