Shimanto-gawa

Map of River

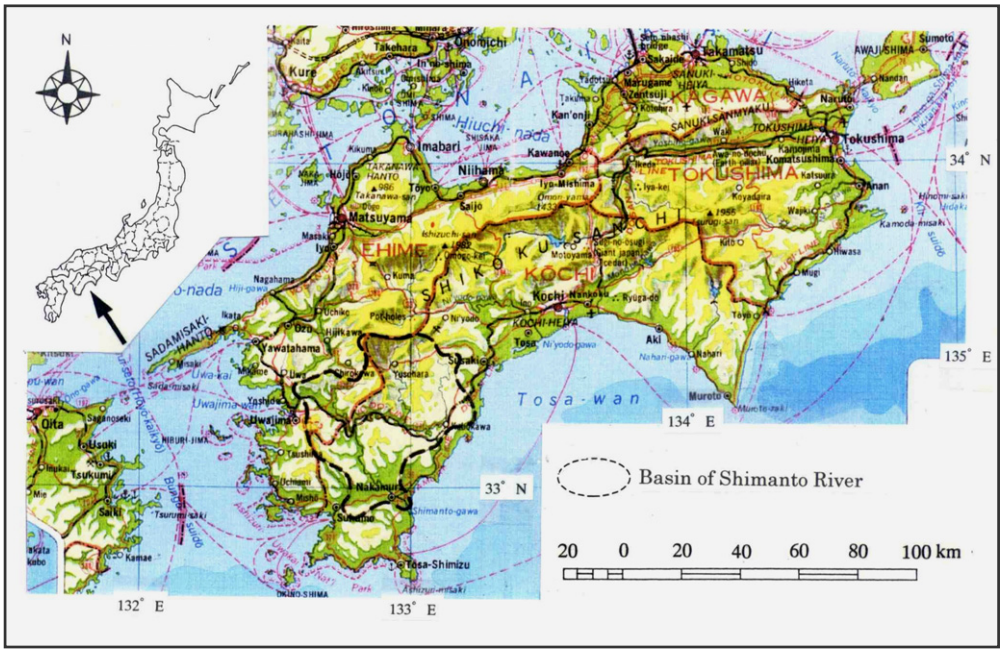


Table of Basic Data

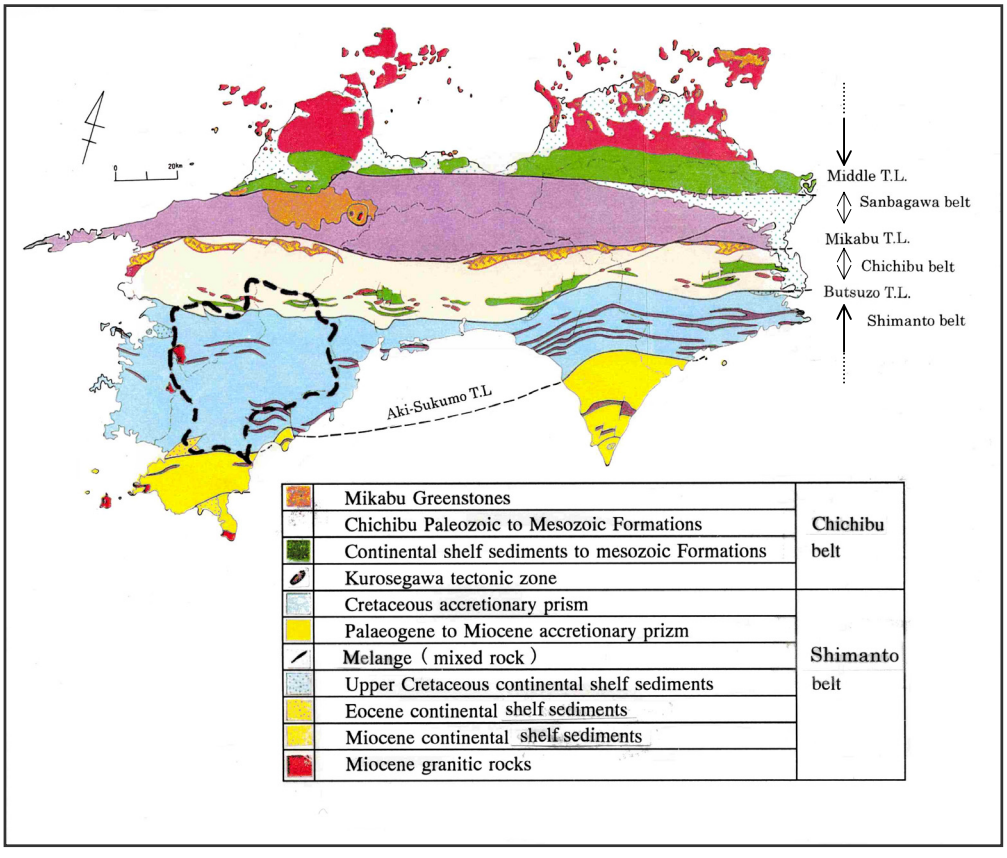
Name: Shimanto-gawa		**Serial No.:** Japan - 7
Location: Shikoku Island , Japan	N 32° 54'44" ~ 33°28'41"	E 132° 33'49" ~ 133°14'04"
Area: 2 270 Km^2	**Length of main stream :** 196 km	
Origin: Mt. Irazu (1 336 m)	**Highest point :** Tengu Highland (1 485 m)	
Outlet: Pacific Ocean	**Lowest point :** River Mouth (0 m)	
Main geological features: Cretaceous accretionary prism (Shimanto Belt)		
Main tributaries: Yusuhara River (458.1 km^2), Hiromi River (348.4 km^2), Ushiro River (206.4 km^2), Nakasuji River (144.5 km^2)		
Main lakes: None		
Main reservoirs: Tsuga reservoir (19.3×10^6 m^3 , 1944)		
Mean annual precipitation: 2 592 mm (basin average)		
Mean annual runoff: 119.2 m^3/s at Gudo (1 807.6 km^2) (1952 ~1996)		
Population: 103 000 (1990)	**Main cities:** Nakamura, Kubokawa	
Land use: Forest (87 %), Rice paddy (3 %), Other agriculture (2 %), Urban (7 %) (1990)		

