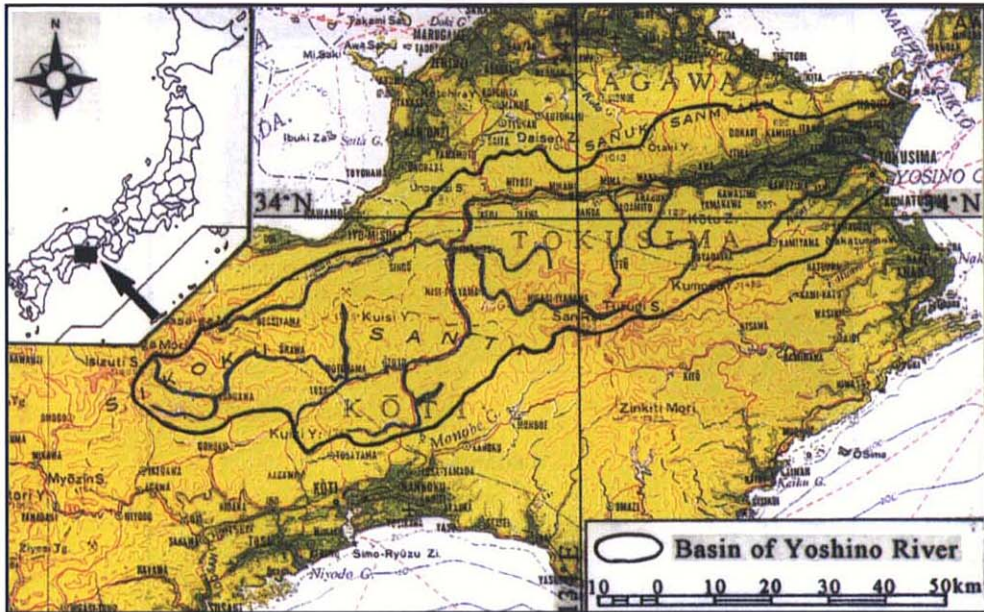


# Yoshino-gawa

## Map of River



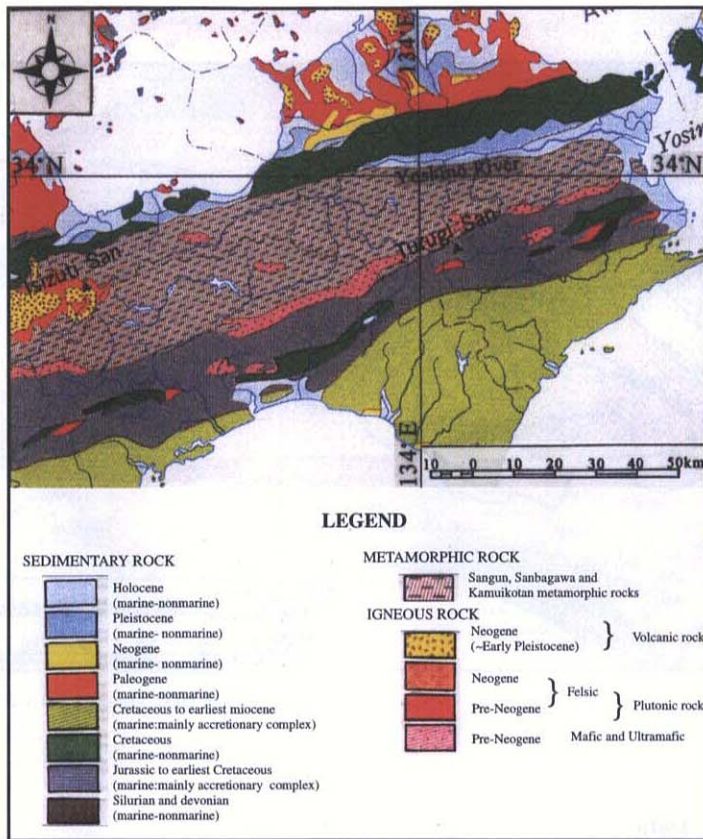
Central Japan, Geographical Survey, MOC, Japan

