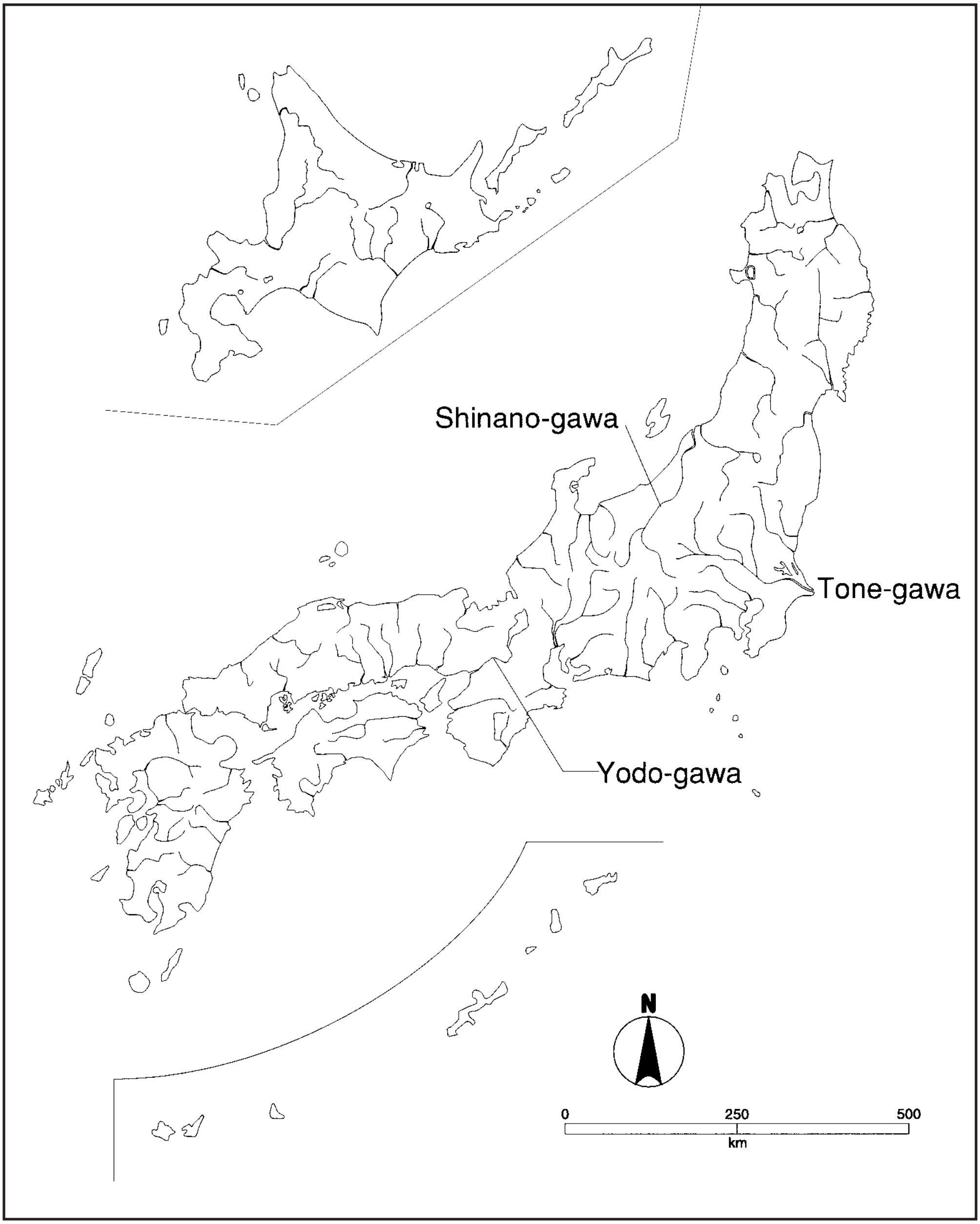
Japan

Japan-10: Shinano-gawa

Japan-11: Tone-gawa

Japan-12: Yodo-gawa



Introduction

The three rivers compiled into this volume are: the Shinano-gawa, the Tone-gawa and the Yodo-gawa, all of which are in Honshu Island. These rivers have very long histories especially in terms of the politics, economy and culture of Japan.

The Shinano-gawa is famous for its length (367 km) as the longest river in Japan. The river originates from a high mountainous area (often referred to as the Japanese Alps) in the centre of Honshu Island. Its plentiful waters flow to the Echigo Plain, where rich rice paddy fields have been developed. The basin is famous for its agricultural production of rice and apples. Hydro-electric power is generated from many dams in the mountainous headwaters.

The Tone-gawa, which flows through the north of the Tokyo Metropolitan area, is a major water resource for the city. The catchment area is the largest in Japan (16,840 km^2) and its population is said to be 12 million. However, 30 million people, including the residents in the Tokyo Metropolitan area, are primarily dependent on the water resources of the Tone-gawa.

The Yodo-gawa flows through the Kansai region, a political and cultural centre of Japan for more than 15 centuries. The famous ancient capitals of Nara (710-784) and Kyoto (784-1868) are located in the river's middle reaches, while Osaka, a modern industrial and commercial city of Japan is at the river mouth. In the upper reaches of the river is Lake Biwa, the biggest lake in Japan. Lake Biwa is a significant water resource, helps to mitigate downstream flooding, and is an area of natural beauty with many tourist resorts. The historical characteristics of the river basin give it much cultural heritage.

All three rivers have been modified in their downstream reaches and river mouth areas to mitigate flood damage to important cities such as Tokyo, Osaka and Niigata.

Acknowledgements

The information on the three rivers was compiled by voluntary members of the IHP Working Group of the Japanese National Committee for UNESCO's International Hydrological Programme (IHP), which is chaired by Dr. TAKEUCHI Kuniyoshi, Yamanashi University. Generous assistance from governmental organizations is acknowledged. Contributors are listed as follows:

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Financial support was provided by:
The Ministry of Education, Culture, Sports, Science and Technology (MEXT), and
The Infrastructure Development Institute (IDI) of Japan.

