Natori-gawa

Map of River

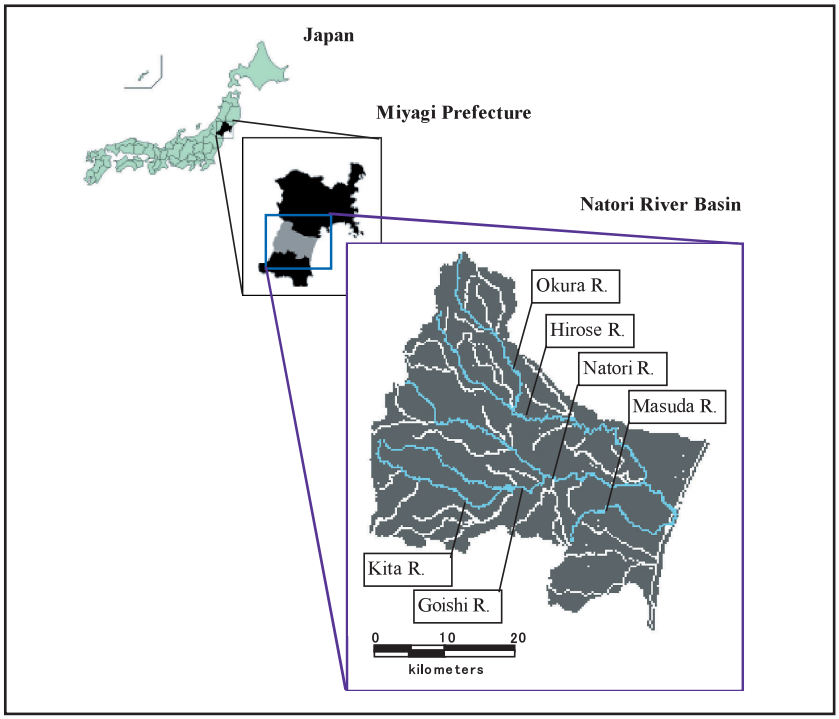


Table of Basic Data

Name: Natori-gawa		**Serial No. :** Japan-14
Location: Northeast Honshu, Japan	N 38° 08' ~ 38° 37'	E 140° 26' ~ 140° 58'
Area: 939 km^2	**Length of main stream:** 55 km	
Origin: Mt Kamurodake	**Highest point:** Mt. Zao (Kumano-dake) (1,841 m)	
Outlet: Pacific Ocean	**Lowest point:** River mouth (0 m)	
Main geological features: volcanic rock, tuff, alluvial deposit		
Main tributaries: Hirose River (316 km^2) , Goishi River (216 km^2)		
Main lakes: Kamafusa (39.3 x 10^6 m^3)		
Main reservoirs: Kamafusa (39.3 x $10^6 m^3$, 1970), Okura (25.0 x $10^6 m^3$, 1961), Tarumizu (4.2 x $10^6 m^3$, 1977)		
Mean annual precipitation: 1,241.8 mm at Sendai (1971-2000).		
Mean annual runoff: 17.11 m^3/s at Yokata (1960-2000)		
Population: 429,600	**Main cities:** Sendai	
Land use: Forest (71.2%), Paddy field (16%), Cropland (3.6%), Orchard (1%), Urban of Residential area (7%), Water surface (1.2%)		

1. General Description

The 354 km long Natori River (Natori-gawa) system, located in the northeast part of Japan, has a catchment area of 939 km^2. The Natori River basin consists of two main subcatchments, which are the Hirose River basin (316 km^2), and the Goishi River basin (216 km^2). It reaches to Yamagata prefecture.

City areas spread throughout the basin. The metropolitan area of Sendai, capital city in the Tohoku district is located in the river basin. The population in the basin is about 429,600, which is 4% of the population nationwide and 42% of that in the city of Sendai. The lower Natori River basin is covered with mainly wide paddy field where there is one of the most famous rice production areas. Mountainous areas receive snow, which is an important water resource for rice plant in spring.

