Shonai-gawa

Map of River

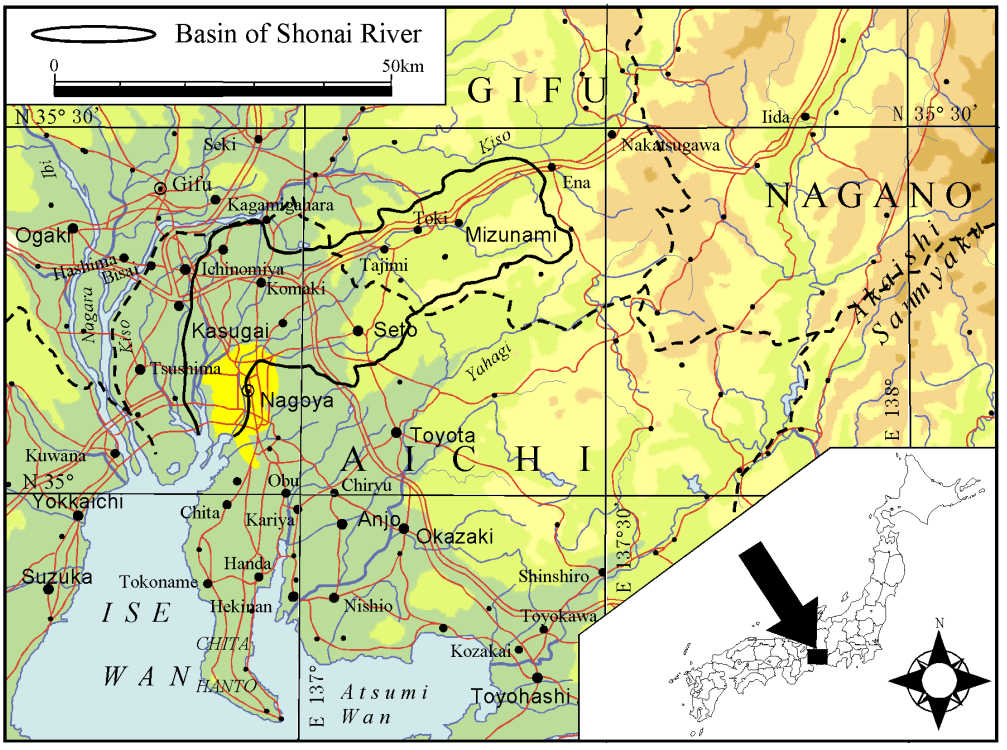


Table of Basic Data

Name: Shonai-gawa		**Serial No.:** Japan-8
Location: Central Honshu, Japan	N 35° 04'~35° 24'	E 136° 49'~137° 20'
Area: 1 010 km^2	**Length of main stream**: 96 km	
Origin: Mt. Yudachi (727 m)	**Highest point:** Mt. Tenbaku (843 m)	
Outlet: Ise Bay, Pacific Ocean	**Lowest point:** River mouth (0 m)	
Main geological features: Upper basin (Neogene, Permian and Carboniferous), Lower basin (Recent, Pleistocene)		
Main tributaries: Yada-gawa (121.7 km^2), Ori-gawa (97.2 km^2)		
Main lakes: None		
Main reservoirs: Origawa reservoir (15.1 × 10^6 m^3, under construction)		
Mean annual precipitation: 2 004 mm at Okawa (1938~1990)		
Mean annual runoff: 26.59 m^3/s at Biwajima (1969~1996)		
Population: 2 416 000 (1990)	**Main cities:** Nagoya, Kasugai, Seto, Tajimi, Toki	
Land use: U (52.9%), P (6.7 %), A (4.4%), F (36.0%)		