Shinano-gawa

Map of River

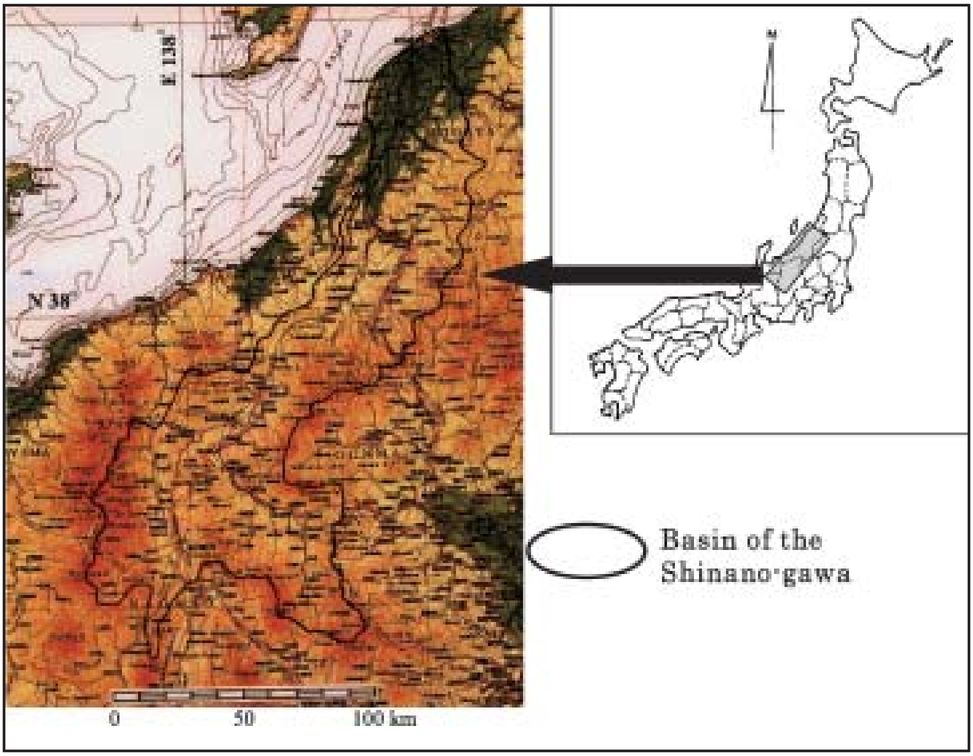


Table of Basic Data

Name: Shinano-gawa		**Serial No. :** Japan-10
Location: Northern Honshu, Japan	N 36° 49' ~ 38° 09'	E 137° 34' ~ 139° 01'
Area: 11,900 km^2	**Length of main stream:** 367 km	
Origin: Mt. Kobushi-ga-dake (2,483 m)	**Highest point:** Mt. Yari-ga-take (3,180 m)	
Outlet: Japan Sea	**Lowest point:** River mouth (0 m)	
Main geological features: Sedimentary rocks; Tertiary, Paleozoic, Volcanic rocks; Andesite, Granitoids		
Main tributaries: Chikuma-gawa (7,163 km^2) (Upper reach), Sai-gawa (3,056 km^2), Uono-gawa (1,504 km^2)		
Main lakes: None		
Main reservoirs: Takase ($76.2 \times 10^6 m^3$), Nanakura ($32.5 \times 10^6 m^3$), Omachi ($33.9 \times 10^6 m^3$), Nagawado ($123 \times 10^6 m^3$), Saguri ($27.5 \times 10^6 m^3$)		
Mean annual precipitation: 1,822 mm (basin average)		
Mean annual runoff: 156×108 m^3 (495 m^3/s)		
Population: 2,900,000 (1990)	**Main cities:** Niigata, Nagaoka, Nagano, Matsumoto	
Land use: Forest (68%), Rice paddy (11%), Other agriculture (6%), Urban (14%)		

1. General Description

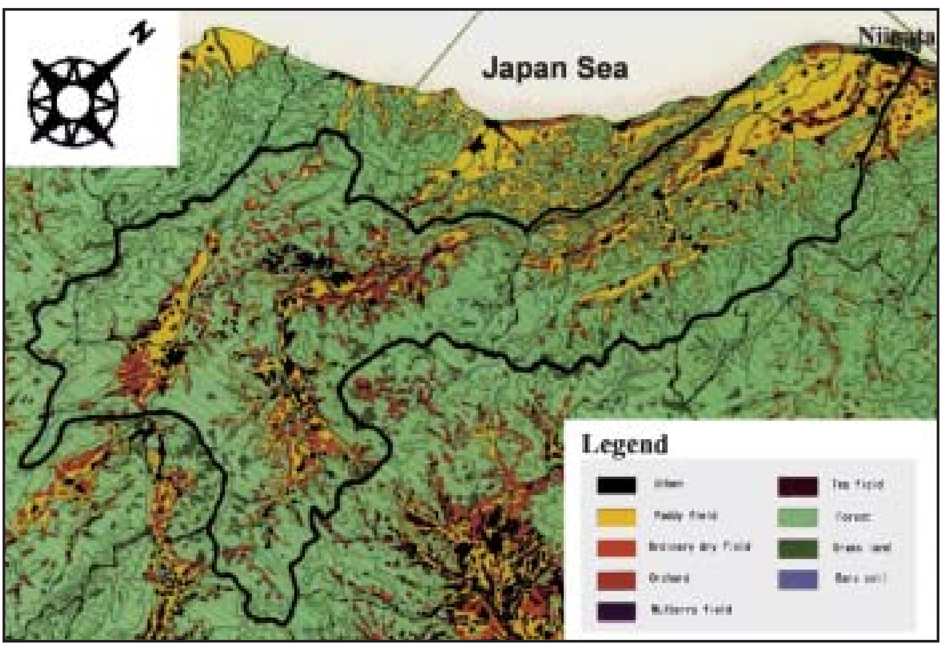
The Shinano-gawa is one of the largest rivers in Japan. It has a catchment area of 11,900 km^2, the third largest in Japan, and a length of 367 km, the longest in Japan. It is called the "Chikuma-gawa" in Nagano Prefecture and "Shinano-gawa" in Niigata Prefecture. The Chikuma-gawa originates from Mt. Kobushi-ga-take (2,475 m), flows north through the Saku basin and joins the Sai-gawa originating from Mt. Yari-ga-take (3,180 m) at Nagano City, and then turns northeast into the Niigata Prefecture through the Zenkouji basin. The Chikuma-gawa's course is 214 km long, and it drains an area of 7,163 km^2. In Niigata Prefecture its name changes to "Shinano-gawa", and it flows northeast across the Echigo plain, one of the best rice producing districts in Japan, before joining the right tributary of the Uono-gawa at Kawaguchi. It finally discharges to Sea of Japan at Niigata City. The population in the basin is about 2,900,000.