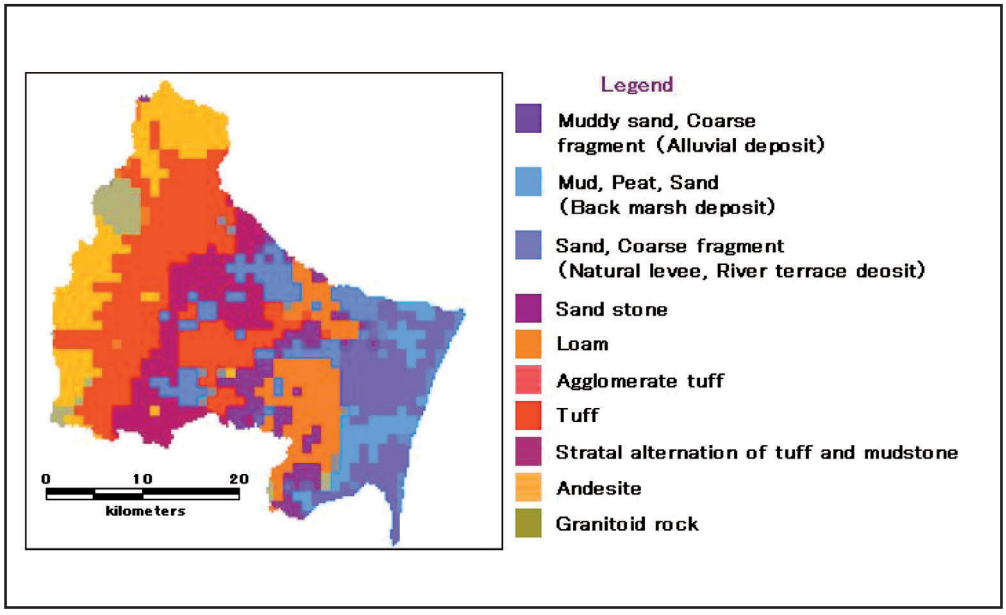
Precipitation in the basin is widely distributed in time and space. The annual precipitation of the Hirose River basin and the Goishi River are about 1,450 mm and 1,390 mm respectively. The mean annual precipitation of the Natori River basin is about 1,680 mm.

High flows occur in the Natori River during the snow melt season from March to April, the rainy season from June to July, and the typhoon season from September to October, respectively.

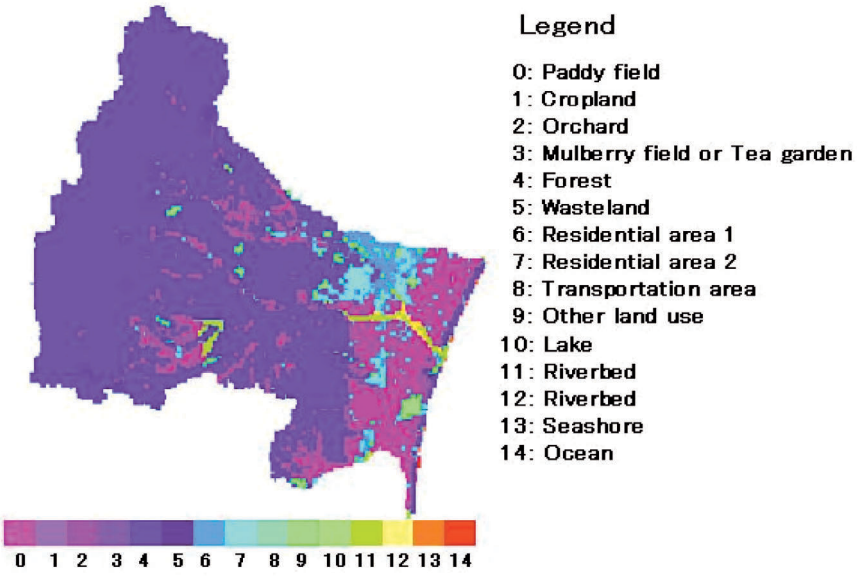
Due to the time and space distribution of high water flows and the large storage capacity of the two main reservoirs, Kamafusa and Okura dams, the river flow conditions are more stable than other Japanese basins.