1. General Description

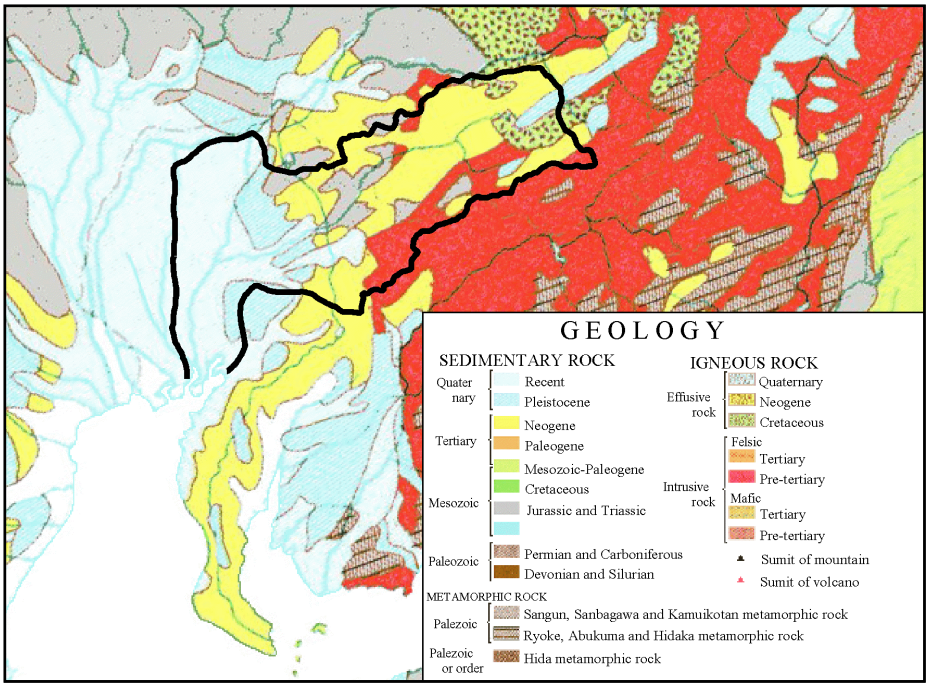
The Shonai-gawa originates from Mt. Yudachi (727 m) located in Yamaoka Town, Ena-gun, Gifu Prefecture, goes through the basin of Gifu - Tohnoh District, passes Tamano Valley, a border between Gifu and Aichi Prefectures, flows through southward in the Nobi plain and finally out to the Ise Bay. It is a so-called Class A river and its main stream has a length of 96 km. The Shonai basin has Nagoya, the fourth largest city in Japan, as well as other rapidly urbanizing cities such as Kasugai, Owari-Asahi, Seto and Tajimi. The river is regarded as one of the more urbanized rivers in Japan.

The Shonai-gawa historically had many names taken from the names of places near the river, for example, Toki, Tamano, Kachi and Biwajima. In the Meiji Era, many of the names were dropped and it was referred to as the Shonai-gawa in Aichi Prefecture; however, it is still sometimes referred to as Toki-gawa in Gifu Prefecture.

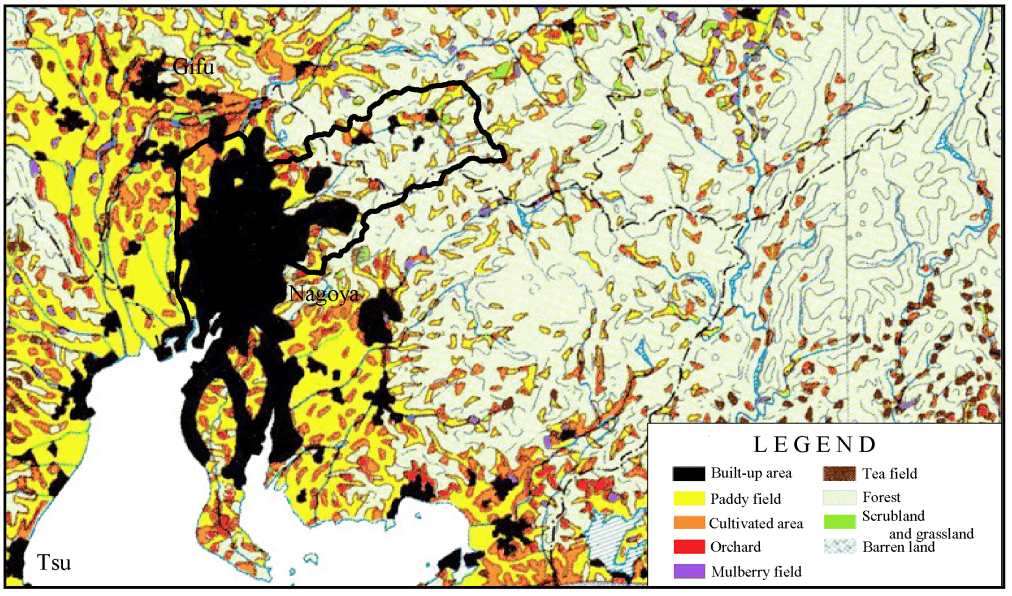
The river basin that has an area of 1 010 km^2 has a long and narrow shape extending east to west. The slope of the basin is gentle and the highest mountain is Tembaku-zan (843 m).