1. General Description

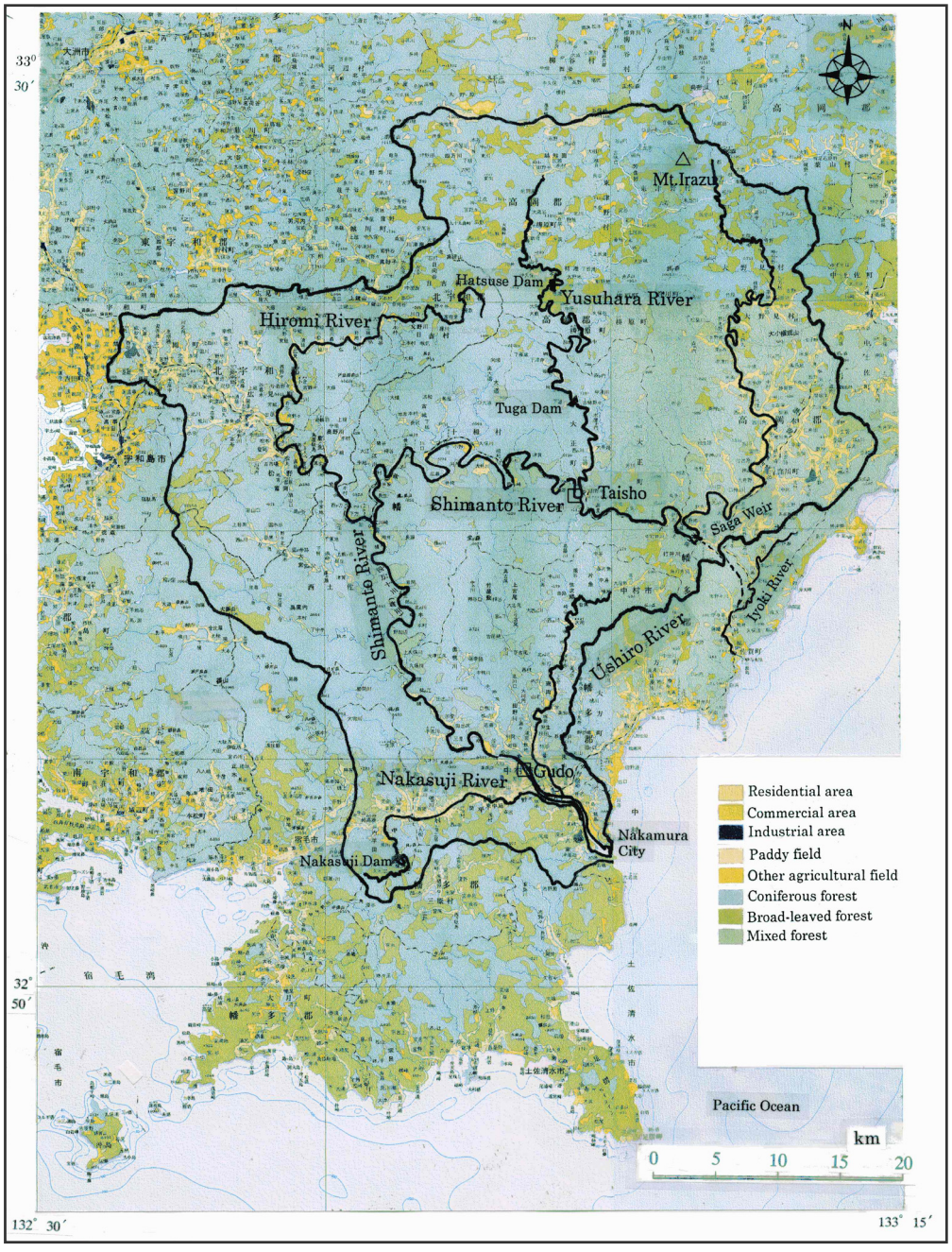
The Shimanto River, 196 km long and draining an area of 2 270 km^2, is one of the largest rivers in Shikoku Island. Originating from Mt. Izaru (1 336 m), it runs meandering through the central part to the western part of the island before flowing out into the Pacific Ocean. The catchment receives an average annual precipitation of 2 600 mm. It is an area of heavy rainfall in Japan, where the greater part of the annual precipitation is brought about by extra-tropical cyclones, which frequently pass to the south of the basin during the warm season (April - October). Baiu fronts bring rainfall in June and July and typhoons from August to October. Most of the precipitation is caused by typhoons. The mean annual discharge, mean maximum discharge and the mean minimum discharge at Gudo (with an area of 1 807.6 km^2) have been 119.2 m^3/s (6.6 m^3/s/100 km^2), 4 987 m^3/s and 8.69 m^3/s respectively, while the value of 574 for the coefficient of the river regime is very large. The population in the basin in 1990 was about 103 000. Because the population density in the basin is low (45 persons/km^2), and because the social demands of development are low, the Shimanto River is identified as one of the natural rivers in Japan.