The spatial distribution of precipitation in the basin is complex. The middle part of the Chikuma-gawa and the middle and lower part of the Sai-gawa are some of the lowest precipitation areas of Japan with annual precipitation of about 1,000 mm. In contrast, the annual precipitation over the upper part of the Sai-gawa, and the upper and lower parts of the Chikuma-gawa, are 1,600-3,000 mm, 1,000-1,400 mm and 1,400-1,800 mm respectively. The central part of Niigata Prefecture, especially in the mountains, is one of the heavy snow regions of Japan. Sometimes, more than a metre depth of snow can fall during a night. The annual precipitation is from 2,200 to 3,000 mm, 40-50% of which is snowfall. The mean annual precipitation of the basin is about 1,800 mm, almost equal to the mean annual precipitation of Japan.

Floods in the Shinano-gawa are caused mainly by frontal rain in early summer (Japan's rainy season, Baiu), typhoons that hit Japan in summer to autumn, and snowmelt in spring. The Shinano-gawa has high-flows from March to September and is considered to be the best water resource in Japan

2. Geographical Information

2.1 Geological Map



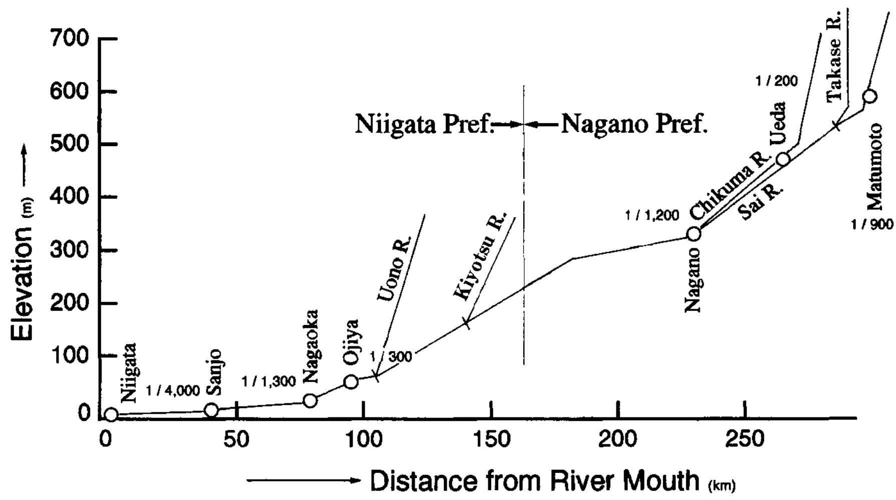
2.2 Land Use Map

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	Land use
1	**Shinano** (Main river)	367 11,900	Mt. Yari-ga-take 3,180 River mouse 0	Niigata, Nagaoka 2,900,000	F (68%) P (11%) A (7%) U (14%)
2	**Chikuma** (Upper reach)	214 7,163	Mt. Kobushi-ga-take 2,475	Nagano, Ueda 1,500,000	
3	**Sai** (Tributary)	161	Mt. Yari-ga-take 3,180	Matumoto 208,972	
4	**Uono** (Tributary)	68 1,504	Mt. Nakano-dak 2,085	Koide, Muikamachi 73,530	

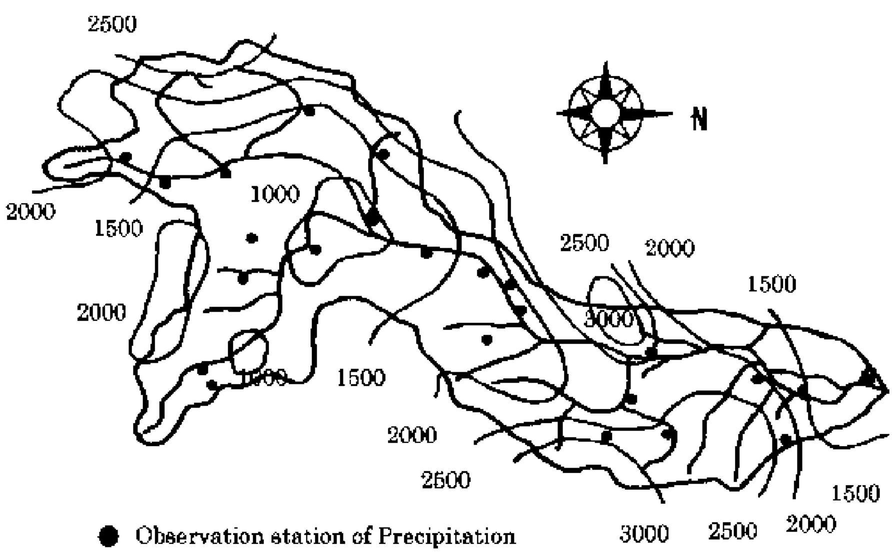
A: Other agricultural field (vegetable, grass) F: Forest L: Lake, River, Marsh O: Orchard
P: Paddy field U: Urban