2. Geographical Information

2.1 Geological Map



2.2 Land Use Map

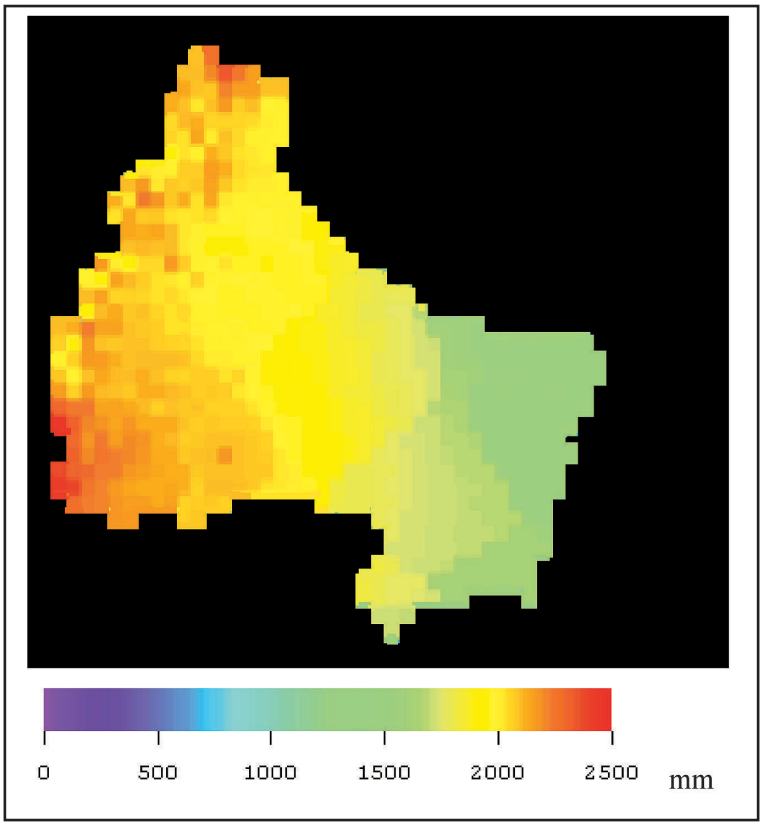


2.3 Characteristics of River and Main Tributaries

No.	Name of river	Length [km] Catchment area [km^2]	Highest peak [m] Lowest point [m]	Cities Population
1	**Natori** (Main river)	55 939	Mt. Zao 1,841 River mouth 0	Sendai (995,725)
2	**Hirose** (Tributary)	125.9 315.9	Mt.Funakata 1,500 Confluence 0	Sendai (995,725)
3	**Masuda** (Tributary)	25.2 39.6	305 Confluence 0	Natori (68,193)
4	**Goishi** (Tributary)	80.1 216.4	Mt. Kamafusa 385 Confluence 30	Kawasaki (11,032)

3. Climatological Information

3.1 Annual Isohyetal Map



3.2 List of Meteorological Observation Stations

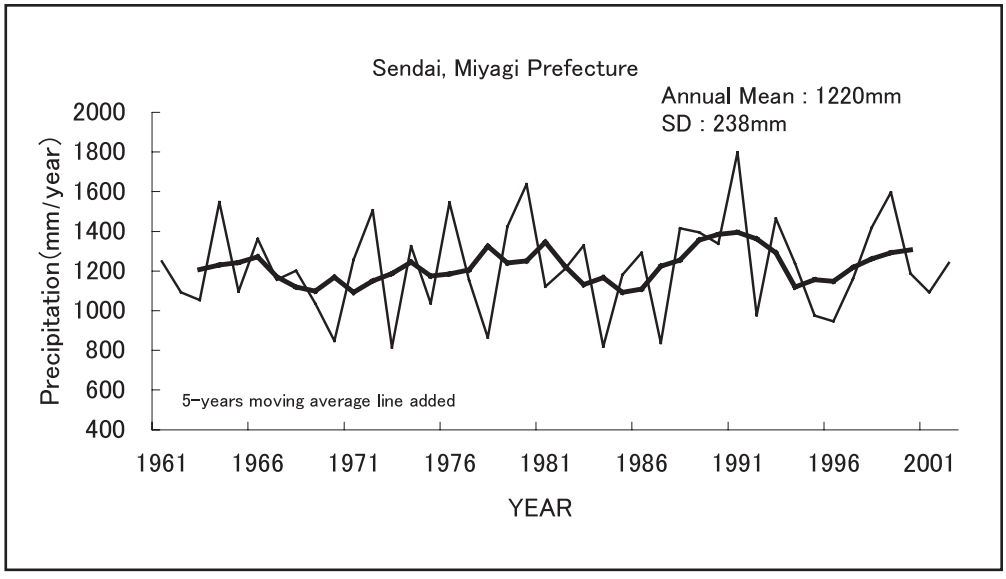
No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [mm]	Mean annual temperature [°C]	Observation items[3]
34421[1]	**Kawasaki**	200	N 38° 10.8' E 140° 37.9'	22	1,451.0	10.6	A
34951[1]	**Nikkawa**	264	N 38° 18.2' E 140° 38.1'	22	1,522.7	10.0	A
47590[2]	**Sendai**	39	N 38° 15.7' E 140° 53.8'	30	1,219.7	12.1	M