## Table of Basic Data

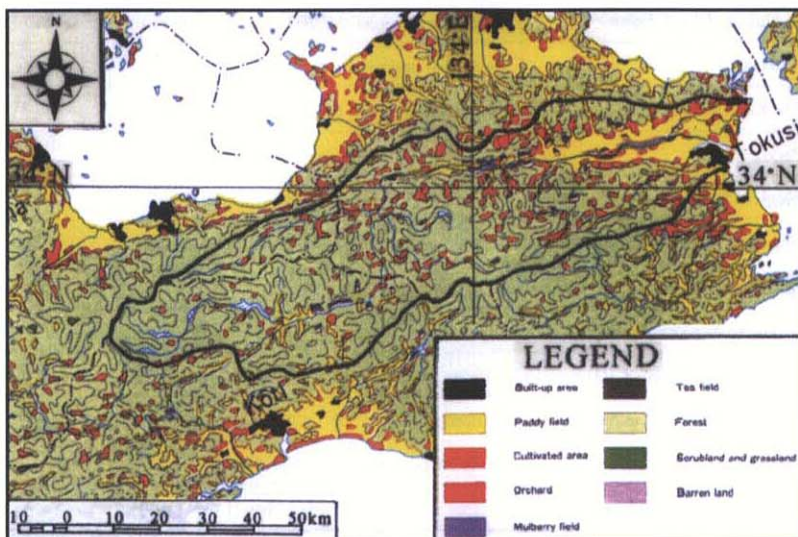
<b>Name:</b> Yoshino River		<b>Serial No.:</b> Japan-1
<b>Location:</b> Shikoku Island, Japan	N 33° 35' 15" ~ 34° 10' 20"	E 133° 8' 15" ~ 134° 33' 40"
<b>Area:</b> 3 750 km <sup>2</sup>	<b>Length of main stream:</b> 194 km	
<b>Origin:</b> Mt. Kamegamori(1 896 m)	<b>Highest point:</b> Mt. Tsurugi(1 955 m)	
<b>Outlet:</b> Pacific Ocean	<b>Lowest point:</b> River mouth(0 m)	
<b>Main geological features:</b> Permian to Middle Mesozoic; Limestone, Chert, Mudstone, Sandstone		
<b>Main tributaries:</b> Dozan River(280 km <sup>2</sup> ), Iya River(366 km <sup>2</sup> ), Kyu-Yoshino River(245 km <sup>2</sup> )		
<b>Main lakes:</b> None		
<b>Main reservoirs:</b> Sameura Reservoir(316 x 10 <sup>6</sup> m <sup>3</sup> , 1977), Ananaigawa Reservoir(46 x 10 <sup>6</sup> m <sup>3</sup> , 1963)		
<b>Mean annual precipitation:</b> 2 100 mm (1954~1979)(basin average)		
<b>Mean annual runoff:</b> 144.4 m <sup>3</sup> /s at Iwazu(2 810 km <sup>2</sup> ) (1953~1991)		
<b>Population:</b> 643 000 (1985)	<b>Main cities:</b> Tokushima, Naruto	
<b>Land use:</b> Forest (87.7%), Rice paddy (4.4%), Other agriculture (3.4%), Urban (1.6%) (1991)		

## 2. Geographical Information

### 2.1 Geological Map



### 2.2 Land Use Map



## 1. General Description

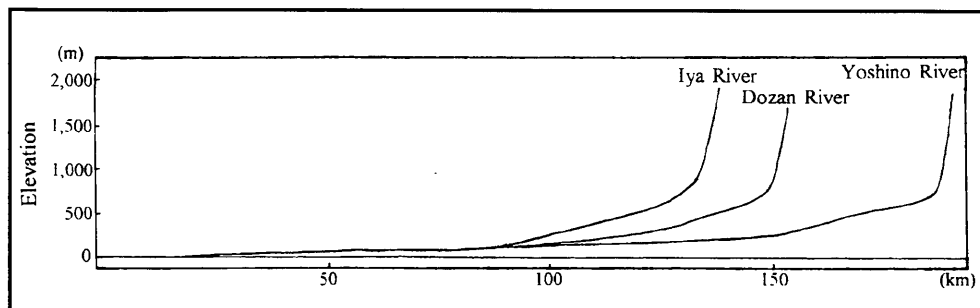
The Yoshino, 194 km long and draining an area of 3 750 km<sup>2</sup>, is the largest river in Shikoku island. Originating from Mt. Kamegamori (1 896 m), it runs through the central part to the eastern part of the island before flowing out into the Pacific Ocean. The catchment receives an average annual precipitation of 2 100 mm while the annual discharge at Iwazu (2 810 km<sup>2</sup>) in 1954 has been 144 m<sup>3</sup>/s (5.3 m<sup>3</sup>/s/km<sup>2</sup>). The reservoir at Sameura Dam built in 1977, has a storage capacity of 316 x 10<sup>6</sup> m<sup>3</sup>. The segment upstream of Ikeda which is in the mountains with narrow paddy fields and hillside paddy terraces (Motoyama area) is considered the upper reach whereas the segment between Ikeda and Iwazu which flows through a 80 km long canyon along the Median Tectonic Line with 1 000 m high mountains in the north and 2 000 m high mountains in the south is considered the middle reach. The population in the basin in 1985 was 643 000.

### 2.3 Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km <sup>2</sup> ]	Highest peak [m] Lowest point [m]	Cities population (1985)	Land use [%] (1991)
1	<b>Yoshino</b> (Main river)	194 2 859	Mt. Kamegamori, 1 896 -----	Tokushima City, etc. 521 300	A, O (3.4) F (87.7)
2	<b>Dozan</b> (Tributary)	45 280	Mt. Sasagamine, 1 860 -----	Shingu Village 6 000	L (3) P (4.4)
3	<b>Iya</b> (Tributary)	32 366	Mt. Tsurugi, 1 955 -----	Nishi-ya Village 5 700	U (1.6)
4	<b>Kyu-Yoshino</b> (Lower branch)	25 245	----- -----	Naruto City, etc. 110 000	