2. Geographical Information

2.1. Geological Map



2.2. Land Use Map

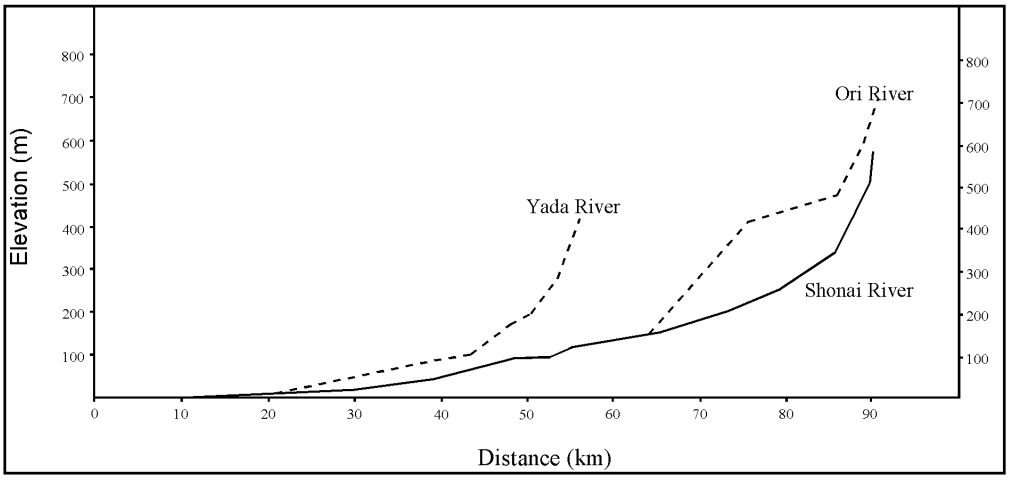


2.3. Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km^2]	Highest peak [m] Lowest point [m]	Cities Population (1985)	Land use [%] (1991)
1	**Shonai** (Main river)	96 1 010	Mt. Yudachi 727 River mouth 0	Tajimi, Nagoya 2 416 000	A (4.4)
2	**Yada** (Tributary)	56 121.7	Mt. Sanage 629 -	Seto, Nagoya 437 600	F (36.0)
3	**Ori** (Tributary)	23.5 97.2	Mt. Tenbaku 843	Mizunami 17 800	P (6.7)
4	**Shin** (Lower branch)	22 232.2	- River mouth 0	Nagoya, Ichinomiya 714 600	U (52.9)

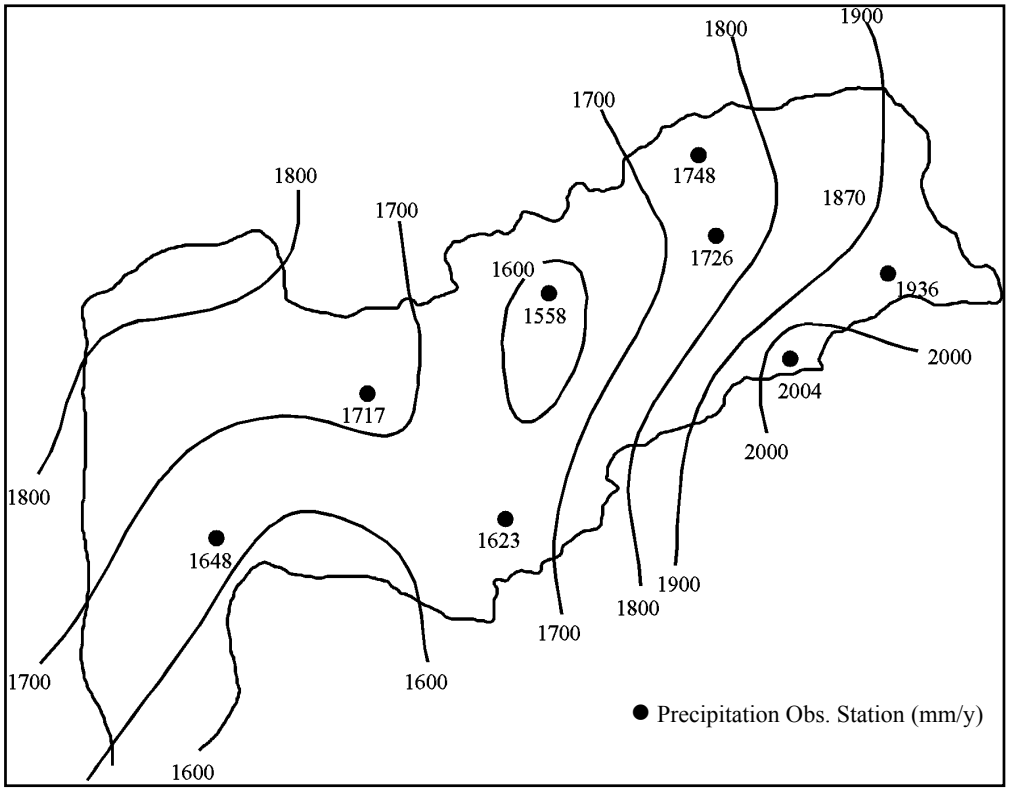
A: Other agricultural field (vegetable, grass) F: Forest P: Paddy field U: Urban areas.