1) Serial Number used by JMA (Japan Meteorological Agency)
2) Serial Number used by WMO (World Meteorological Organization)
3) A: The AMeDAS (Automatic Meteorological Data Acquisition System) observation. The observation items are precipitation, air temperature, wind speed, wind direction and sunshine duration.
M: Meteorological observation. Fourteen items including precipitation, air temperature, sunshine duration, solar radiation, wind speed, wind direction.

3.3 Monthly Climate Data (Observation station: Sendai)

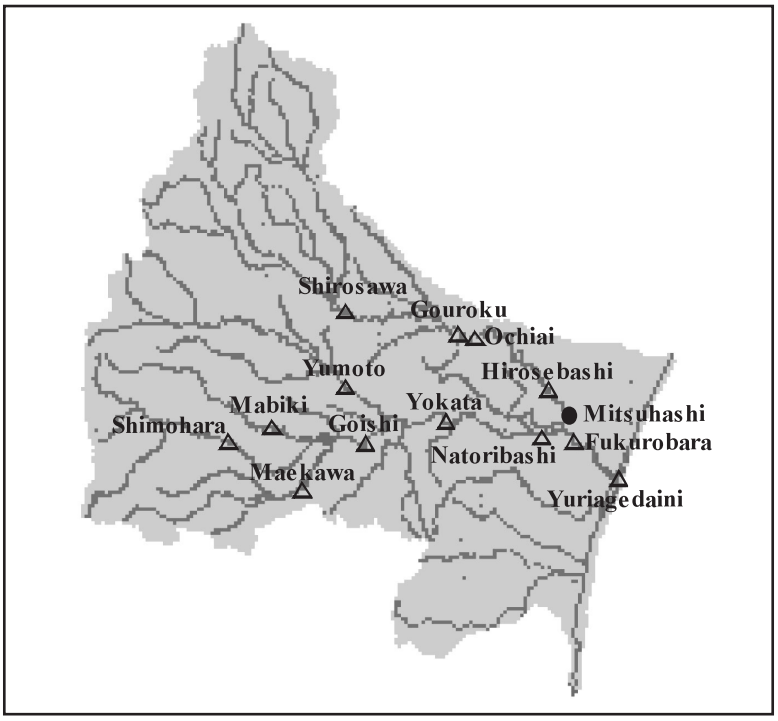
Observation Item	Observation station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [℃]	**Sendai**	1.5	1.7	4.5	10.1	14.9	18.3	22.1	24.1	20.4	14.8	9.1	4.3	12.1	1971-2000
Precipitation [mm]	**Sendai**	33.1	48.4	73.0	98.1	107.9	137.9	159.7	174.2	218.4	99.2	66.8	26.4	1,241.8	1971-2000
Solar radiation [$MJ/m^2/d$]	**Sendai**	7.9	10.5	13.4	16.1	17.7	14.5	14.1	14.6	11.4	10.3	7.9	7.0	12.1	1972-2000
Duration of Sunshine [hr]	**Sendai**	151.3	151.9	182.3	190.9	198.7	127.9	127.7	155.4	119.8	151.8	140.2	144.7	1,842.6	1971-2000