2. Geographical Information

2.1. Geological Map



2.2. Land Use Map

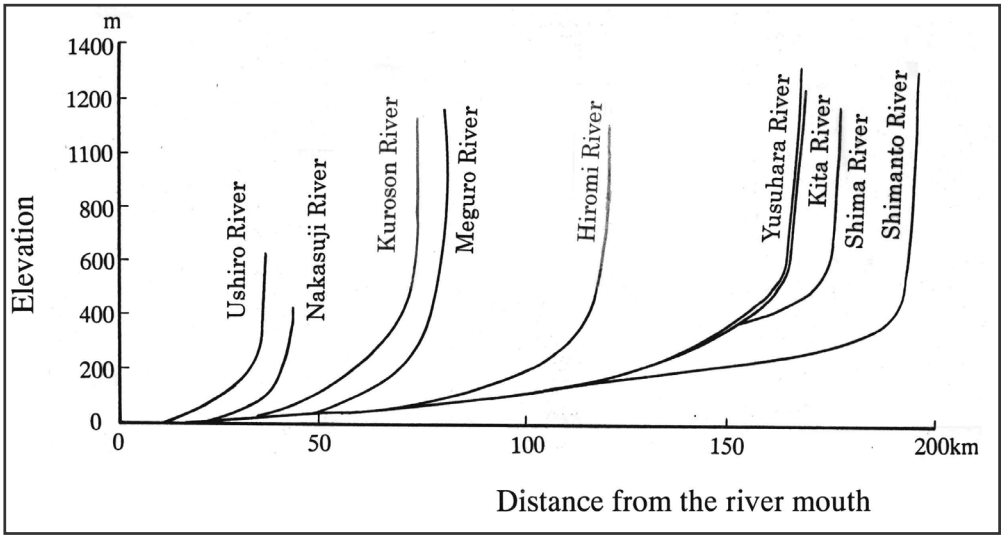


2.3. Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km^2]	Highest peak [m] Lowest point [m]	Cities population (1985)	Land use [%] (1990)
1	**Shimanto** (Main river)	196 1 807.6	1 336 0	Nakamura City, etc 68 200	A• O(2) F(87) L(1) P(3) U(7)
2	**Yusuhara** (Tributary)	68.1 458.1	1 485 130	Yusuhara town, etc 9 600	
3	**Hiromi** (Tributary)	56.3 348.4	1 055 29	Hiromi town, etc 26 400	
4	**Ushiro** (Tributary)	35.5 206.4	678 1	Nakamura City, etc 18 800	
5	**Nakasuji** (Lower branch)	36.4 144.5	458 1.5	Nakamura City, etc 13 300	

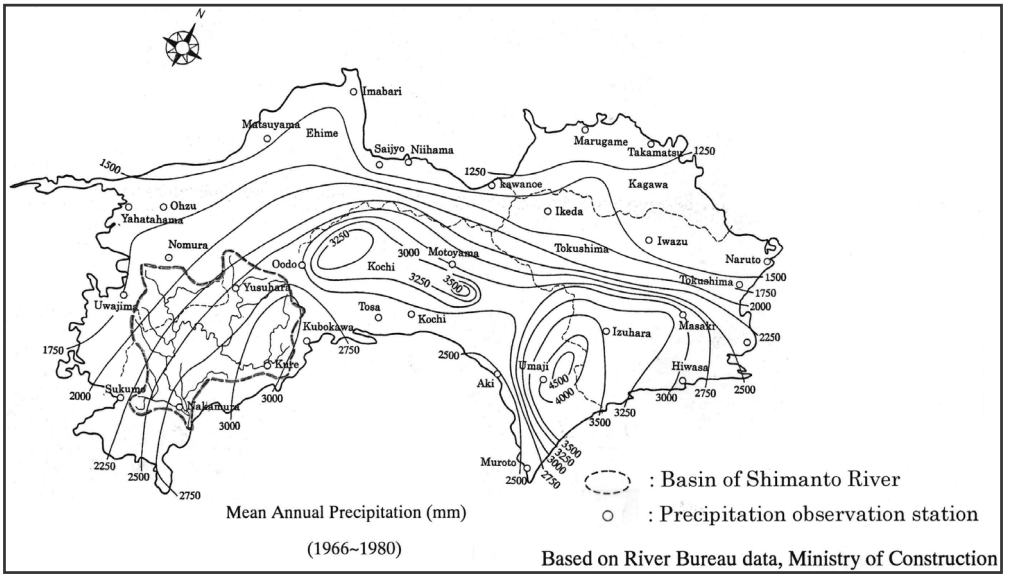
P: Paddy field O: Orchard A: Other agricultural field (vegetable, grass) F: Forest L: Lake, River, Marsh U: Urban