2.4. Longitudinal Profiles



3. Climatological Information

3.1. Annual Isohyetal Map and Observation Stations



3.2. List of Meteorological Observation Stations

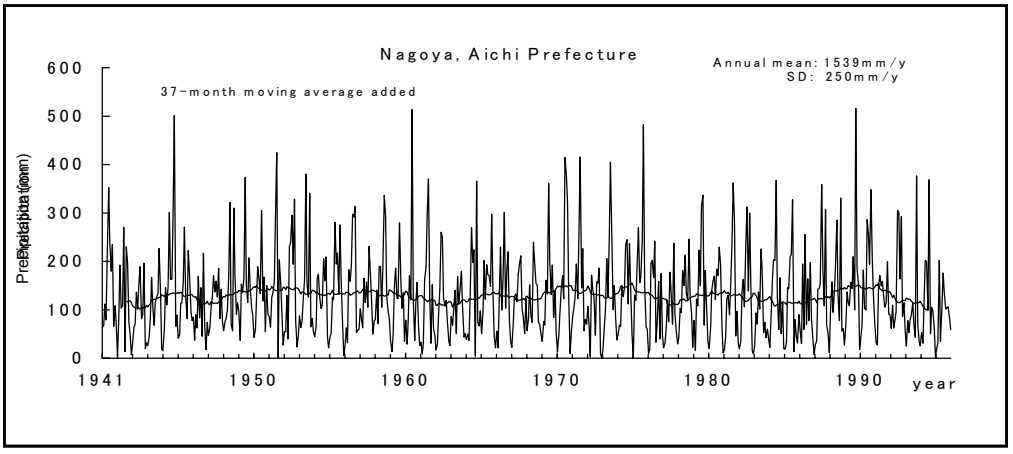
No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [mm]	Observation items [1)]
50902 *	**Okawa**	335	N 35° 18' E 137° 17'	1938~present	2 004 (1966~90)	P
50915 *	**Tajimi**	98	N 35° 19' E 137° 07'	1974~present	1 558 (1975~90)	P
50919 *	**Yamaoka**	456	N 35° 20' E 137° 23'	1975~present	1 936 (1976~90)	P
50911 *	**Rontochi**	320	N 35° 23' E 137° 20'	1969~present	1 870 (1973~90)	P
50916 *	**Seto**	163	N 35° 14' E 137° 07'	1973~present	1 623 (1974~90)	P
50908 *	**Nagoya**	15	N 35° 12' E 136° 54'	1970~present	1 648 (1971~90)	P
**	**Nagoya**	51.1	N 35° 10' E 136° 58'	1891~present	1 534 (1961~90)	DS,P,SR

*: Serial Number used by The River Bureau, Ministry of Construction
**: Meteorological Observatory, Japan Meteorological Agency
1) DS: Duration of sunshine; P: Precipitation; SR: Solar radiation

3.3. Monthly Climate Data

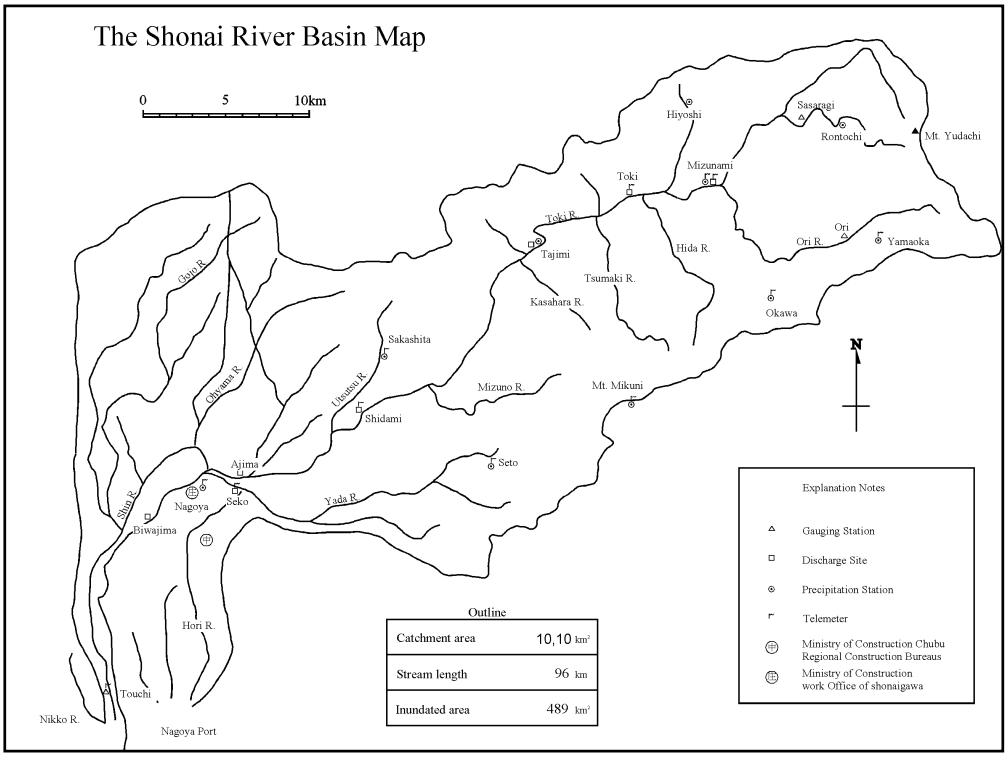
Observation item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	**Nagoya**	3.7	4.3	7.6	13.8	18.4	22.0	25.8	27.1	23.1	17.0	11.5	6.2	15.1	1961~90
Precipitation [mm]	**Nagoya**	42.3	63.8	110.2	150.5	157.1	217.9	212.5	145.1	211.0	114.1	70.5	40.0	1 534.9	1961~90
Evaporation [mm]	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar radiation [MJ/m²/d]	**Nagoya**	9.1	11.3	14.1	16.0	17.7	15.7	15.7	16.5	12.7	11.4	9.1	8.3	13.1	1974~90
Duration of sunshine [hr]	**Nagoya**	166.8	159.0	190.3	176.6	201.5	146.2	157.3	196.3	138.6	163.2	157.2	161.9	2 015.0	1961~90