3.4 Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1 Map of Streamflow Observation Station



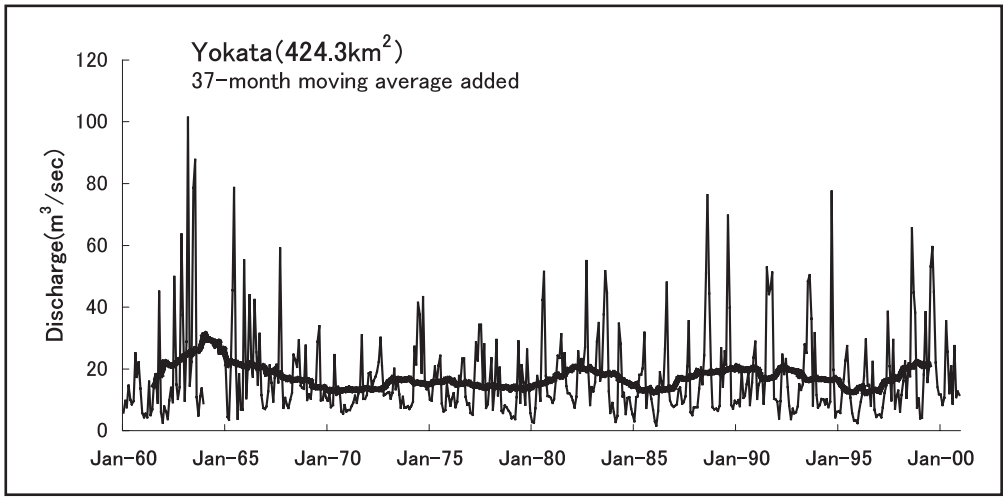
4.2 List of Hydrological Observation Stations[1)]

No.[2)]	Station	Location	Catchment area (A) [km^2]	Observation period	Observation items[3)]
1362120277099	**Yokata**	N 338° 12' 49" E 140° 49' 3"	424.3	1960 - present	Q
1362120240030	**Natoribashi**	N 338° 12' 4" E 140° 53' 22"	431.3	1975 - present	Q
1362120240080	**Hirosebashi**	N 338° 13' 58" E 140° 53' 35"	309.3	1960 - present	Q

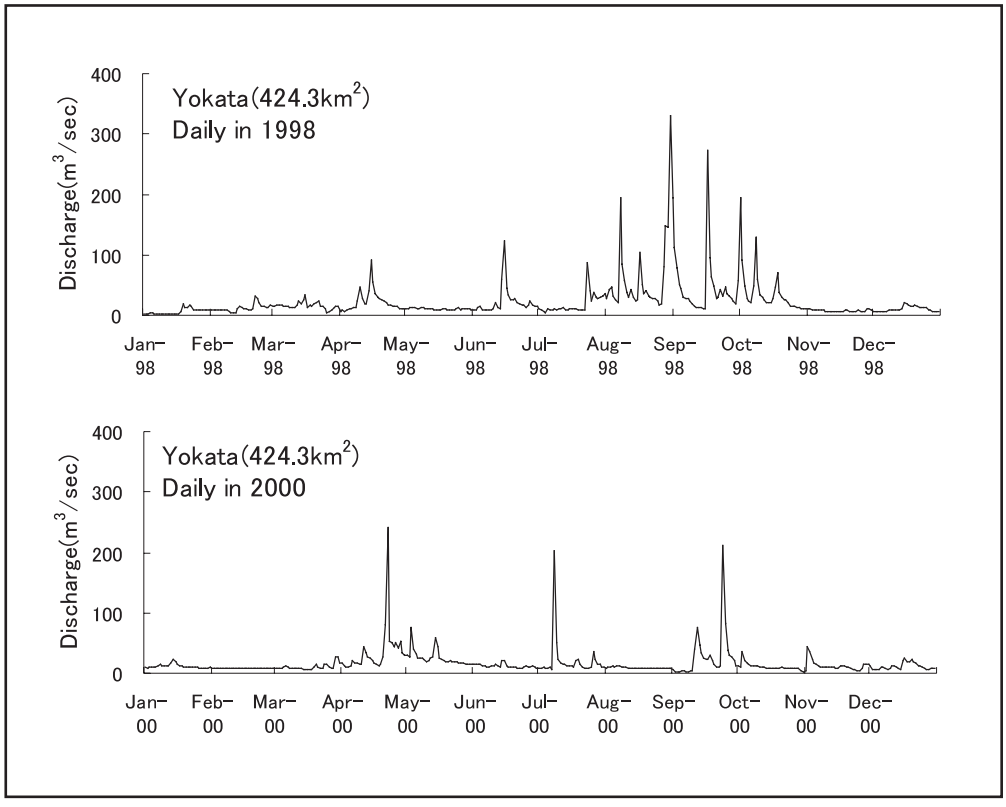
No.[2)]	$\overline{Q}$[4)] [m^3/s]	Qmax[5)] [m^3/s]	$\overline{Q}$max[6)] [m^3/s]	$\overline{Q}$min[7)] [m^3/s]	Q/A [m^3/s/100km^2]	Qmax/A [m^3/s/100km^2]	Period of statistics
1362120277099	17.11	843.73	297.13	3.14	4.03	198.85	40
1362120240030	15.56	1,701.61	697.94	0.77	3.61	394.53	21
1362120240080	10.12	1,304.15	441.98	0.33	3.27	421.65	30