2.4. Longitudinal Profiles



3. Climatological Information

3.1. Annual Isohyetal Map and Observation Stations



3.2. List of Meteorological Observation Stations

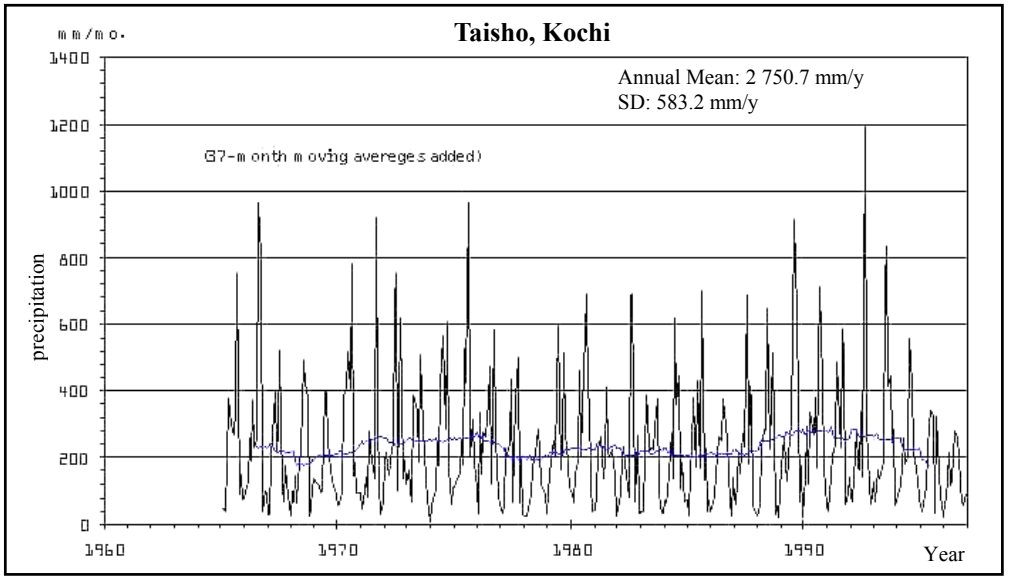
No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [1] [mm]	Mean annual evaporation	Observation items [2]
80302*	**Funato**	430	N 33°25'09" E 113°05'09"	1943~present	3 349	-	P (TB)
80303*	**Onomi**	330	N 33°19'55" E 133°08'45"	1941~present	3 318	-	P (TB)
80306*	**Taisho**	160	N 33°10'32" E 132°58'31"	1951~present	2 734	-	P (TB)
80309*	**Yoshifuji**	120	N 33°14'04" E 132°39'46"	1932~present	1 884	-	P (TB)
80313*	**Tomiyama**	70	N 33°06'00" E 132°58'18"	1951~present	2 478	-	P (TB)
80316*	**Yamana**	15	N 32°57'59" E 132°49'08"	1981~present	2 457	-	P (TB)
74516* *	**Shimizu**	31	N 32°43'12" E 133°00'48"	1941~1960	2 571	1 519	P (TB)

*: Serial number used by River Bureau, Ministry of Construction.
**: Meteorological Observatory, Japan Meteorological Agency.
1) Period for the mean is from the beginning of the observation to 1996.
2) P: Precipitation, TB: Tipping bucket with recording chart.

3.3. Monthly Climate Data

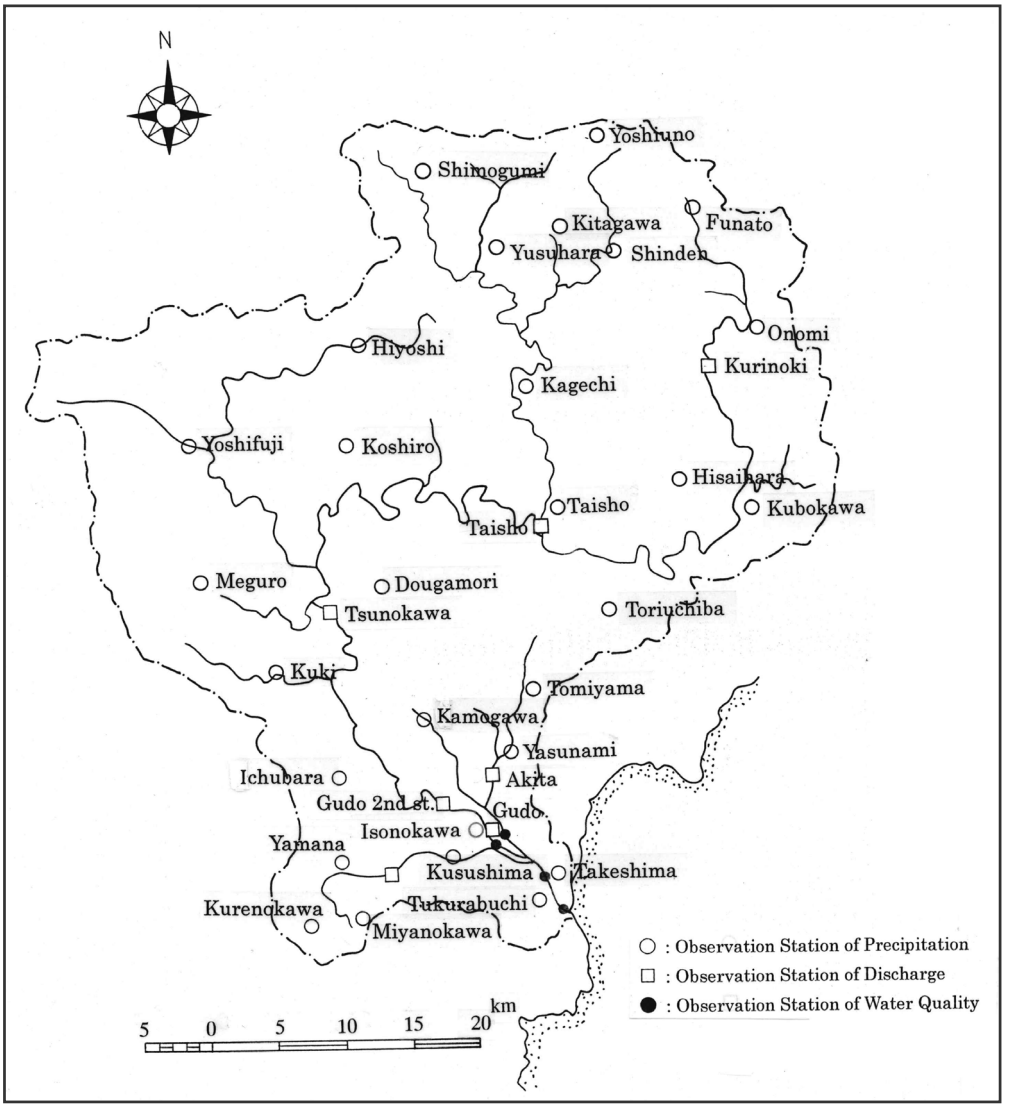
Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [ºC]	Shimizu	8.1	8.8	11.8	16.5	19.8	22.6	26.1	27.2	24.9	20.4	15.8	10.7	17.7	1961 ~1990
Precipitation [mm]	Shimizu	85.4	117.0	168.3	246.0	265.3	344.3	239.9	246.7	324.4	243.9	135.2	71.3	2 487.7	1961 ~1990
Evaporation [mm]	Shimizu	91.7	91.4	116.8	137.1	139.3	127.3	163.3	183.3	144.4	129.3	102.1	93.1	1 519.2	1941 ~1960
Solar radiation [MJ/m^2/d]	Shimizu	10.4	12.0	14.1	16.3	17.1	16.2	19.3	19.0	15.0	13.0	10.3	9.9	14.4	1974 ~1990
Duration of sunshine [hr]	Shimizu	180	164	185	173	183	150	218	235	176	177	165	177	2 183	1961 ~1990