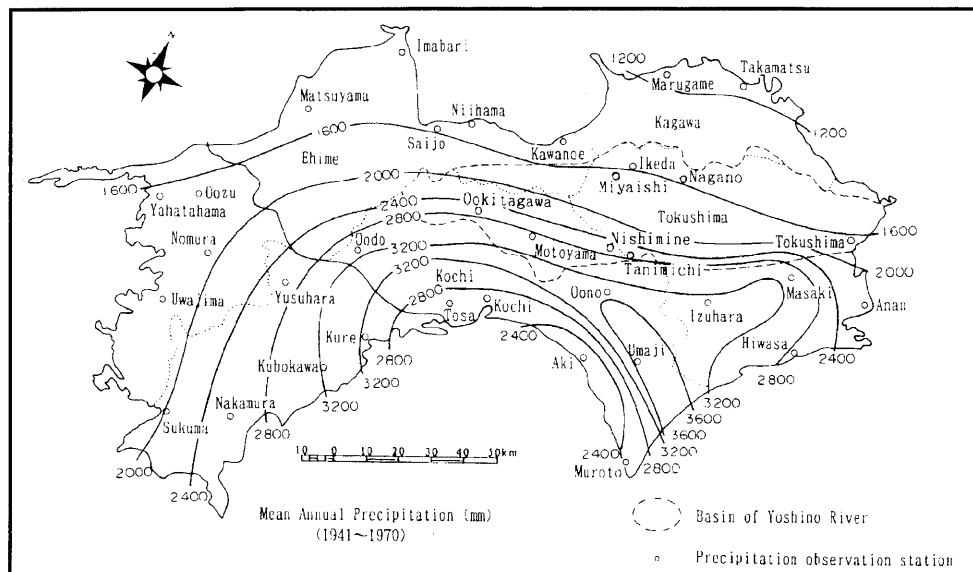
A: Other agricultural field (vegetable, grass) F: Forest L: Lake, River, Marsh O: Orchard  
P: Paddy field U: Urban

### 2.4 Longitudinal Profiles



### 3. Climatological Information

#### 3.1 Annual Isohyetal Map and Observation Stations



Based on River Bureau data, Ministry of Construction

#### 3.2 List of Meteorological Observation Stations

No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation <sup>1)</sup> [mm]	Mean annual evaporation	Observation items <sup>2)</sup>
80702 *	Okitagawa	400	N 33° 48' 11" E 133° 27' 27"	1955~present	2 771		P(TB)
80703 *	Motoyama	255	N 33° 45' 16" E 133° 35' 25"	1942~present	2 712		P(TB)
80705 *	Nishimine	560	N 33° 48' 17" E 133° 49' 45"	1957~present	2 667		P(TB)
80712 *	Tanimichi	700	N 33° 51' 02" E 133° 53' 50"	1954~present	2 740		P(TB)
80713 *	Miyaishi	260	N 33° 57' 21" E 133° 47' 59"	1953~present	1 674		P(TB)
80714 *	Ikeda	160	N 34° 01' 26" E 133° 47' 40"	1942~present	1 508		P(TB)
80716 *	Nagano	240	N 34° 00' 21" E 134° 02' 05"	1955~present	1 589		P(TB)
**	Tokushima	2	N 34° 03' 54" E 134° 34' 36"	1961~1990	1 615		P(TB)

\*: Serial number used by River Bureau, Ministry of Construction.

\*\* : Meteorological Observatory, Japan Meteorological Agency.

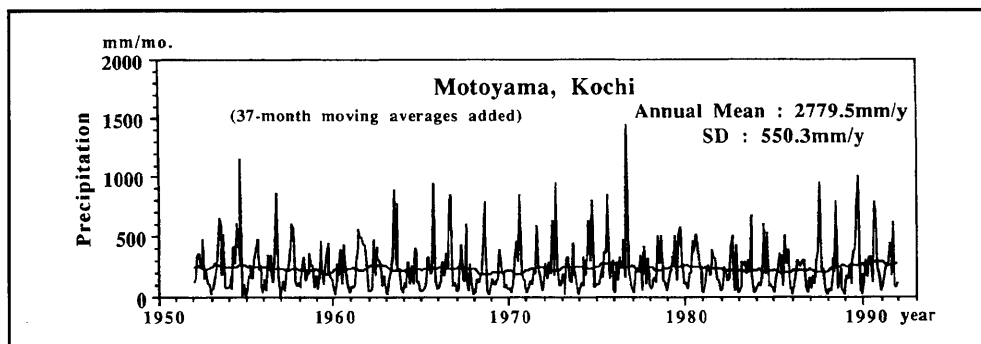
1) Period for the mean is from the beginning of the observation period to 1990.

2) P: Precipitation, TB: Tipping bucket with recording chart.