1) 13 water stage stations and 4 discharge stations are operated in the Natori River basin.
2) Serial Number used by Ministry of Land, Infrastructure and Transport
3) H: water level, Q: discharge, Q is obtained from rating curve.
4) $\overline{Q}$: Mean annual discharge
5) Q max : Maximum discharge
6) $\overline{Q}$ max: Mean maximum discharge
7) $\overline{Q}$ min: Mean minimum discharge

4.3 Long-term Variation of Monthly Discharge



4.4 Annual Pattern of Discharge



4.5 Unique Hydrological Features

The Natori River basin has two main reservoirs, which are Okura dam reservoir with a lake area of about 1.6 km^2 and a storage capacity of 28 million m^3, and Kamafusa dam reservoir with an area of about 3.9 km^2 and storage capacity of 45.3 million m^3. The catchment areas of Okura and Kamafusa are 88.5 km^2 and 195.3 km^2 respectively.

These two dams play an important role of a regulating reservoir for flood control and water supply. In case of flooding of the main Natori River, these dams are controlled to reduce the high water flow to the lower basins. Also, a headwork in the middle steam irrigates 32 km^2 of paddy field.

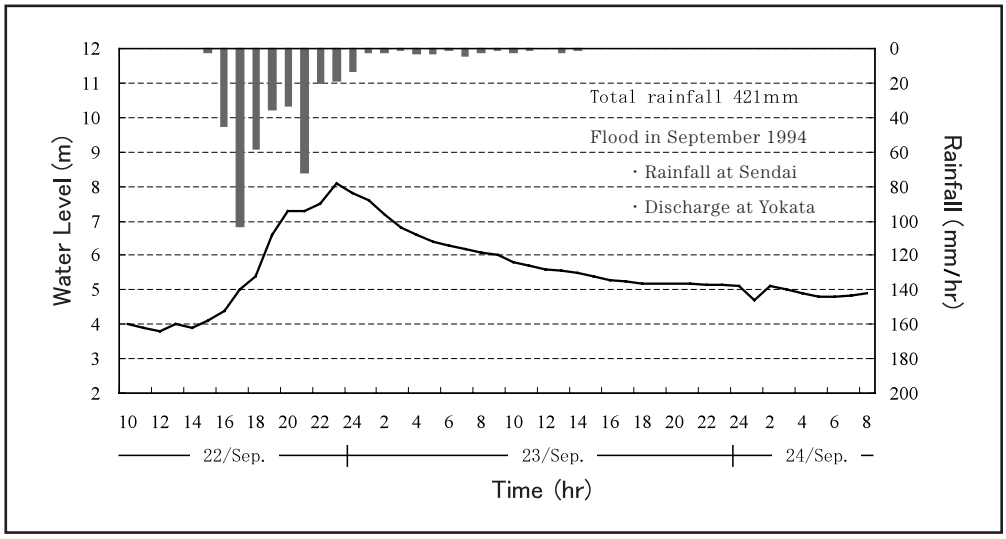
The Natori River also provides a water supply for 1 million people in Sendai city. When severe drought occurs, the users of the water in the downstream areas, the central government and related local governments convene a task force committee and coordinate measures against drought. The minimum necessary water is discharged from the two dams and the headwork for water use in the downstream areas.