3.4. Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1. Map of Streamflow Observation Stations



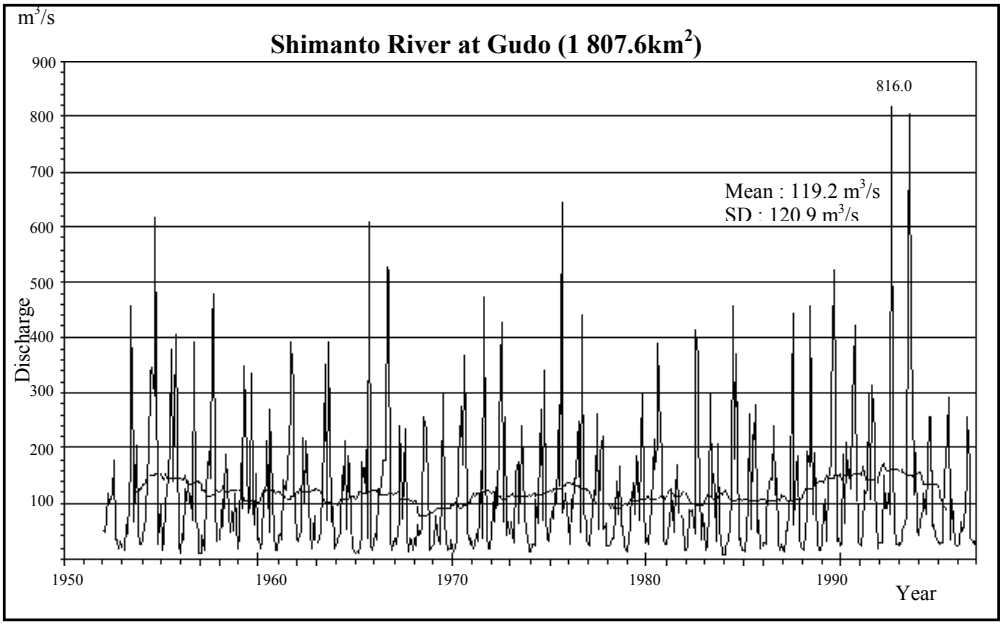
4.2. List of Hydrological Observation Stations

No.*	Station	Length to river mouth [km]	Catchment area (A) [km^2]	Observation period	Observation items [1] (frequency)
80303	**Taisho**	93.00	942.0	1940~present	Q
80304	**Gudo**	9.55	1 807.6	1931~present	Q~WQ
80305	**Akita**	7.20	145.7	1966~present	Q
80306	**Isonokawa**	14.35	93.9	1955~present	Q

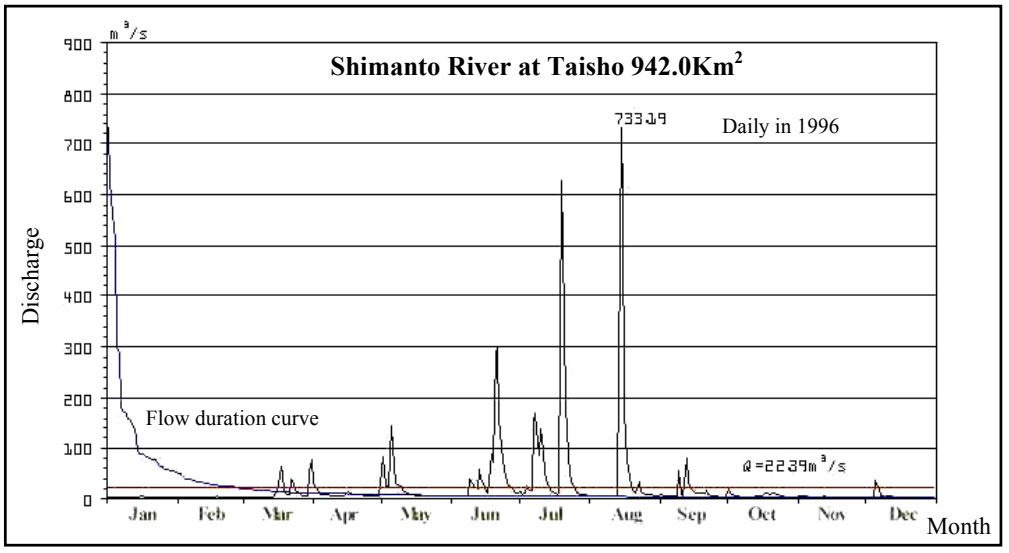
No.*	$\overline{Q}$ [2] [m^3/s]	Q max [3] [m^3/s]	$\overline{Q}$ max [4] [m^3/s]	$\overline{Q}$ min [5] [m^3/s]	$\overline{Q}$ / A [m^3/s/100km^2]	Q max / A [m^3/s/100km^2]	Period of statistics
80303	49.0	9 096	3 684	1.31	0.14	391	1960~1996
80304	119.2	13 381	4 987	8.69	0.48	276	1952~1996
80305	7.7	1 736	625	0.13	0.09	429	1979~1996
80306	6.2	980	307	0.42	0.45	327	1953~1996

