Yasu-gawa

Map of River

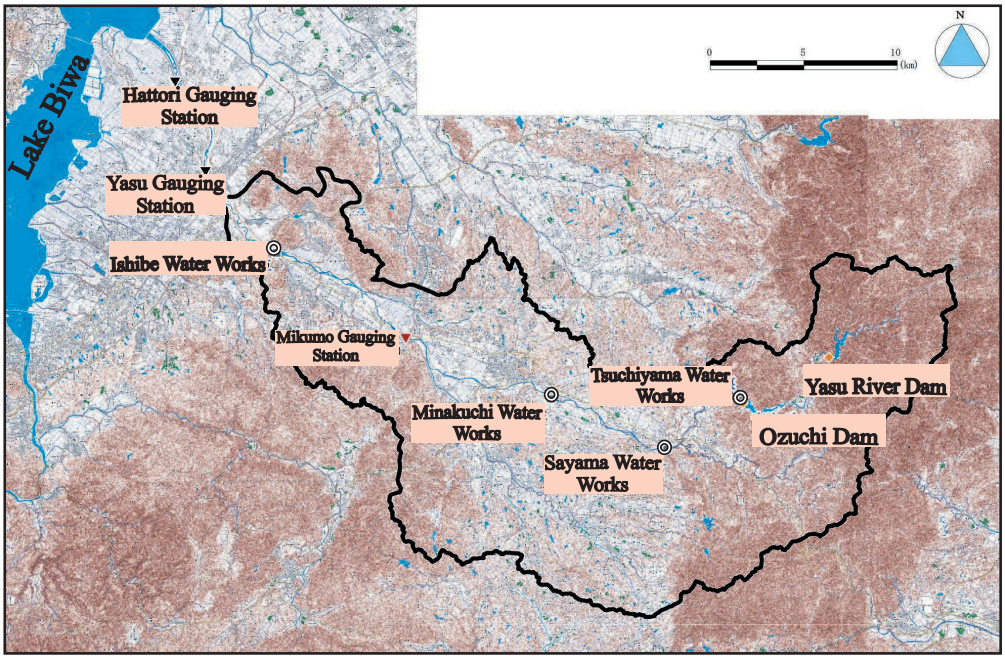


Table of Basic Data

Name: Yasu-gawa		**Serial No. :** Japan-15
Location: Honshu Island, Japan	N 34° 50' ~ 35° 5'	E 136° 0' ~ 136° 30'
Area: 382.4 km^2	**Length of main stream:** 65 km	
Origin: Mount Gozaisho	**Highest point:** Mt. Gozaisho (1,235 m)	
Outlet: Lake Biwa	**Lowest point:** River Mouth (97 m)	
Main geological features: Sandstone, Plutonic granite		
Main tributaries: Yasu River, Soma River		
Main lakes: None		
Main reservoirs: Yasu, Ozuchi, Ohara		
Mean annual basin precipitation: 1,587 mm at Yasu		
Mean annual runoff: 570 mm at Yasu		
Population: 260,467 (Nov, 2003)	**Main cities:** Otsu located just outside the basin	
Land use: Forest (60.7%), Paddy (17.3%) , Urban 6.5 % (1997)		

1. General Description

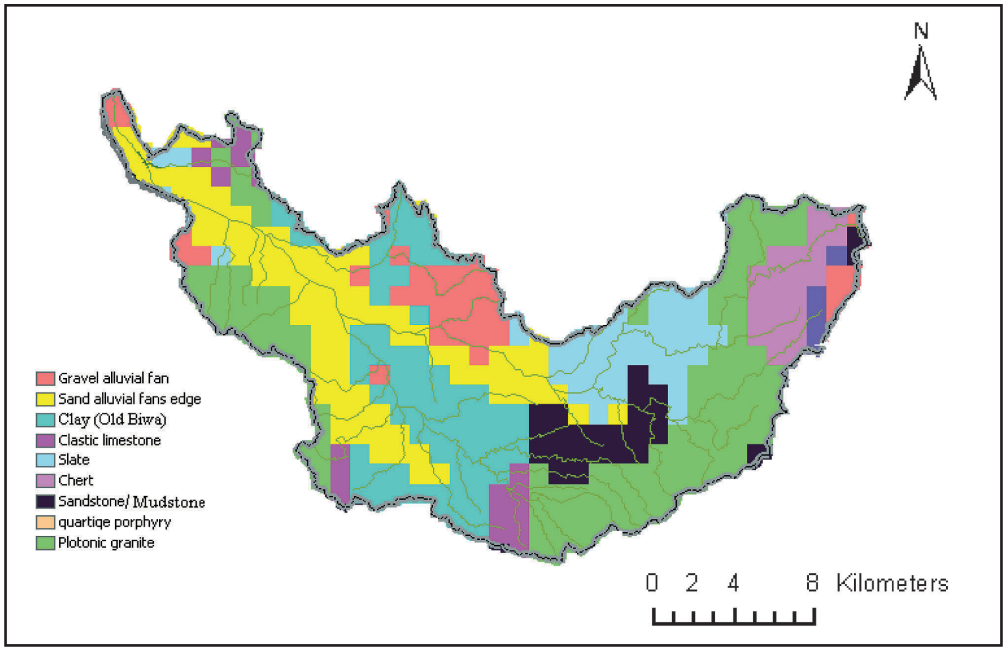
Yasu is the largest river flowing into Lake Biwa which is the largest fresh water lake in Japan. Yasu River has a catchment area of 377.42 km^2 upstream Yasu gauging point and the main channel is 65 km long. The basin is located in Shiga prefecture with a small portion protruding into Mie prefecture on Honshu island central Japan. The river has two main tributaries namely Kashiki and Ukawa draining the north eastern and south western parts of the basin respectively.