2.4 Longitudinal Profiles



3. Climatological Information

3.1 Annual Isohyetal Map and Observation Stations



3.2 List of Meteorological Observation Stations

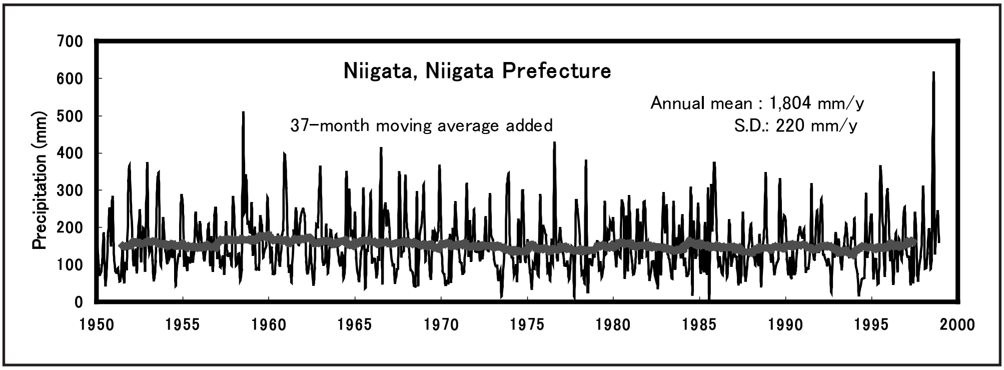
No.*	Station	Elevation [m]	Location	Observation period	Mean annual precipitation[1] [mm]	Mean annual evaporation	Observation items[2]
40316	**Ohyu**	300	N 37° 10' 36" E 139° 05' 24"	1954 - present	2,737.8	N	P
40318	**Kamizyo**	250	N 37° 20' 54" E 139° 03' 00"	1974 - present	2,725.2	N	P
40319	**Myozin**	162	N 37° 12' 07" E 138° 52' 36"	1955 - present	2,699.0	N	P
4036521	**Kitamaki**	1,090	N 36° 03' 16" E 138° 29' 04"	1951 - present	1,047.8	N	P
4036520	**Koya**	845	N 36 07' 24" E 138 34' 18"	1955 - present	1,125.2	N	P
4036516	**Nagakubo shinmachi**	679	N 36° 14' 58" E 138° 16' 42"	1954 - present	1,004.1	N	P
4036513	**Kakeyu**	715	N 36° 18' 02" E 138° 08' 30"	1955 - present	1,236.6	N	P
4036522	**Niekawa**	900.5	N 36° 00' 29" E 137° 51' 38"	1954 - present	1,724.4	N	P
4036504	**Kinasa**	721.5	N 36° 40' 48" E 138° 00' 28"	1952 - present	1,427.6	N	P
**	**Nagano**	418	N 36° 39' 06" E 138° 11' 07"	1889 - present	981	N	DS, P, SR
**	**Niigata**	2	N 37° 54' 30" E 139° 03' 00"	1886 - present	1,804	1,110.2 (1880 - 1950)	DS, P, SR

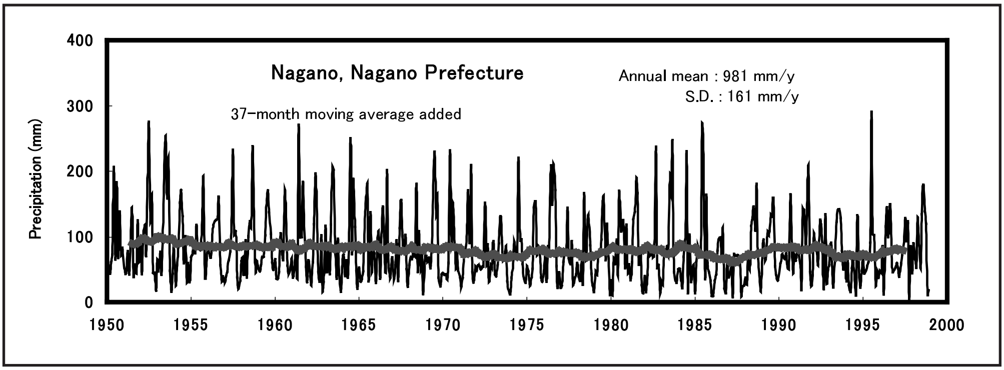
* Serial number used by River Bureau, Ministry of Land, Infrastructure and Transportation.
** Meteorological Obsevatory, Japan Meteorological Agency.
1) Period of the mean is from the beginning of the observation to present.
2) P: Precipitation DS: Duration of sunshne SR: Solar radiation

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]	**Niigata**	2.6	2.5	5.4	11.2	16.1	20.4	24.5	26.2	22.0	16.0	10.2	5.3	13.5	1971 - 2000
Precipitation [mm]	**Niigata**	180.3	128.0	104.6	93.6	103.3	128.3	178.2	142.7	163.0	148.9	200.6	204.4	1,775.8	1971 - 2000
Evaporation [mm]	**Niigata**	32.9	37.7	62.2	97.5	126.2	136.3	156.8	179.2	117.8	81.1	52.1	36.5	1,110.2	1888 - 1950
Solar radiation [$MJ/m^2/d$]	**Niigata**	5.1	7.7	11.3	15.7	18.0	17.1	17.2	17.3	12.6	9.9	6.1	4.4	11.8	1971 - 2000
Duration of sunshine [hr]	**Niigata**	56.1	72.9	130.9	181.9	204.8	168.1	182.7	214.8	146.4	142.8	90.0	59.4	137.6	1971 - 2000

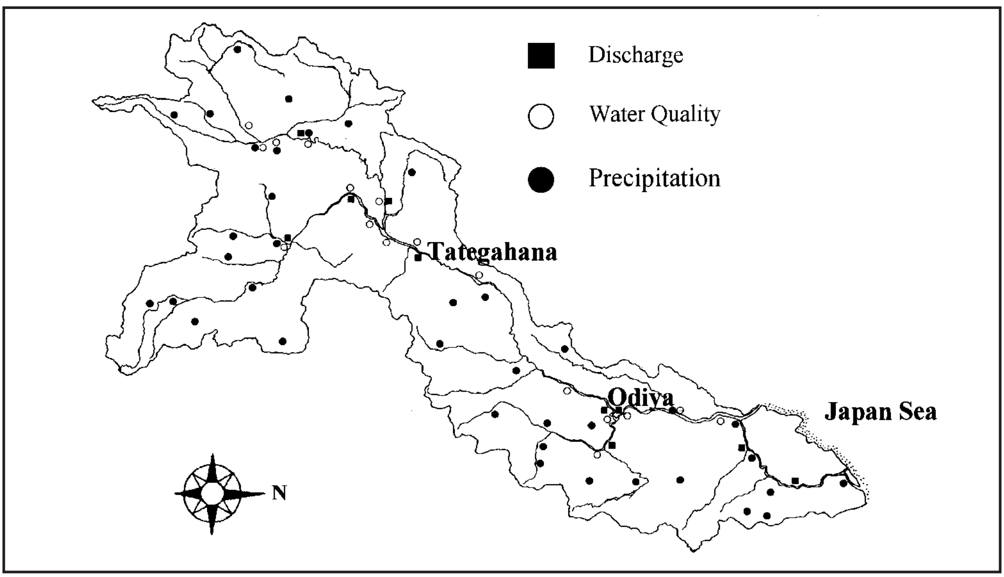
3.4 Long-term Variation of Monthly Precipitation