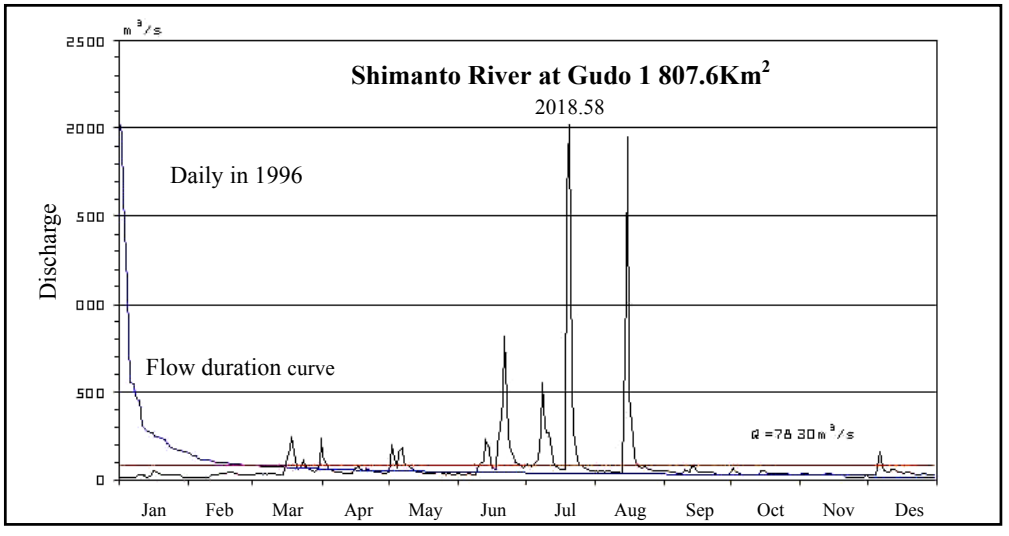
*:Serial number by River Bureau, Ministry of Constraction
1) Q: Discharge, WQ: Water quality
2) Mean annual discharge
3) Maximum discharge
4) Mean maximum discharge
5) Mean minimum discharge

4.3. Long-term Variation of Monthly Discharge



4.4. Annual Pattern of Discharge





4.5. Annual Maximum and Minimum Discharges

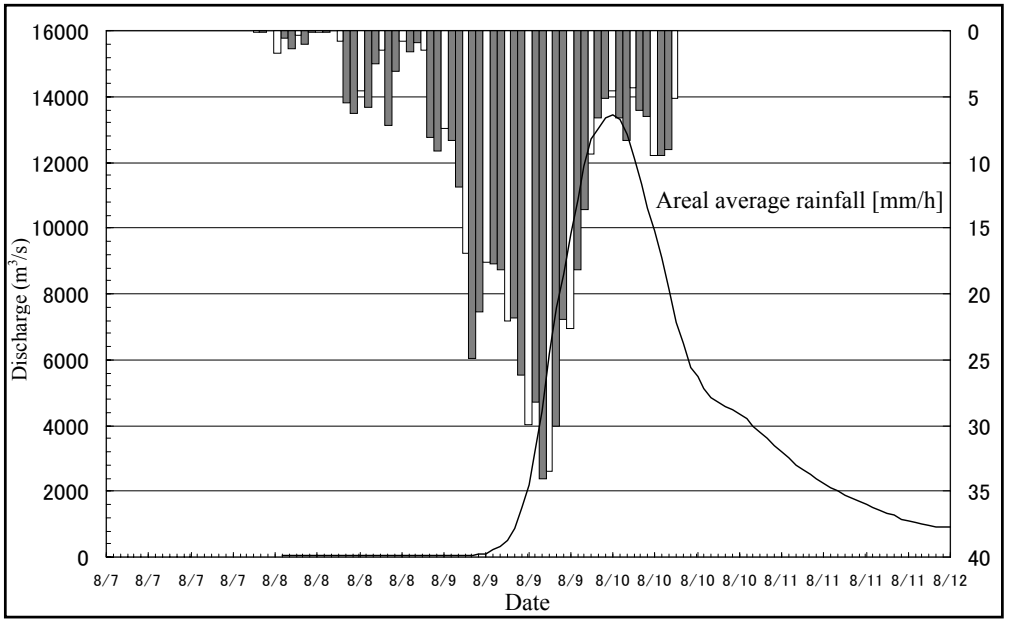
At Gudo [1 807.6 km^2]

Year	Maximum [1]		Minimum [2]		Year	Maximum [1]		Minimum [2]	
	Date	[m^3/s]	Date	[m^3/s]		Date	[m^3/s]	Date	[m^3/s]
1975	8.17	8 521	12.26	21.62	**1986**	7.13	2 055	12.03	4.61
1976	9.07	3 874	2.01	15.24	**1987**	7.17	4 088	2.11	3.19
1977	8.25	4 024	12.29	9.03	**1988**	6.25	4 581	2.21	8.21
1978	8.03	2 789	12.22	7.06	**1989**	8.27	6 015	1.01	3.13
1979	6.29	6 133	1.24	4.91	**1990**	8.22	6 290	8.12	11.21
1980	8.05	4 920	2.18	9.50	**1991**	9.28	2 402	11.27	10.96
1981	8.01	1 419	12.17	5.80	**1992**	8.19	9 351	12.27	9.00
1982	8.27	10 229	1.15	7.28	**1993**	8.10	6 582	1.04	10.12
1983	9.27	3 370	12.21	3.27	**1994**	7.26	4 640	12.08	24.72
1984	6.17	3 444	1.04	4.28	**1995**	7.04	3 471	2.28	19.02
1985	6.22	2 160	2.04	5.37	**1996**	7.20	3 881	1.06	18.02