3.4. Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1. Map of Streamflow Observation Stations



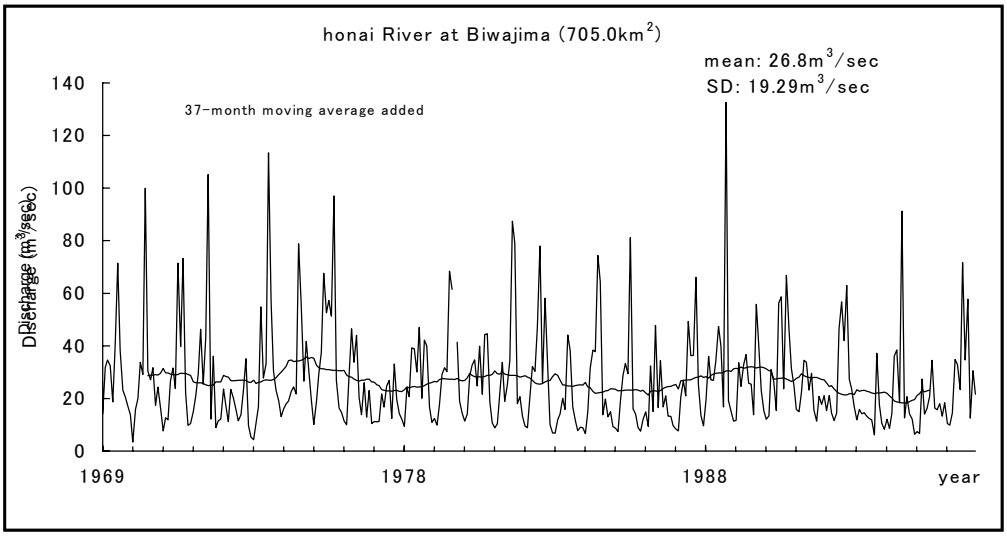
4.2. List of Hydrological Observation Stations

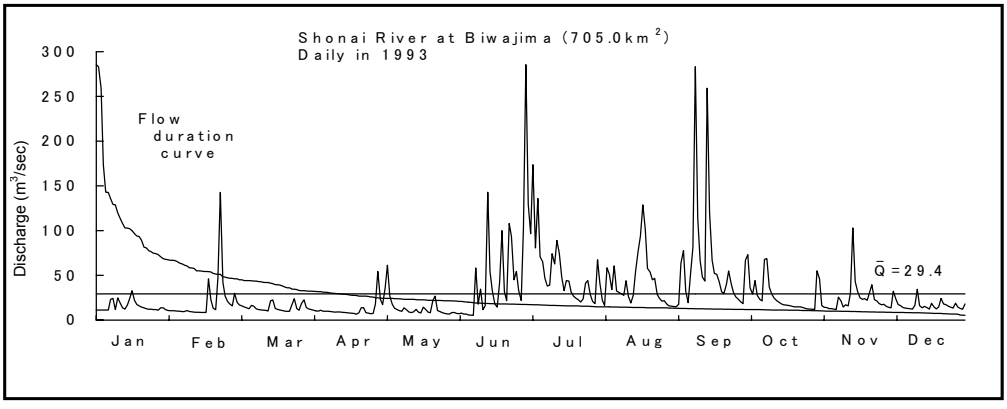
No.*	Station	Location from the river mouth [km]	Catchment area (A) [km^2]	Observation period	Observation items [1] (frequency)
50909	**Biwajima**	15.7	705.0	1938~present	Q (10 day)
50919	**Shidami**	32.7	532.0	1974~present	Q (15 day)
50908	**Tajimi**	49.1	367.0	1971~present	Q (10 day)
50922	**Toki**	57.8	284.6	1977~present	Q (15 day)
50905	**Seko**	21.6 (3.6 from the confluence)	105.0	1960~present	Q (15 day)