### 3.3 Monthly Climate Data

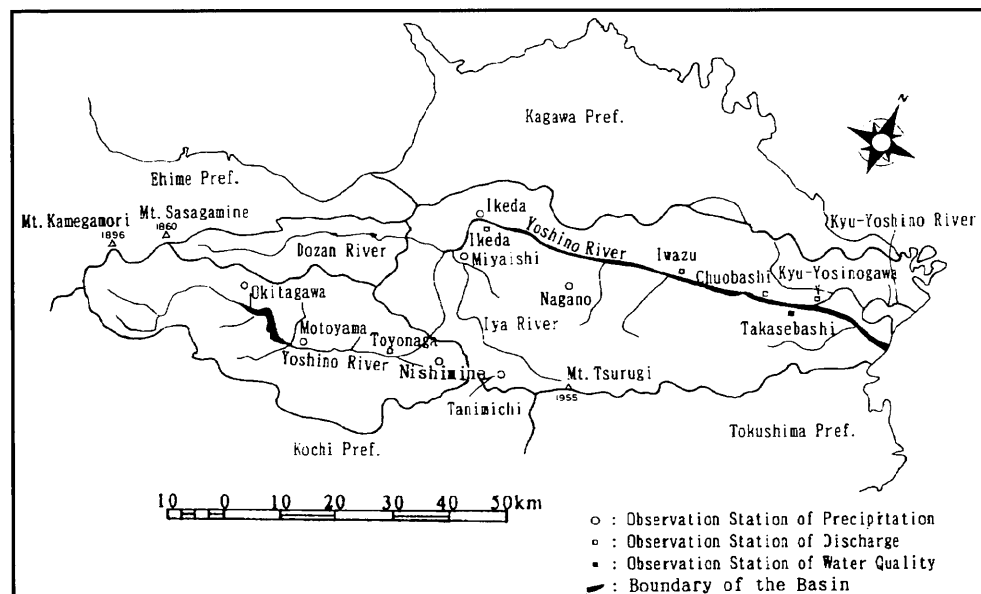
Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	Tokushima	5.4	5.7	8.7	14.3	18.6	22.1	26.1	27.2	23.7	18.1	12.9	7.9	15.9	1961~1990
Precipitation [mm]	Tokushima	46.7	56.3	83.1	130.9	136.6	229.6	168.6	178.4	307.8	141.7	96.9	37.9	1614.6	1961~1990
Solar radiation [MJ/m <sup>2</sup> /d]	Matsuyama	8.2	10.2	13.1	16.4	18.5	17.1	18.5	18.2	13.5	11.7	8.6	7.6	13.5	1974~1990
Duration of sunshine [hr]	Tokushima	156	143	169	173	192	148	190	213	151	158	146	154	1994	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	Location	Catchment area (A) [km <sup>2</sup> ]	Observation period	Observation items <sup>1)</sup> (frequency)
80702	Toyonaga	N 33° 24' 15" E 133° 10' 10"	933	1958~present	Q(10d), WQ(m)
80706	Ikeda	N 34° 01' 46" E 133° 50' 37"	2 074	1954~present	Q(10d)
80712	Iwazu	N 34° 03' 44" E 133° 11' 55"	2 810	1953~present	Q(10d)
80713	Chuobashi	N 34° 05' 13" E 134° 21' 02"	3 044	1955~present	Q(10d)
80715	Kyu-Yoshinogawa	N 34° 08' 16" E 134° 28' 21"	—	1963~present	Q(10d)

No.*	$\bar{Q}$ <sup>2)</sup> [m <sup>3</sup> /s]	Q max <sup>3)</sup> [m <sup>3</sup> /s]	$\bar{Q}$ max <sup>4)</sup> [m <sup>3</sup> /s]	$\bar{Q}$ min <sup>5)</sup> [m <sup>3</sup> /s]	$\bar{Q} / A$ [m <sup>3</sup> /s/100km <sup>2</sup> ]	Q max / A [m <sup>3</sup> /s/100km <sup>2</sup> ]	Period of statistics
80702	65.8	9 801	1 750	8.26	7.05	1050	1958~1990
80706	106.0	14 047	3 080	12.83	5.11	677	1954~1990
80712	144.5	14 900	3 800	22.37	5.14	530	1953~1990
80713	132.9	14 303	3 530	20.10	4.37	470	1955~1990
80715	47.1	280	109	21.28			1963~1990