4.6 Annual Maximum and Minimum Discharges

At Yokata [424.3 km^2]

Year	Maximum [m^3/s]	Minimum [m^3/s]	Year	Maximum [m^3/s]	Minimum [m^3/s]	Year	Maximum [m^3/s]	Minimum [m^3/s]
1970	152.17	4.41	**1980**	245.90	2.31	**1990**	331.37	4.23
1971	222.32	4.87	**1981**	368.64	6.65	**1991**	417.73	4.23
1972	153.67	10.64	**1982**	391.07	2.60	**1992**	85.26	0.98
1973	59.78	3.32	**1983**	264.46	2.92	**1993**	383.80	2.37
1974	327.93	5.94	**1984**	195.61	1.64	**1994**	750.92	1.52
1975	58.08	4.60	**1985**	242.29	1.00	**1995**	154.16	1.26
1976	73.39	5.12	**1986**	843.73	0.74	**1996**	113.47	1.62
1977	297.92	1.99	**1987**	141.18	1.84	**1997**	269.75	1.05
1978	114.59	4.00	**1988**	373.27	5.44	**1998**	330.03	2.14
1979	198.74	2.84	**1989**	563.30	2.59	**1999**	672.16	1.25

4.7 Hyetographs and Hydrographs of Major Floods



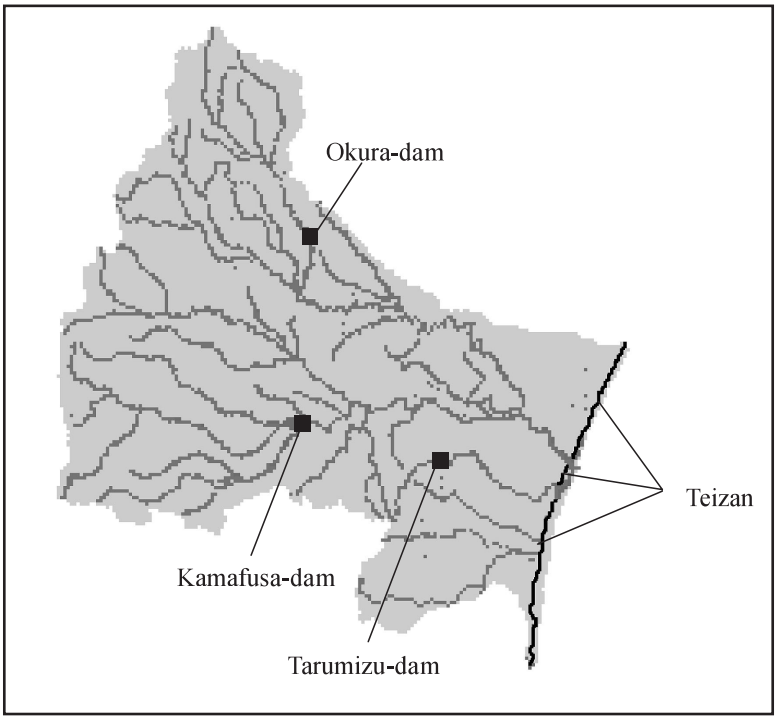
5. Water Resources

5.1 General Description

The water of the Natori River was mainly used for agricultural water and navigation services in the past. The first water utilization canal of Natori River for irrigation was constructed in 1606 and the canal was planed and designed by domain head Tsunamoto Moniwa. Since 1597, feudal lord Date government had constructed Teizan canal from the Abukuma River to the Kitakami River, 50km, for ship transportation. This canal is the longest in Japan.

In modern era, the Okura dam and the Kamafusa dam were constructed in 1961 and 1970, respectively. The first term of Natori River Water Control Work was implemented in 1954 for flood control. The second period of the work in 1962 was in response to increasing demand for water due to the development of the industrial economy.