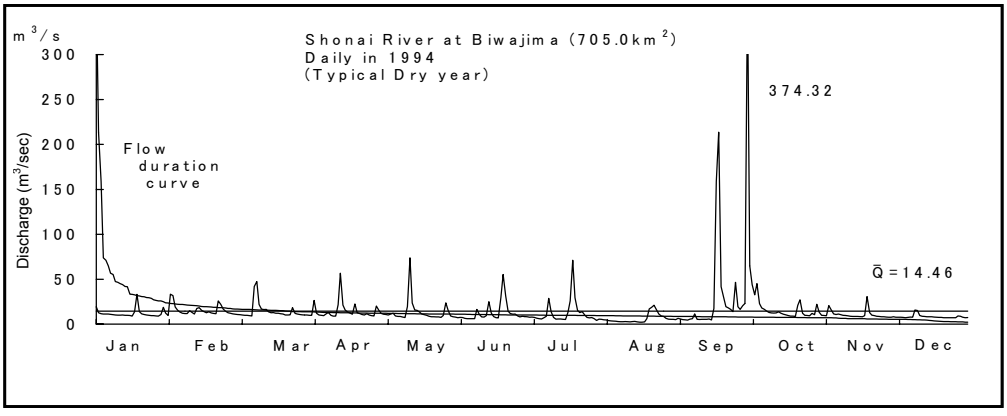
No.*	$\overline{Q}$ [2] [m^3/s]	Q max [3] [m^3/s]	$\overline{Q}$ max [4] [m^3/s]	$\overline{Q}$ min [5] [m^3/s]	$\overline{Q}$ / A [m^3/s/100km^2]	Q max / A [m^3/s/100km^2]	Period of statistics
50909	26.59	2 196	1 017	4.84	3.77	311	1969~96
50919	20.02	2 279	984	2.99	3.76	428	1975~96
50908	13.86	1 836	718	2.26	3.77	500	1976~96
50922	10.96	1 672	673	2.07	3.85	588	1977~96
50905	4.57	816	263	0.91	4.35	777	1970~96

*: Serial number used by The River Bureau, Ministry of Construction
Q: Discharge; 2) Mean annual discharge; 3) Maximum discharge; 4) Mean maximum discharge; and 5) Mean minimum discharge

4.3. Long-term Variation of Monthly Discharge







4.5. Unique Hydrological Features

The cities in the Kanare and Ueta river basins (the former is the secondary branch of the Shonai-gawa and the latter is a branch of the Tenpaku river which is a Class B river in Japan) have been urbanized rapidly from the late sixties. These two basins together with the basin of another Class B river, the Yamazaki river, are identified as the Shonai Runoff Experimental Catchment. An investigation of the changes of runoff characteristics of these three basins, which have reached the end of their urbanization, has been undertaken with the initial hydrological observations made in 1969. It was followed by intensive investigation for more than 10 years. They produced important research findings about the relationship between urbanization and flood runoff characteristics.

The basin of the Shin-gawa, which is a branch of the Shonai-gawa, is adjacent to Nagoya City and has convenient transportation services. Therefore, in recent years the basin has undergone remarkable development. Population and capital have been flowing into this basin and concentrating in the hills having water retention properties, and in lowland with paddy fields having retarding properties. A comprehensive flood control plan involving water storage and permeable ground systems aimed at reducing the loads to rivers and suppressing the increase of runoff coefficient has been implemented in this basin.

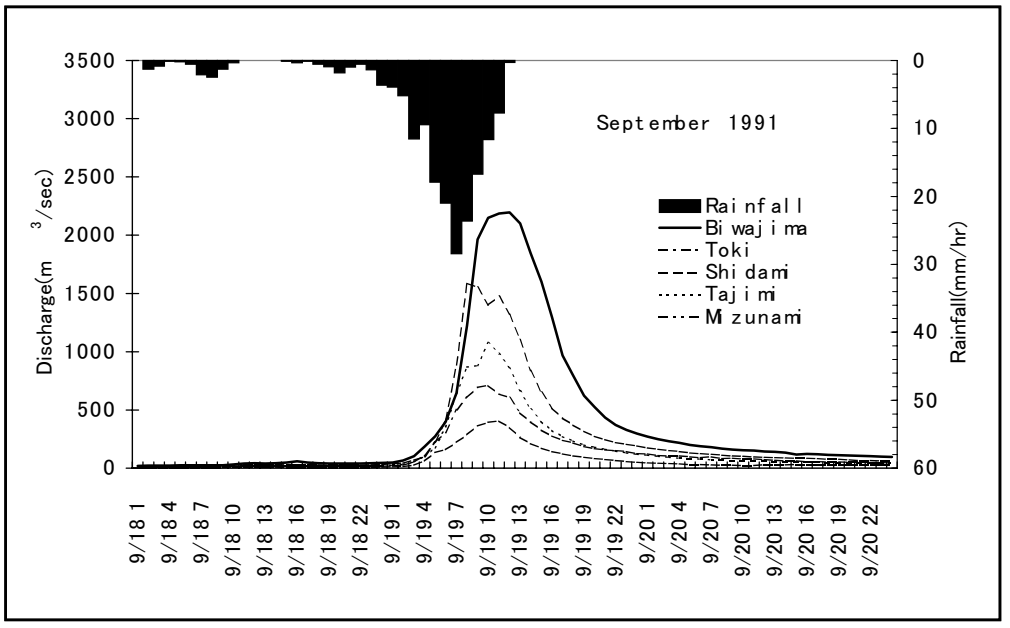
4.6. Annual Maximum and Minimum Discharges