\*: Serial number used by River Bureau, Ministry of Construction

1) Q: Discharge, WQ: Water quality

10d: 10-day, m: Monthly

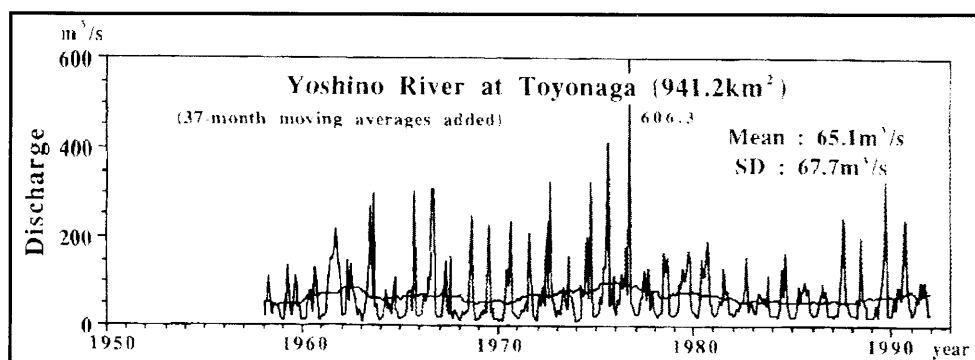
2) Mean annual discharge

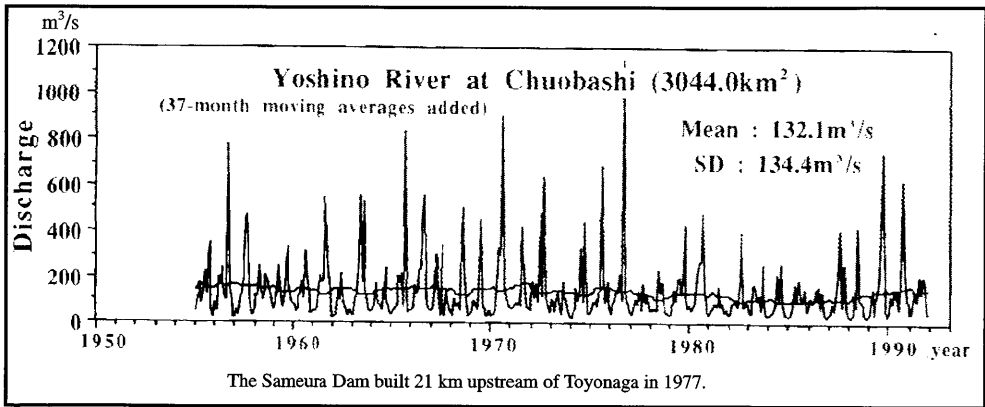
3) Maximum discharge

4) Mean maximum discharge

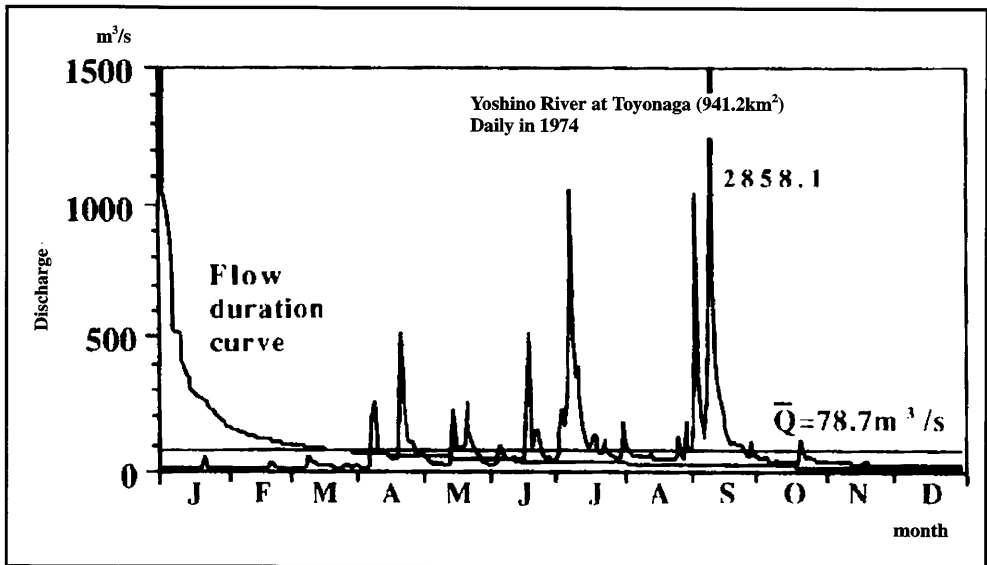
5) Mean minimum discharge

## 4.3 Long-term Variation of Monthly Discharge





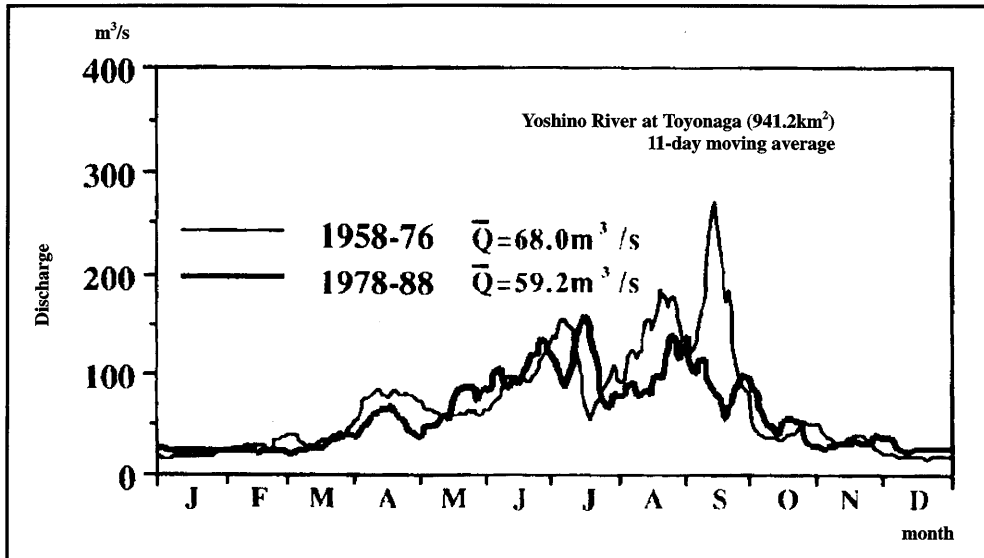
4.4 Annual Pattern of Discharge





#### 4.5 Unique Hydrological Features

The annual discharge patterns before and after the construction of the Sameura Dam in 1977.



Note that the transbasin canal Kochi Diversion above Sameura Dam also started operating in 1977.

#### 4.6 Annual Maximum and Minimum Discharges

At Iwazu [2 810 km<sup>2</sup>]