4. Hydrological Information

4.1 Map of Streamflow Observation Stations



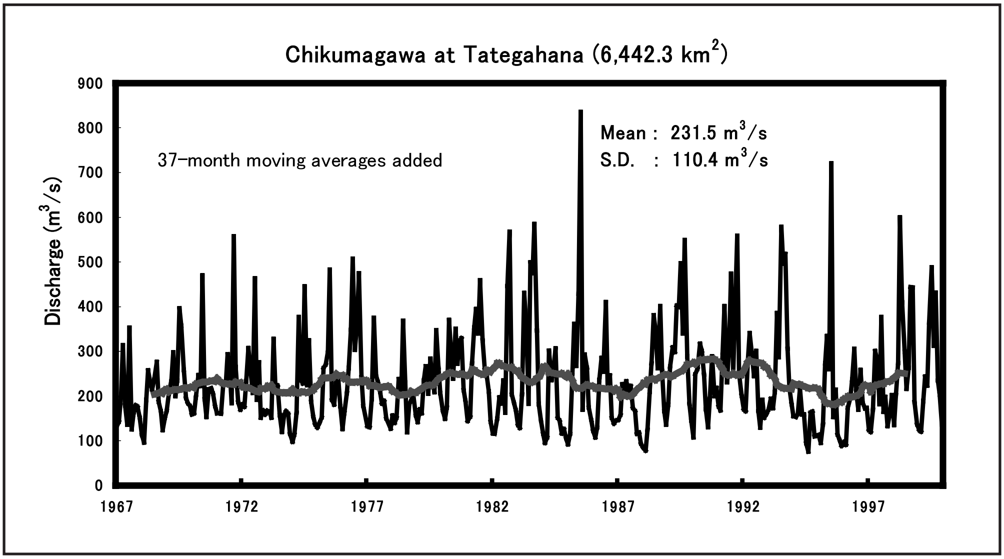
4.2 List of Hydrological Observation Stations

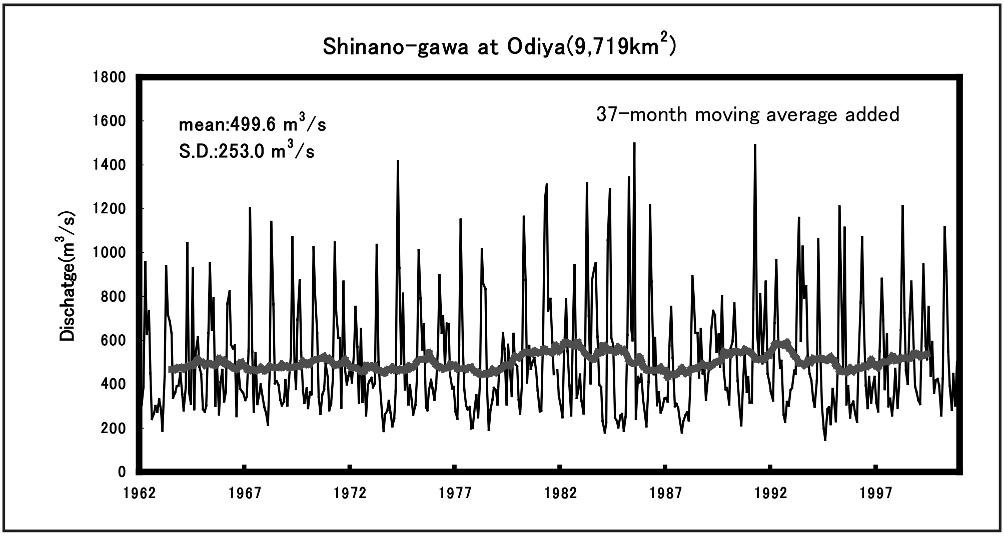
No.*	Station	Location	Catchment area (A) [km²]	Observation period	Observation items[1] (frequency)
40316	**Odiya**	45 km	9,719	1942 - present	Q (h)
402037	**Tategahana**	155.3 km	6,442.3	1975 - present	Q (h)
4036503	**Ikuta**	212.1 km	2,036.4	1975 - present	Q (h)
4036508	**Kuisege**	186.4 km	2,595.9	1949 - present	Q (h)
4036516	**Koichi**	9.0 km**	2,773.0	1953 - present	Q (h)

No.*	$\overline{Q}$[2] [m³/s]	Qmax[3] [m³/s]	$\overline{Q}$max[4] [m³/s]	$\overline{Q}$min[5] [m³/s]	$\overline{Q}$/A [m³/s/100km²]	Qmax/A [m³/s/100km²]	Period of statistics
40316	503	9,638	3,776	91	5.18	99	1951 - 1999
402037	232	7, 440	2,485	94	3.60	115.49	1975 - 1999
4036503	53.65	1,361.6	1,092.6	17.51	2.63	66.86	1975 - 1999
4036508	61.93	1,529.4	1,288.0	15.25	2.39	58.92	1949 - 1999
4036516	124.33	1,067.8	1,368.6	37.93	4.48	38.50	1953 - 1999