At Biwajima [705.0 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]
1969	6.26	592.84	12.31	6.78	**1983**	9.28	1 929.56	6.11	3.26
1970	6.16	1 377.14	1.26	0.45	**1984**	6.27	946.01	1.02	5.53
1971	9.26	1 443.87	3.23	3.10	**1985**	6.30	977.06	1.02	5.56
1972	7.18	1 601.39	8.31	3.36	**1986**	7.13	359.45	2.14	4.33
1973	10.14	426.20	6.17	2.92	**1987**	5.14	508.40	9.05	5.57
1974	8.26	707.11	2.03	2.86	**1988**	9.25	1 602.43	1.17	5.81
1975	7.04	1 564.99	12.29	7.74	**1989**	9.20	1 864.30	8.25	5.75
1976	9.09	1 270.45	2.02	7.88	**1990**	9.18	1 187.62	9.08	5.08
1977	11.17	560.18	8.23	6.08	**1991**	9.19	2 196.02	9.10	5.15
1978	9.12	253.90	9.12	4.91	**1992**	8.12	359.59	8.05	3.18
1979	7.02	757.70	6.16	6.33	**1993**	9.09	671.06	6.06	4.05
1980	8.27	1 322.71	1.01	6.93	**1994**	9.30	913.80	8.18	1.87
1981	10.09	763.72	8.06	6.17	**1995**	7.06	557.28	12.31	5.38
1982	8.17	1 180.24	2.11	6.19	**1996**	7.08	598.68	6.02	3.57

1), 2) Instantaneous observation by recording chart

4.7. Hyetographs and Hydrographs of Major Floods



5. Water Resources

5.1. General Description

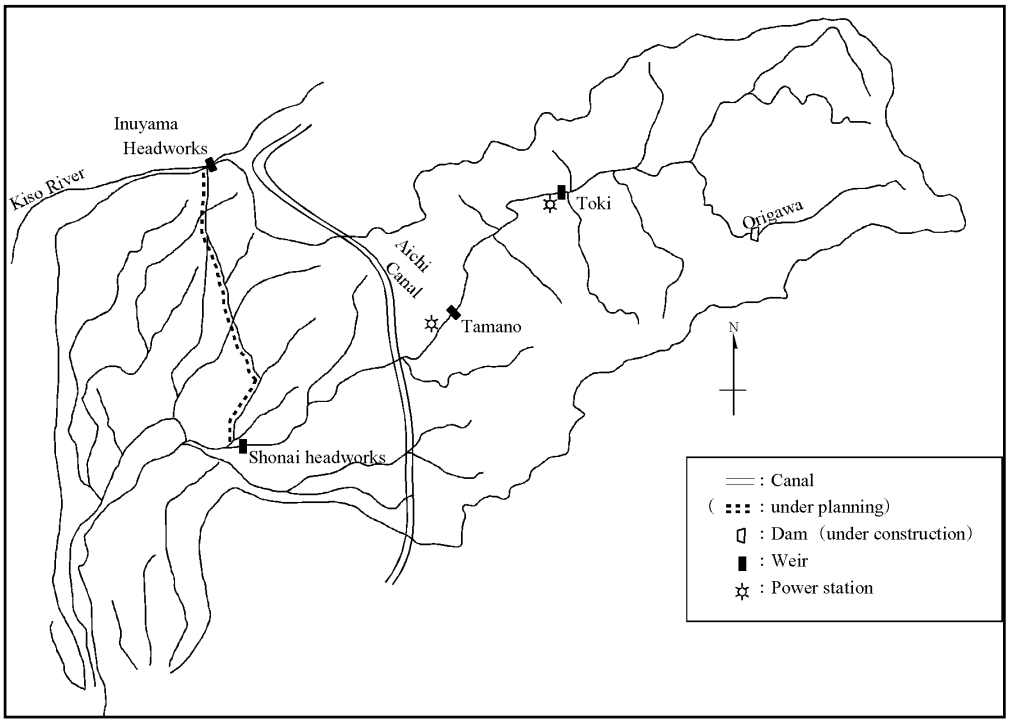
Water utilization in the Shonai River System has not advanced very much because of a number of factors. The first is due to the topography of the basin, which is quite flat, and therefore there are only a few placed suitable for the construction of dams. The second factor is that the normal flow regime of the river is not so good. Thirdly, the upper reach of the basin is one of the most famous industrial areas for pottery and chinaware in Japan. The effluents from these industries, which contain potter's clay, contribute to the poor water quality downstream. To alleviate the pollution problem, some projects to divert water from the adjoining Kiso River System to the Shonai River System have been implemented. These include the Aichi canal which crosses the Shonai basin and leads water to the Chita peninsula and the Tono Waterworks which directs water to the eastern part of Mino region in the upper basin of the Shonai-gawa. In recent years, the water quality and flow regime have improved because the effluence from factories have been progressively regulated and that more water from outside of the river system have been diverted to the Shonai-gawa.