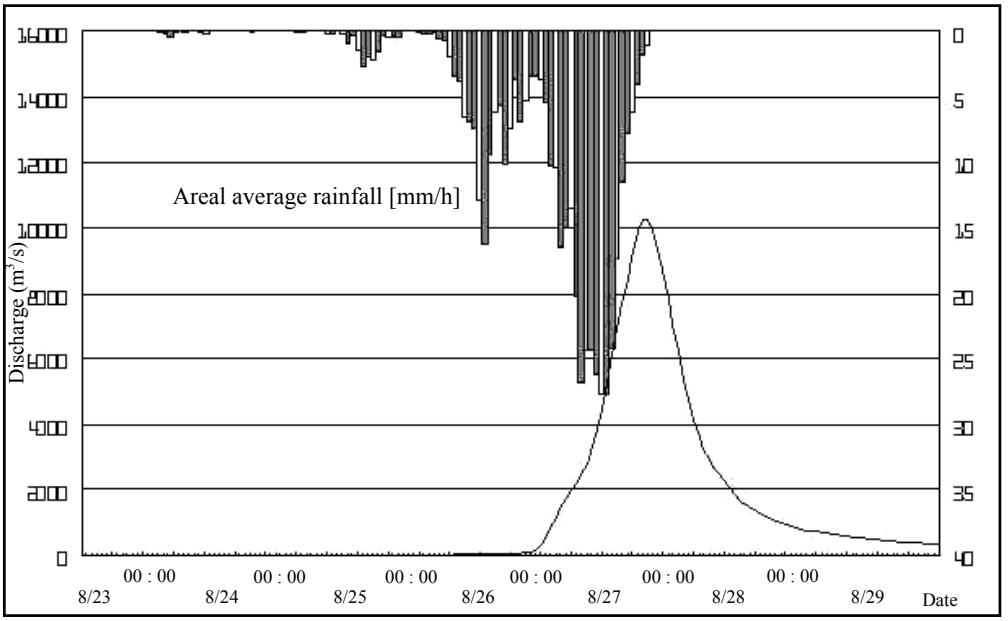
1), 2) Instantaneous observation by recording chart

4.6. Hyetographs and Hydrographs of Major Floods

Gudo 1963 August



Gudo 1982 August



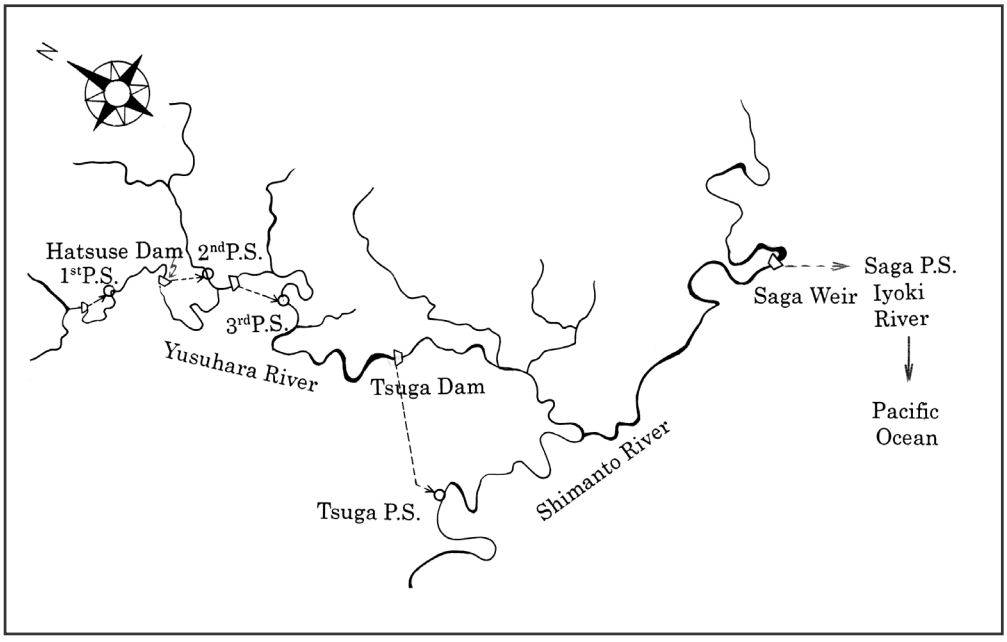
Based on River Bureau data, Ministry of Construction

5. Water Resources

5.1. General Description

Since the past, water of the Shimanto river has been used mainly for agriculture. At present, it irrigates agricultural areas of 6 800 ha, and supplies municipal and industrial water to Nakamura City. Besides, six power stations (the 1st Power Station, the 2nd P.S., the 3rd P.S., Tsuga P.S. built along its tributary, Yusuhara River, Matsubagawa P.S. built in the upstream of the main stream, and Saga P.S. built in the Iyoki River outside the basin) generate a maximum electric power of 42 450 kW. The hydropower water (3.63 m^3/s at ordinary times and 12.52 m^3/s at the maximum) used at Saga power station through the Saga diversion weir flows out to the Pacific Ocean directly through Iyoki River outside of the basin. Because the Tsuga dam was built before the Second World War, it had no responsibility of releasing enough water to maintain streamflow downstream, and there were reaches with little water for ecosystems in the down stream of Tsuga dam. At the time of the renewal of hydropower water use in 1994, it was decided to discharge 1.91 m^3/s during the summer period from April 1 to September 30 and 1.15 m^3/s during the winter period from October 1 to March 31, from Tsuga dam to solve the problem of the "little water reaches". After the Second World War, during the 54 year period from 1945 to 1998, floods with discharges in excess of 5 000 m^3/s (2.77 $m^3/s/km^2$) have occurred 33 times at Gudo, and all the floods were caused by heavy rainfalls related to typhoons. The maximum flood discharge of 13 380 m^3/s (7.40 $m^3/s/km^2$) at Gudo was recorded by the Typhoon 6320 that occurred in 1963.