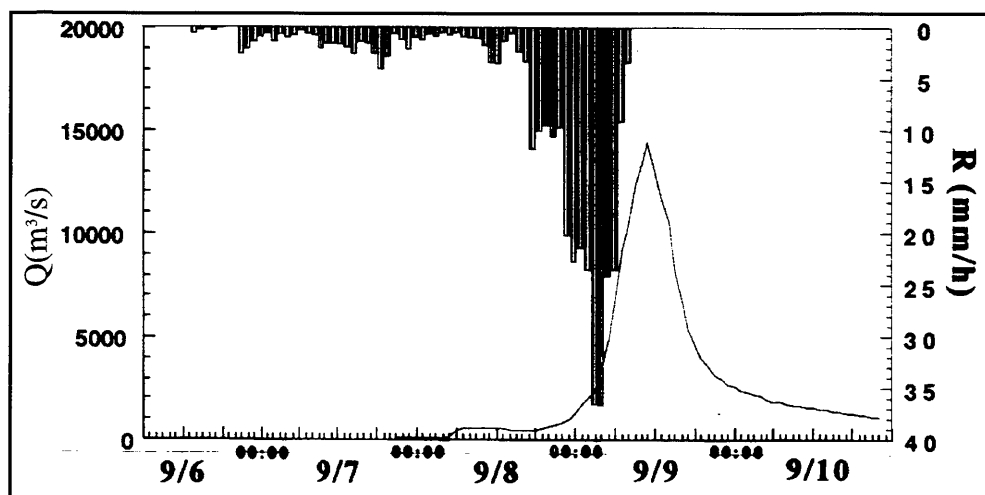
Year	Maximum <sup>1)</sup>		Minimum <sup>2)</sup>		Year	Maximum <sup>1)</sup>		Minimum <sup>2)</sup>	
	Date	[m <sup>3</sup> /s]	Month	[m <sup>3</sup> /s]		Date	[m <sup>3</sup> /s]	Month	[m <sup>3</sup> /s]
1970	7.05	12 820	2	17.4	1981	9.06	1 140	1	28.2
1971	10.23	6 780	1	19.6	1982	8.27	11 070	2	25.5
1972	8.15	6 030	12	23.2	1983	9.28	6 300	12	29.0
1973	5.02	1 240	1	15.1	1984	8.22	5 510	1	27.3
1974	9.09	14 470	1	9.5	1985	10.06	1 819	2	24.6
1975	8.23	13 870	12	28.3	1986	9.21	1 670	12	25.5
1976	9.12	11 450	2	25.2	1987	10.17	7 650	2	22.4
1977	11.17	2 230	12	27.3	1988	6.03	4 650	11	22.9
1978	8.03	4 700	5	28.6	1989	9.20	6 790	1	15.9
1979	10.01	9 540	10	10.5	1990	9.19	11 180	1	27.0
1980	9.11	6 640	2	43.7	1991	9.28	3 850	11	32.7

1), 2) Instantaneous observation by recording chart

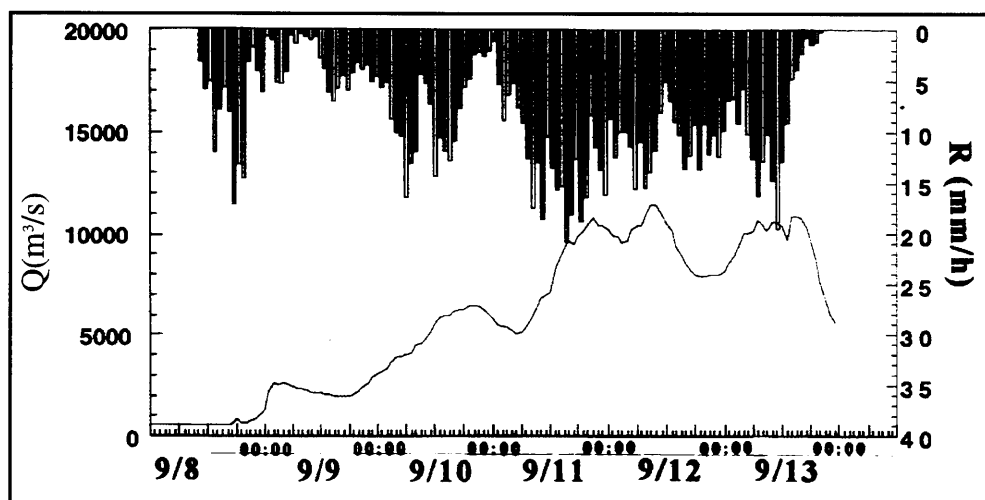


## 4.7 Hyetographs and Hydrographs of Major Floods

Iwazu 1974 September



Iwazu 1976 September



Based on River Bureau data, Ministry of Construction

## 5. Water Resources

## 5.1 General Description

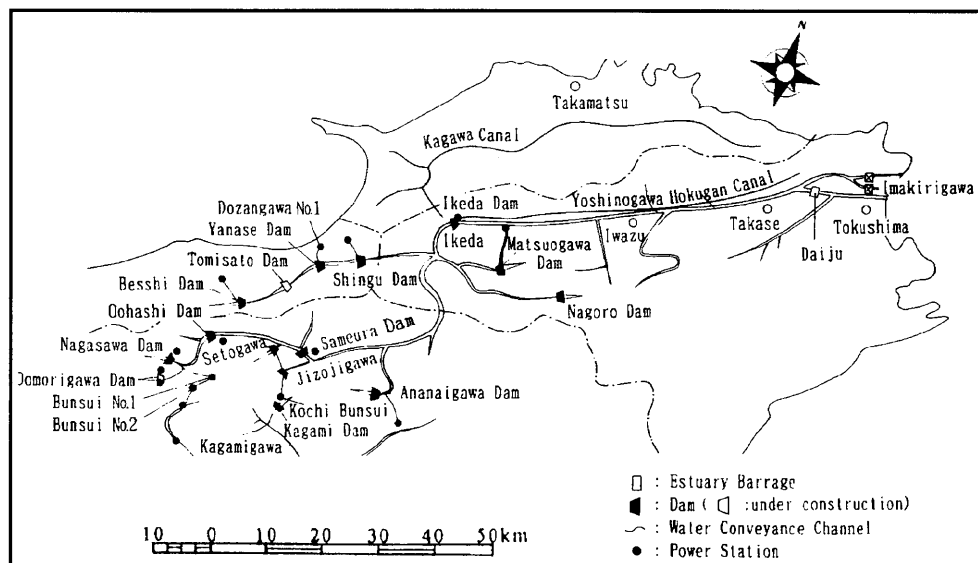
The Yoshino catchment occupies about 20% of the Shikoku Island. In the North, it lies adjacent to the dry area along the Seto Inland Sea. Many diversion tunnels, canals and power generation projects have been built to harness and divert the Yoshino waters to the northern and southern regions. There are 31 run-of-river type hydropower stations using the Yoshino waters. These were built mostly before the World War II in the tributaries in connection with the interbasin water transfer.