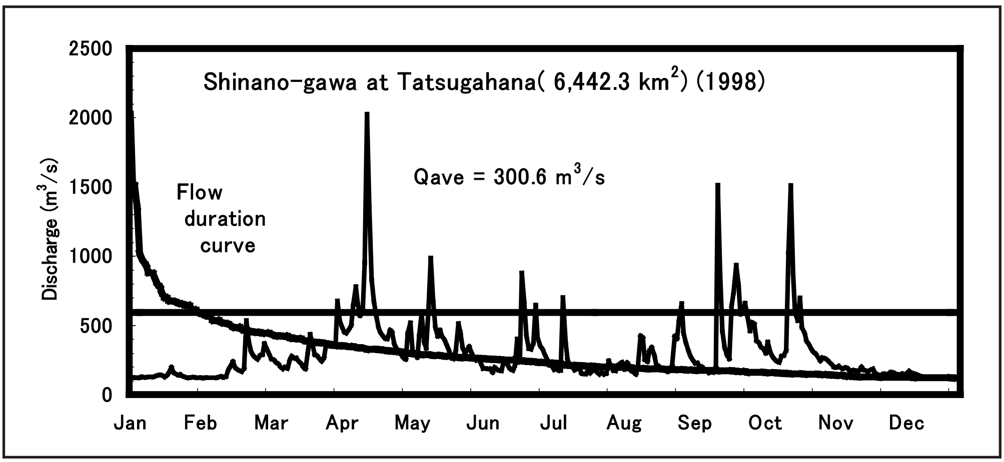
* Serial Number used by The River Bureau, Ministry of Land, Infrastructure and Transportation
** Distance from the confluence of the Chikuma river
1) Q(h): Discharge and Water level 2) Mean annual discharge 3) Maximum discharge 4) Mean maximum discharge
5) Mean minimum discharge

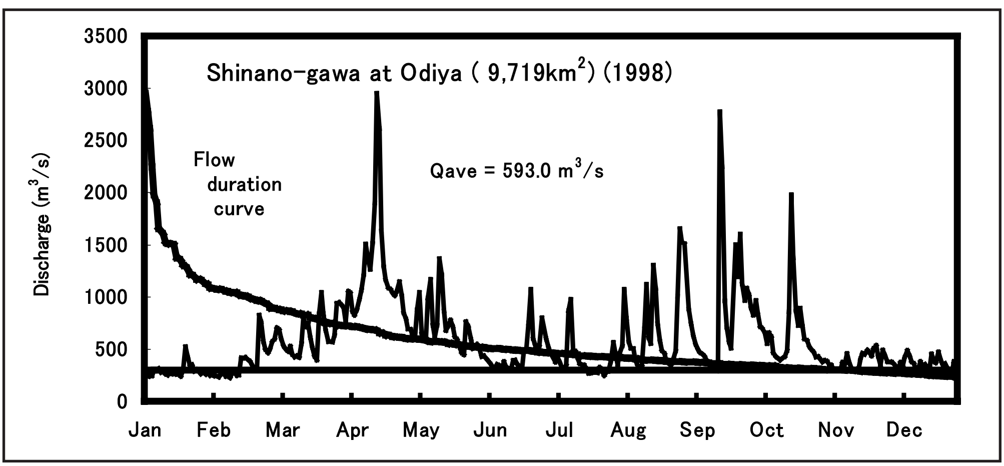
4.3 Long-term Variation of Monthly Discharge





4.4 Annual Pattern of Discharge





4.5 Unique Hydrological Features

In ancient times, the present Echigo Plain was a giant estuary-like lake and was slowly filled with sedimentary deposits carried down by the Shinano-gawa, to form marshy, low-lying land. As it was marshy, once flooding occurred, water overflowed from the river and washed away houses and fields, and caused loss of life. In 1716, Kazuemon Honma first petitioned the government to construct the Ohkouzu diversion channel. It was to be requested again and again in the course of the following 200 years, until finally it was approved with construction beginning in 1909. The construction was completed some 22 years after it began in 1931. The diversion channel, approximately 10 km long, diverts the flood waters of the Shinano-gawa into the Sea of Japan. Before the construction of the diversion channel, major floods occurred on average every 3 or 4 years. But after the completion of the channel, there has been very little damage and as a result, the Echigo Plain has been developing rapidly.

Myoken Weir was constructed in 1989 just upstream at Nagaoka City, where the Shinano-gawa pours onto the flood plain of the Nagaoka-Niigata area. The weir length is 524 m and 8 motor-controlled gates are installed. One of them is used for flushing sediment. Upstream of the weir the maximum control volume that can be stored is 1,100,000 m^3. The weir has three functions: one is to protect the river bed from excessive erosion, the second is to stabilize the flow upstream of the weir which shows a diurnal fluctuation due to the operation of the Shinano-gawa (Odiya) Hydropower Plant just upstream of the weir, and the third is to support the planned bridge carrying the national highway.

The Sekiya Diversion Channel is located on the western margin of central Niigata City. Although the Sekiya Diversion Channel was planned in the Edo era, the construction of the channel was not started until 1968, and was completed in 1973. The channel length is 1.8 km and it is 240-280 m wide. It has both flood control and water usage functions. It protects Niigata City, the largest seaside city on the Japan Sea, against flooding by the Shinano-gawa, and it prevents saltwater intrusion of the estuary. Moreover, it protects the Niigata coast from erosion and the Niigata-Nishi port against sedimentation.

4.6 Annual Maximum and Minimum Discharges

Chikuma-gawa at Tategahana [6,442.3 km^2]

Year	Maximum 1)		Minimum 2)		Year	Maximum 1)		Minimum 2)	
	Date	[m^3/s]	Month	[m^3/s]		Date	[m^3/s]	Month	[m^3/s]
1984	5/2	1,261.35	1/30	83.71	**1992**	7/18	984.08	9/18	111.01
1985	7/1	4,238.46	3/7	72.33	**1993**	9/10	1,934.65	3/21	120.82
1986	7/17	1,108.30	2/23	105.59	**1994**	9/30	1,342.42	8/18	53.93
1987	3/21	692.42	10/30	44.16	**1995**	7/12	2,905.71	12/28	81.54
1988	6/4	1,912.44	2/29	56.06	**1996**	6/26	1,835.30	1/2	76.94
1989	9/20	2,062.76	1/5	120.58	**1997**	7/18	1,172.46	11/11	97.62
1990	9/20	1,401.36	7/29	44.64	**1998**	9/16	2,998.18	12/29	115.93
1991	9/19	2,524.96	2/9	144.99	**1999**	8/15	4,050.94	1/2	102.08