5.2 Map of Water Resource 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
Goishi	**Kamafusa**	195.25	45.3	39.3	F,N,P,W,I	1970
Okura	**Okura**	88.5	28	25	F,N,A,P,W,I	1961
Masuda	**Tarumizu**	9.7	4.7	4.2	F,W,N	1977

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

Date	Water Level at Natori Bridge [m]	Rainfall [mm] Duration	Meteorological cause	Death and Missing	Major damages
1947.9	9.65	302 at Sendai (11th - 15th)	Typhoon "Catherine"	—	IBF: 2021
1948.9	9.85	351 at Sendai (15th - 17th)	Typhoon "Ion"	—	House destroy, House inundated
1950.8	10.65 (3,060 m^3/s)	233 at Sendai (2nd - 4th)	Tropical storm	6 4	House destroy, House inundated
1958.9	8.06	132 at Sendai (17th - 18th)	Tropical storm	—	House inundated
1982.9	7.65	189 at Sendai	Tyhoon	—	
1986.8	7.65	402 at Sendai (4th - 5th)	Tropical storm	—	House totally destroyed 3 IAF: 2080 IBF 12000
1994.9	8.12	251 at Sendai (22nd - 23rd)	Regional downpour	—	House totally destroyed 7 IAF: 2080 IBF: 3139

IAF: Inundation above floor, IBF: Inundation below floor in number of houses.

Major Droughts

Year	Season	Minimum Discharge (m^3/s)	Water Restriction period	Restriction ratio
1973	Jul. - Sep.	4.1	1st 10/Aug. - 26/Sep. 2nd 21/Aug. - 12/Sep.	80% 67%
1978	Jul. - Aug.	0.71	—	—
1982	Jul.	2.25	—	—
1985	Aug. - Sep.	0.62	—	—
1987	May	0.08	—	—
1994	Jul. - Sep.	0.84	—	—

5.5 Groundwater and River Water Quality

River Water Quality[1] at Natori bridge[2] in 2000

Date	1/5	2/2	3/1	4/19	5/10	6/7	7/5	8/1	9/6	10/4	11/8	12/6
pH	7.7	7.7	7.7	8.1	7.6	7.9	7.9	7.7	7.9	7.9	8.0	7.7
BOD [mg/l]	0.8	0.5	1.0	0.7	0.5	1.2	0.8	1.6	0.8	0.6	1.2	0.6
COD_{Mn} [mg/l]	1.3	1.7	1.6	1.5	1.3	3.1	2.4	1.8	2.4	3.0	1.9	1.7
SS [mg/l]	2	1	1	4	3	2	3	1	2	4	3	2
Discharge[3] [m^3/s]	9.01	7.99	8.24	29.11	10.57	4.16	1.07	3.01	4.96	19.79	11.20	9.60

1) Observed once a month on a dry day normally several days after rainfall.
2) Located near Sendai City 7.4 km upstream from the river mouth.
3) Discharge on the water quality observation date.

6. Socio-cultural Characteristics

The Natori River basin is located in the central of Miyage prefecture, and includes Sendai city, the capital city of the Tohoku district. Many industrial activities are concentrated in this basin.

The watercourse supplies much water to Sendai Plain with a population of one million people and then flows into the Pacific Ocean. The river mouth is named as the Idoura lagoon, which supports large populations of birds, and is designated as a wildlife refuge area.

Although one of the tributaries, the Hirose River is in the urban area of Sendai city, there is much nature that can be seen, including sweet fishes and singing frogs. The ministry of Environment has selected the Hirose River as one of the 100 best waters in Japan.

From the era of Feudal Lord, Masamune Date, the Natori River has been indispensable for water supply and ship transportation. Teizan Unga (Canal) is the longest canal in Japan, which connects the Abukuma, Natori, Naruse, and Kitakami rivers. The Kinagashi trench was also linked between the Hirose and Natori rivers for ship transportation for timbers.

The Natroi River basin will continue to be developed and support the Tohoku district as expressways and new railway systems will be constructed for upgrading of infrastructure.

7. References, Databooks and Bibliography

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