During the 39 year period from 1947~1985, there have been 127 occurrences of floods with discharges in excess of  $2\,000\text{ m}^3/\text{s}$  ( $0.713\text{ m}^3/\text{s}/\text{km}^2$ ) at Iwazu. i.e. approximately 2 - 4 times a year on average. Of these, 71 floods (56%) were typhoon related and occurred mostly in September while the remaining 56 floods were Baiu related and occurred during late June to early July. The typhoon related floods were generally more severe than Baiu related floods. There have been 25 occurrences of floods with discharges in excess of  $8\,000\text{ m}^3/\text{s}$  ( $2.86\text{ m}^3/\text{s}/\text{km}^2$ ) at Iwazu during the 41 year period from 1945~1985.

Because of the steep gradient of the river and the concentration of most of the precipitation in the basin during the Baiu and typhoon seasons, the runoff flows down very quickly to the sea causing the basin to experience droughts. A number of reservoirs have therefore been built in the basin, mostly after the war. The largest is the reservoir created by Sameura Dam ( $316 \times 10^6\text{ m}^3$ ), which was completed in 1977 for flood control, irrigation, municipal and industrial water supply, power generation, and environmental preservation. The dam construction caused a drastic change to the river flow pattern at Motoyama Station as seen in the monthly discharges of section 4.3.

Water supply systems are generally planned to cope with 10-year droughts. But the basin has been experiencing frequent water shortages recently. This may be attributed to the rapid increase of water demand in municipal and industrial sectors. Lower precipitation in the recent times may also be contributing to the problem.

## 5.2 Map of Water Resources Systems



## 5.3 List of Major Water Resources Facilities

## Major Reservoirs

Name of river	Name of dam (reservoir)	Catchment area [km <sup>2</sup> ]	Gross capacity [10 <sup>6</sup> m <sup>3</sup> ]	Effective capacity [10 <sup>6</sup> m <sup>3</sup> ]	Purpose <sup>1)</sup>	Year of completion
Yoshino	Nagasawa	70.0	31.9	28.4	P	1949
	Omorigawa	21.5	19.1	17.3	P	1959
	Ohashi	145.0	24.0	19.0	P	1939
	Sameura	472.0	316.0	289.0	A,F,I,N,P,W	1977
	Inamura	2.4	5.8	5.1	P	1982
	Ananaigawa	52.7	46.3	43.3	P	1963
	Ikeda	1904.0	12.7	4.4	A,F,I,N,P,W	1974
Dozan	Besshi	15.2	5.6	5.4	I,P	1965
	Tomisato	101.2	53.2	47.6	F,I,P,W	*
	Yanase	170.7	32.2	29.6	A,F,I,P,W	1953
	Shingu	254.3	13.0	11.7	A,F,I,P	1975
Iya	Nagoro	21.2	1.4	1.2	P	1961
	Matsuogawa	26.0	14.3	12.6	P	1953
Kyu-Yohino	Miyakawauchi	23.1	1.4	1.2	A,F,N	1963

## Major Interbasin Transfer

Name of transfer line	Names of rivers and places connected		Length [km]	Maximum capacity [m <sup>3</sup> /s]	Purpose <sup>1)</sup>	Year of completion
	From	To				
Kochi Diversion Setogawa conveyance canal	Seto River	Jizoji River	4.5	4.4	I, W	1978
Kochi Diversion Jizojigawa conveyance canal	Jizoji River	Kagami River	9.4	6.0	I, W	1978
Ehime Diversion Yanase Diversion	Dozan River	Akanoi River		5.8	A, I, P, W	
Ehime Diversion Shingu Diversion	Dozan River	Kawanoe City		8.0	A, I, P	
Ehime Diversion Besshi Diversion	Dozan River	Akanoi River		1.2	I, P	
Kagawa Diversion	Yoshino River	Kagawa Prefecture	7.7	15.8	A, I, P	1975