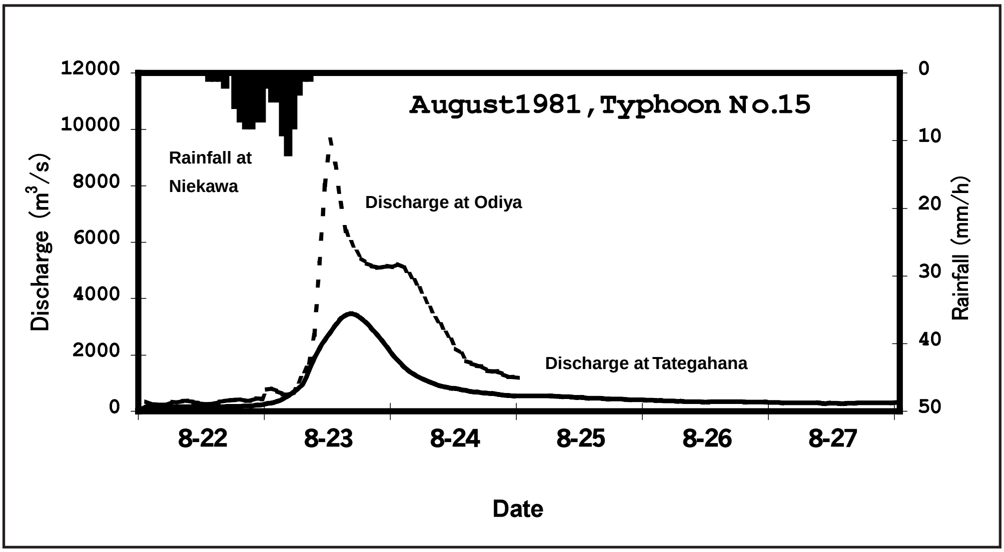
1), 2) Instantaneous observation by recording chart

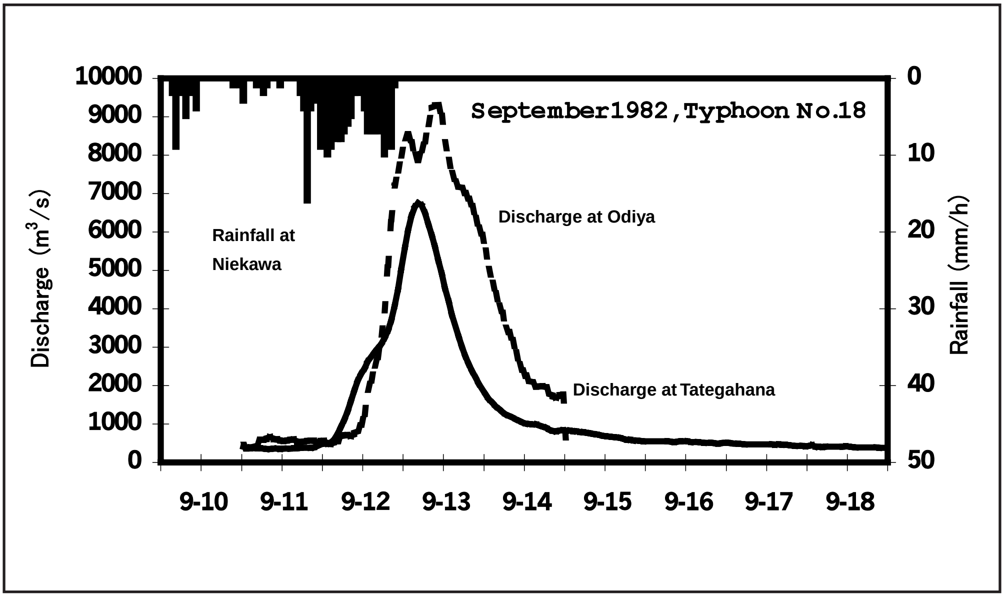
Shinano-gawa at Odiya [9,719 km²]

Year	Maximum[1)]		Minimum[2)]		Year	Maximum[1)]		Minimum[2)]	
	Date	[m³/s]	Date	[m³/s]		Date	[m³/s]	Date	[m³/s]
1980	4/7	2,830	2/27	52	**1990**	9/20	3,570	8/17	53
1981	8/23	9,640	5/31	61	**1991**	8/31	3,230	12/8	50
1982	9/13	9,300	7/4	45	**1992**	6/21	2,090	8/20	23
1983	9/29	7,810	2/24	81	**1993**	5/14	3,100	1/25	80
1984	5/2	4,160	8/22	76	**1994**	4/13	2,010	2/6	74
1985	7/1	7,200	1/28	85	**1995**	7/12	4,700	2/26	61
1986	9/3	2,560	8/30	87	**1996**	6/26	2,360	8/15	76
1987	3/25	2,160	10/15	77	**1997**	4/8	2,790	9/3	88
1988	6/4	2,990	2/23	92	**1998**	9/16	5,970	2/12	108
1989	9/20	3,180	1/7	146	**1999**	6/30	4,000	8/3	69