As evidenced above, there is no possibility of using the main river water as a source of drinking water at the present time. Although water for agriculture is pumped mainly at Kasugai and Nagoya Cities, the benefiting area tends to decrease with increasing urbanization of the basin. Industrial water is pumped for paper mills in the area of the middle reaches through perforated concrete pipes buried at the riverbed. There are also two hydropower stations (with a total capacity of 760 kW) in the upper reaches of the main river. A new hydropower station with a maximum output of 1 800 kW is going to be constructed across the Ori River, a tributary of Shonai-gawa, which once had three hydropower stations and were abandoned in 1993 after the construction of the Ori River Dam.

A new development project, the Kiso River Channel Project, is under planning. The goals of this project include the reduction of flood damage in the Shin basin, provision of compensation water to the

Hori River and the development of a new municipal water supply by constructing a new channel linking the Kiso, Shin and Shonai rivers.

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^2]	Gross capacity [$10^6 m^3$]	Effective capacity [$10^6 m^3$]	Purpose [1)]	Year of completion
Ori	**Ori-gawa**	55	15.1	12.9	F, N, P	(2003)

1) F: Flood control N: Maintenance of normal flows P: Hydro-power

5.4. Major Floods and Droughts

Major Floods at Biwajima.

Date	Peak discharge [m^3/s]	Rainfall [mm] Duration	Meteorological cause	Dead and missing	Major damages (Districts affected)
1957.8.8	N.A.	310.1 2days	Concentrated severe storm	33	N.A.
1972.7.13	1601	284.7 6 days	Bai-u front	6	Inundation above floor 324 Inundation below floor 560
1983.9.28	1930	243.0 3 days	Typhoon No.10	4	N.A.
1989.9.20	1846	190.0 3 days	Typhoon No.22	1	Inundation above floor 104 Inundation below floor 103
1991.9.19	2196	186.3 3 days	Typhoon No.18	0	Inundation above floor 12 Inundation below floor 127

5.5. Groundwater and River Water Quality

River Water Quality [1] at Biwajima-bashi [2] in 1996

Date	1/23	2/7	3/6	4/3	5/15	6/5	7/3	8/7	9/18	10/16	11/6	12/4
pH	7.0	7.1	7.0	7.0	6.9	7.2	7.0	7.7	7.2	7.1	7.0	6.9
BOD [mg/l]	6.6	7.1	5.8	4.1	4.5	6.5	3.8	5.4	3.4	3.4	5.4	4.7
COD_{Mn} [mg/l]	19.0	21.6	14.3	8.6	12.3	15.0	9.3	11.9	9.8	7.2	10.9	11.1
SS [mg/l]	10	10	13	13	9	12	10	10	8	18	10	11
Discharge [4] [m^3/s]	6.69	5.84	10.27	20.10	9.89	5.67	12.82	7.11	11.90	26.78	10.03	10.88

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

At the 19 km point from the river mouth, the Shonai-gawa has a section where the right bank is made to be lower for several tens of meters. This is the Shin River Weir. The construction of this weir was started in 1784 at the orders of Munechika Tokugawa, the lord general of Tokugawa's Owari Clan at that time. The right bank was cut down to half its height for 40 ken (about 73 m), so that the weir formed could divert flood water from the Shonai River to the Ise Gulf through the Shin River which was newly cut and covered. The series of these flood control works which were completed in 1787 (the Tenmei Era 7) is called "Tenmei no Kaishu".

Originally, the right bank of the Shonai-gawa has been made to be lower than the left bank. Following this, both the weir and the Shin River were made on the right bank of Shonai-gawa. The reason for this idea was to protect the area around Nagoya Castle, which stretches over the side of the left bank from flood damage.

The weir, after the repair in 1883 (Meiji Era 16), is still functioning. However, according to current flood control plan, it is to be closed in the future in order to reduce flood damage in the Shin River basin. This river basin has a long history and many ruins and old burial mounds. Its history is highlighted after the 16th Century when many Samurais (Japanese warriors) such as Nobunaga, Hideyoshi and Ieyasu contended for the unification of Japan. In particular, during the Edo Era under the rule of Tokugawa's Owari Clan, many flood protection works were carried out to protect Nagoya Castle. Excavation works during this period produced the Hori River and the Shin River, which have

become the lower branches of the Shonai-gawa. Since the Meiji Era, the basin has become the center of the Chubu Industrial Zone where basic industries such as motorcars, airplanes and electric machinery have been developed and promoted extensively. At the present time the population of the basin exceeds 2.4 million.

The Shonai-gawa provides open recreational space for people living in a megalopolis area. In particular, many parks and cycling tracks are used by a large number of people in the Yada River area, which is one of the tributaries of the Shonai-gawa. Although the river lies in an urbanized area, it is important to note that it has many valuable natural conditions such as mud flats and reed fields, which provide important ecosystems.

7. References, Databooks and Bibliography

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