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

\*: under construction

## 5.4 Major Floods and Droughts

### Major Floods at Iwazu [2 810 km<sup>2</sup>]

Date	Peak discharge [m <sup>3</sup> /s]	Rainfall [mm] Duration	Meteorological cause	Dead and missing	Major damages (Districts affected)
1945. 9.17 ~9.20	14 300	300 9.15~9.17	Typhoon	47	
1953. 9.26	10 119		Typhoon	1	Tokushima City, Kami-ita Town, Yoshino Town
1954. 8.18	9 250	305 8.16~8.19	Typhoon	2	Downstream
1954. 9.14	14 900	341 9.12~9.15	Typhoon	9	Downstream
1961. 9.16	11 960	420 9.14~9.17	Typhoon	11	Tokushima City, Kami-ita Town
1970. 8.21	12 820	330 8.20~8.23	Typhoon	3	Tokushima City, Kami-ita Town, Yoshino Town
1974. 9.09	14 470	342 9.06~9.09	Typhoon	0	Anabuki Town, Sadamitsu Town, Mikamo Town
1975. 8.16	10 480	351 8.15~8.19	Typhoon	1	Anabuki Town, Sadamitsu Town, Mitsuno Town
1975. 8.23	13 870	343 8.20~8.24	Typhoon	17	Tokushima City, Kami-ita Town, Ishii Town
1976. 9.11	11 450	1,093 9.08~9.13	Typhoon	10	Ishii Town, Kamoshina Town, Kawashina Town

### Major Droughts

Period	Affected areas	Major damages and counteractions
1977. 8	Tokushima City	Water supply cut ratio at the first stage: 29%
1982. 7	Tokushima City	Water supply cut ratio at the first stage: 21%
1983. 8~1983. 9	Tokushima City	Water supply cut ratio at the first stage: 22% at the second stage: 25%
1984. 10~1985. 3	Tokushima City	Water supply cut ratio at the first stage: 8% at the second stage: 21%
1986. 8	Tokushima City	Water supply cut ratio at the first stage: 19%
1988. 2~1988. 4	Tokushima City	Water supply cut ratio at the first stage: 16%
1988. 8	Tokushima City	Water supply cut ratio at the first stage: 19%
1988. 11~1989. 2	Tokushima City	Water supply cut ratio at the first stage: 8% at the second stage: 24%
1990. 8	Tokushima City	Water supply cut ratio at the first stage: 18% at the second stage: 21%
1992. 7~1992. 8	Tokushima City	Water supply cut ratio at the first stage: 18%

## 5.5 Groundwater and River Water Quality

### River Water Quality <sup>1)</sup> at Takasebashi <sup>2)</sup> in 1985

Date	Jan 8	Feb 25	Mar 5	Apr 22	May 20	Jun 4	Jul 8	Aug 19	Sep 3	Oct 1	Nov 25	Dec 3
pH	7.5	7.3	7.4	7.4	7.5	7.4	7.5	7.6	7.2	7.6	7.4	7.5
BOD [mg/l]	1.8	0.3	1.2	1.1	0.8	0.8	1.0	1.0	0.5	0.4	0.6	0.5
COD <sub>Mn</sub> [mg/l]	1.0	1.3	1.2	1.5	1.3	1.2	1.0	1.3	1.3	1.5	1.0	0.5
SS [mg/l]	2	3	3	5	3	4	5	6	2	5	2	1
Coliform group <sup>3)</sup> [MPN/100ml]	2.0 x 10	2.0 x 10	1.7 x 10 <sup>2</sup>	2.4 x 10 <sup>3</sup>	1.7 x 10 <sup>3</sup>	2.7 x 10 <sup>2</sup>	3.1 x 10 <sup>3</sup>	4.9 x 10 <sup>2</sup>	4.9 x 10 <sup>2</sup>	1.1 x 10 <sup>3</sup>	1.1 x 10 <sup>3</sup>	2.1 x 10 <sup>2</sup>
Discharge <sup>4)</sup> [m <sup>3</sup> /s]	26.88	40.28	43.99	144.06	88.80	68.14	88.42	126.28	68.21	117.05	48.34	42.82

- 1) Observed once a month on a dry day normally several days after rainfall.
- 2) Located near Tokushima City 18 km upstream from the river mouth.
- 3) Measurement method: BGLB (brilliant green lactose bile) culture MPN (most probable number) method.
- 4) Discharge on the water quality observation date.

## 6. Socio-cultural Characteristics

The Yoshino is called "Shikoku Saburo", meaning the third among many Japanese rivers that are very important to people but often difficult to tame. Tokushima City is famous for its summer festival parade of "Awaodori" dancing. Oboke and Koboke located between Otoyo and Ikeda are famous gorges attracting many sightseers. Shikoku Island has long been the place for religious pilgrimage. There are 88 stops for pilgrims in the whole island, of which 19 are situated in the Yoshino Basin.

## 7. References, Databooks and Bibliography (In Japanese)

- Geographical Survey Institute (1990): *The national atlas of Japan*, Ministry of Construction. (2.1, 2.2)
- Japan Dam Foundation (1993): *Dam nenkan* (Yearbook of dams), vol. 7. (5.3)
- National Astronomical Observatory (1993): *Rika nenpyo* (Science yearbook), vol. 66, (Maruzen Inc., Tokyo). (3.3)
- River Bureau (1953~1991): *Ryuryo nenpyo* (Streamflow yearbook), vol. 6~44, Ministry of Construction. (4.2, 4.3, 4.4, 4.5, 4.6)
- River Bureau (1985): *Suishitsu nenpyo* (River water quality yearbook), vol. 26, Ministry of Construction. (5.5)
- River Bureau (1942~1991): *Uryo nenpyo* (Rainfall yearbook), vol. 2-39, Ministry of Construction. (3.2, 3.4)
- Shikoku Regional Construction Bureau (1993): *Summary of activities*, Ministry of Construction. (5.2)