5.2. Map of Water Resources Systems



5.3. List of Major Water Resources Facilities

Major Reservoirs

Name of river	Name of weir or dam (reservoir)	Catchment area [km^2]	Gross capacity [10^6 m^3]	Effective capacity [10^6m^3]	Purpose[1)]	Year of completion
Shimanto	**Saga**	377.7		0.894	P	1931
Yusuhara	**Hatsuse**	171.2	1.454	1.121	P	1937
	Tsuga	381.0	19.300	14.000	P	1944
Nakasuji	**Nakasuji**	21.1	12.600	12.000	FNAWI	1999

Major Interbasin Transfer

Name of transfer line	Name of rivers and places connected		Length [km]	Maximum capacity [m^3/s]	Purpose[1)]	Year of completion
	From	To				
Saga Power Station	**Shimanto River**	**Iyoki River**	6.87	12.52	P	1931

1) A: Agricultural use
F: Flood control
I: Industrial use
N: Maintenance of normal flows
P: Hydro-power
W: Municipal water supply

5.4. Major Floods and Droughts

Major Floods at Gudo (1 807.6 km^2)

Date	Peak discharge [m^3/s]	Rainfall[mm] Duration [day]	Meteorological cause	Dead and missing	Major damages (Districts affected)
1963.8.9	13 381	697 7~10	Typhoon 6309	1	Nakamura City
1966.8.15	4 920	547 13~17	Typhoon 6613	0	Nakamura City
1970.8.21	8 552	313.5 20~21	Typhoon 7010	0	Nakamura City
1971.8.29	9 847	570 28~30	Typhoon 7123	0	Nakamura City
1972.7.23	7 617	393.5 22~25	Typhoon 7209	0	Nakamura City
1975.8.16	8 521	412.0 16~17	Typhoon 7505	0	Nakamura City
1979.9.30	6 133	273.5 29~30	Typhoon 7916	0	Nakamura City
1982.8.27	10 229	444.5 24~28	Typhoon 8213	0	Nakamura City
1992.8.19	9 351	557 17~19	Typhoon 9211	0	Nakamura City
1993.8.10	6 582	285 7~10	Typhoon 9307	0	Nakamura City

5.5. Groundwater and River Water Quality

River Water Quality [1] at Gudo[2] in 1997

Date	Jan 8	Feb 5	Mar 6	Apr 23	May 19	Jun 19	Jul 22	Aug 17	Sep 24	Oct 16	Nov 17	Dec 15
pH	8.3	7.7	7.8	7.7	7.5	7.8	8.0	7.6	7.5	7.5	7.4	7.9
BOD [mg/l]	0.4	0.4	0.5	1.1	0.5	0.3	0.2	0.5	0.6	0.2	0.4	0.2
COD_{Mn} [mg/l]	0.7	1.0	1.2	1.3	1.4	1.4	1.0	1.2	0.9	1.0	0.6	0.9
SS [mg/l]	<1	<1	<1	<1	1	<1	<1	2	<1	<1	<1	<1
Coliform group[3] [MPN/100ml]	2.3 $\times 10^2$	4.1 $\times 10^2$	1.7 $\times 10^2$	4.9 $\times 10^2$	1.7 $\times 10^3$	1.7 $\times 10^3$	2.2 $\times 10^4$	2.2 $\times 10^4$	1.3 $\times 10^4$	4.6 $\times 10^2$	1.1 $\times 10^4$	7.0 $\times 10^2$
Discharge[4] [m^3/s]	28.12	26.52	28.01	35.63	84.26	32.83	54.52	67.48	77.44	37.89	35.82	30.60

1) Observed once a month on a dry day normally several days after rainfall.
2) Located in Nakamura City 9.55 km upstream from the river mouth.
3) Measurement method: BGLB (brilliant green lactose bile) culture MPN (most probable number) method.
4) Daily discharge when the water quality was observed.

6. Socio-cultural Characteristics

The Shimanto-gawa is one of the few rivers in Japan where plentiful nature is left undisturbed. The Shimanto has beautiful green river-scapes, clear blue graceful flow, and people co-inhabiting with, and is called “the last limpid stream in Japan”, and attracts attention from the whole country. As well as general tourists, “nature lovers” who row canoes or boats on the Shimanto-gawa and enjoy camping on the dry riverbed have rapidly increased. “Ichijyo” Festival and Citizen Festival are held in Nakamura City located at the lowermost reach of the Shimanto-gawa. The number of tourists visiting Nakamura City is about one million a year including the river tourists. In recent years, various co-operative efforts by the river administrators and local residents have been made to maintain the natural environment of the Shimanto-gawa as a precious asset for the future.

7. References, Databooks and Bibliography

Geographical Survey Institute, (1985): The national atlas of Japan, Ministry of Construction (2.1, 2.2).
Japan Dam Foundation, (1998): Damu nenkan (Yearbook of dams), Vol.7. (5.3).
Japan Meteorological Agency, (1991): Climatic table of Japan, Vol.1(3.2, 3.3).
National Astronomical Observatory, (1998): Rikanenpyo (Science yearbook), Vol.71, (Maruzen Inc., Tokyo). (3.3).
River Bureau, (1941-1996): Uryou nenpyou (Rainfall Yearbook), Vol.1~44, Ministry of Construction (3.2, 3.4).
River Bureau, (1948-1996): Ryuryo nenpyou (Streamflow Yearbook), Vol.1~49, Ministry of Construction (4.2, 4.3, 4.4, 4.5, 4.6).
Shikoku Regional Construction Bureau, (1996): Summary of activities, Ministry of Construction (2.3, 5.2).