1), 2) Instantaneous observation by recording chart

4.7 Hyetographs and Hydrographs of Major Floods





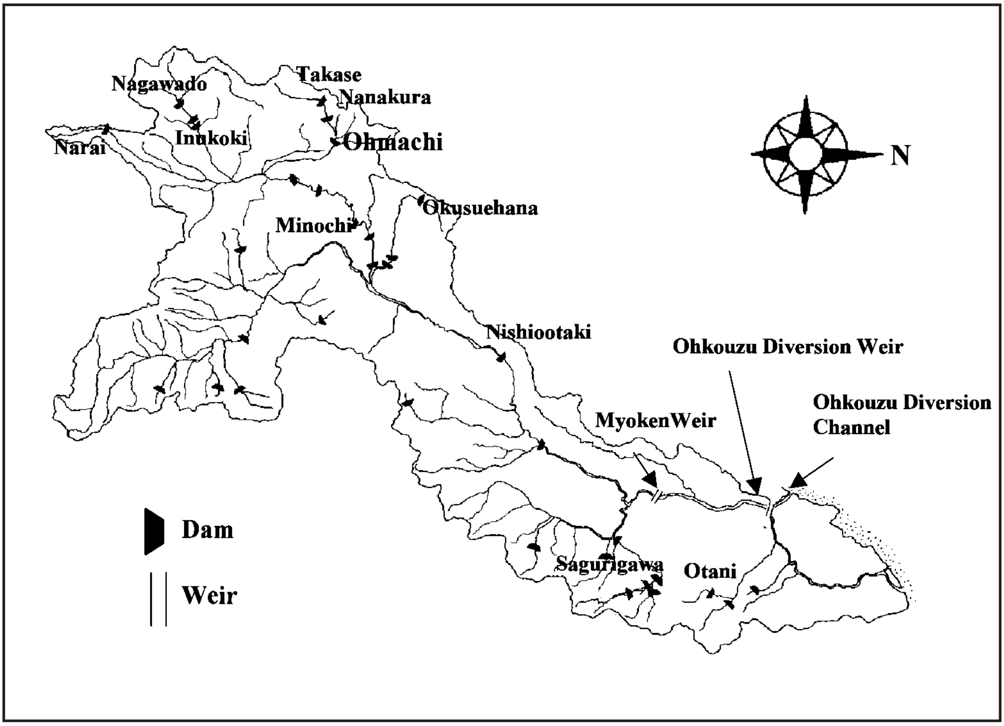
5. Water Resources

5.1 General Description

The Shinano-gawa has the greatest annual discharge, 154×10^8 m^3, of any river in Japan. Development of this water resource was started before Word War II but greatly increased after the war. A number of dams for hydropower have been constructed in the Chikuma-gawa and upper Sai-gawa basins, both of which have many suitable places for dam construction because of their steep topography, especially in the Sai-gawa basin. Several large hydroelectric power plants have been built by the Tokyo Electric Company along the Takase-gawa in the upper reaches of the Sai-gawa near its source, Mt. Yari-ga-take (3,180 m). The Takase Dam with a height of 176 m is one of the largest dams in the Orient. The Shin-Takase-gawa power plant is located downstream of the Takase Dam and its output is 1,280 MW. The combined output from the plants in the Takase-gawa is 1344.9 MW. The total power produced in all the basins is 2,618 MW.

Nowadays, water from Shinano-gawa is fully used not only for hydropower but also for irrigation, industrial usage and municipal water supply. It irrigates 12,647 ha of agricultural land, and supplies 15.2 m^3/s of municipal and 15.2 m^3/s of industrial water.

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 [10^6m^3]	Effective capacity [10^6m^3]	Purposes[1)]	Year of completion
Takase	**Takase**	131.0	76.2	16.2	P	1981
Takase	**Ohmachi**	193.0	33.9	28.9	F, N, W, P	1985
Azusa	**Midono**	431.0	15.1	4.0	P	1969
Azusa	**Nagawado**	380.5	123.0	94.0	A,P	1968
Saguri	**Sagurigawa**	76.2	27.5	19.8	F, N, P, W	1991

A: Agricultural use F: Flood control N: Maintenance of normal flows P: Hydropower W: Municipal water supply

5.4 Major Floods and Droughts

Major Floods at Odiya

Date (year. month)	Peak discharge [m³/s]	Rainfall [mm] Duration	Meteorological cause	Dead and Missing	Major damages (Districts affected)
1959.8	5,570	-	Typhoon No.7	-	Mid stream
1969.8	6,110	8.8-8.12	Stationary front	0	Mid stream, Uono river basin
1978.6	5,870	385 6.25 - 6.27	Bai-u front	2	Mid stream, Uono river basin
1981.8	9,640	166 8.22 - 8.23	Typhoon No.15	0	Upper and mid stream
1982.9	9,300	167 9.11 - 9.12	Typhoon No.18	2	Upper and mid stream
1983.9	7,810	116 9.27 - 9.28	Typhoon No.10	3	Upper and mid stream
1985.7	7,200	107 6.29 - 6.30	Typhoon No.6	0	Upper and mid stream
1998.9	5,970	113 9.15 - 9.16	Typhoon No.5	0	Mid stream

Major Drought

Period	Affected areas	Major damages and counteractions
7 - 9, 1994	Whole basin	Water supply cut to 10-50% of normal. Duration 31 July to 21 August

5.5 Groundwater and River Water Quality

River Water Quality[1] at Cyouseibashi[2] between 2000/6 - 2001/5

Date	6/21	7/19	8/23	9/20	10/18	11/15	12/20	1/17	2/21	3/21	4/18	5/16
pH	7.2	7.6	7.6	7.8	7.9	7.4	7.3	7.5	7.9	7.5	7.2	7.5
BOD [mg/l]	0.9	1.3	1.1	0.7	1.1	0.7	0.7	0.8	1.1	1.1	0.6	0.8
COD_{Mn} [mg/l]	—	11.1	—	—	—	—	—	—	—	—	—	2.1
SS [mg/l]	10	112	12	52	5	10	12	8	6	15	20	14
Coliform group[3] [MPN/100ml]	2.3×10^3	2.8×10^4	3.3×10^3	3.3×10^4	1.3×10^4	1.1×10^4	1.7×10^4	1.3×10^3	4.9×10^2	3.3×10^3	1.7×10^3	2.3×10^3
Discharge[4] [m³/s]	368.2	597.9	227.2	417.5	234.0	303.4	503.7	373.1	343.5	603.4	1,170.5	703.8

1) Observed once a month on a dry day normally several days after rainfall.
2) Located in Nagaoka City 28 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 Chikuma-gawa catchment area is 7,163 km^2, about 10% of which is flat land. The principal activity on this flat land is agriculture, mainly rice production, and the irrigated area is 49,600 ha. Apples are cultivated in the Zenkouji plain as one of the specialties of the Nagano Prefecture. There are many hot springs, such as Tokura, Kamiyamada and Nozawa, along the Chikuma-gawa,. Tourism is one of the major industries of the basin. As amply demonstrated by the Winter Olympic Games held in Nagano, there are many ski resorts as well as mountain and hot spring resorts. Moreover, every year 6,500,000 people visit “Zenkouji” because the head temple of the Buddhist Tendai sect is in Nagano city.

The history of the Shinano-gawa is one of fighting floods. As described in Section 4.5, people suffered from floods until the completion of the Ohkouzu Diversion Channel. Nowadays, by using the plentiful waters of the Shinano-gawa, the Echigo Plain is the best granary in Japan, and specialises in rice production.

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