The Yasu River basin is mainly covered with forest and paddy fields which have remained as the main land use classes over the last 20 years. Recent changes in land use indicate that urbanisation is growing from the lower area near Lake Biwa and more changes are occurring in the Ukawa sub catchment than in the Kashiki sub catchment.

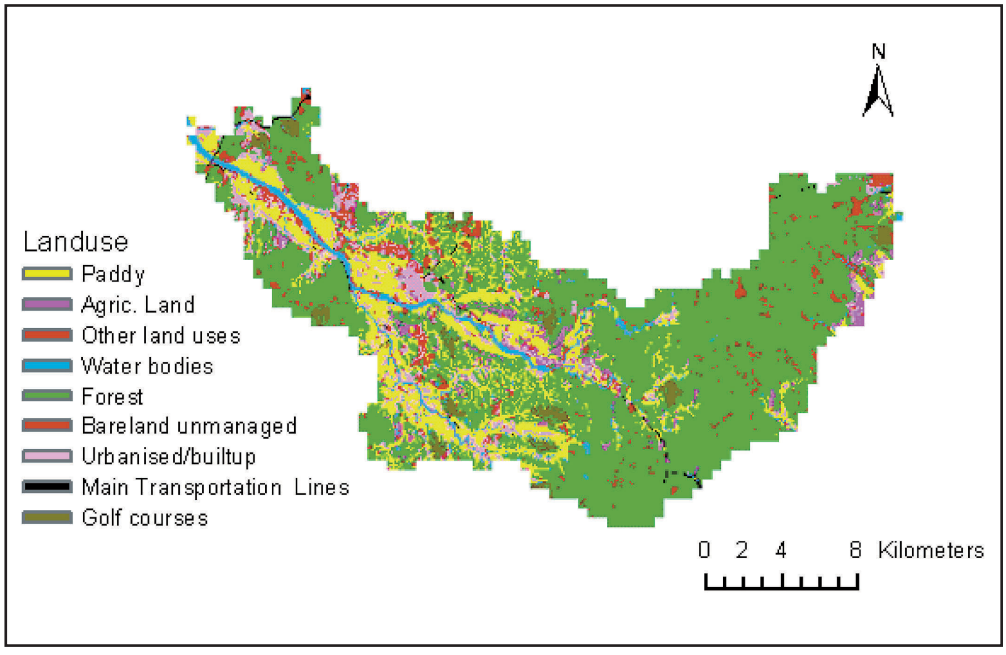
Rainfall is unevenly distributed in the basin with a clear trend for mountainous parts to receive more rainfall. The basin receives a high proportion of annual rainfall during summer and typhoon seasons depending on the location. Stations in higher altitudes have a great proportion of the annual rainfall during typhoon season while those in the lower part of the river basin receive more rainfall during summer season controlled by the Baiyu front.

2. Geographical Information

2.1 Geological Map



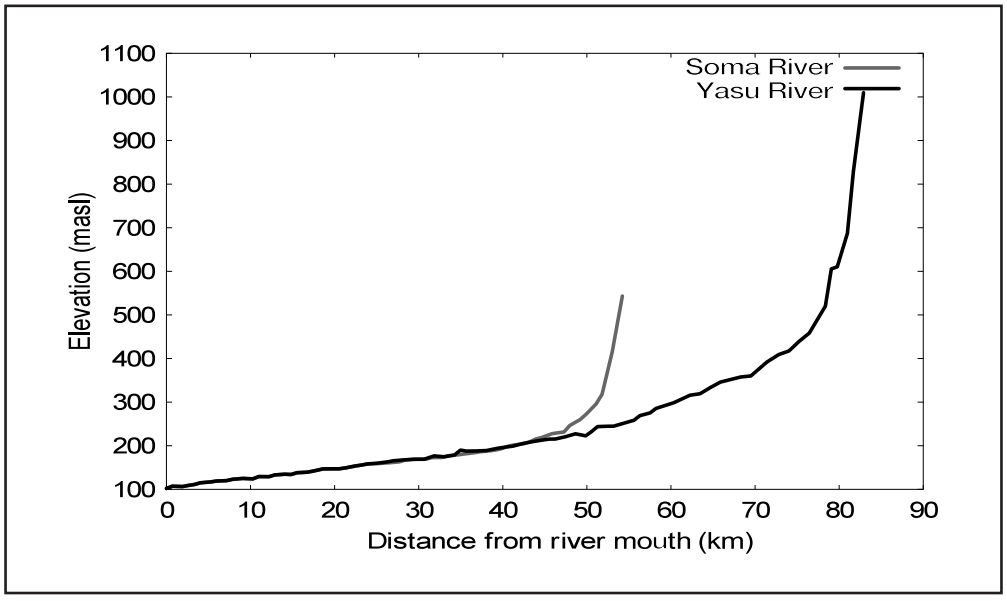
2.2 Land Use Map



2.3 Characteristics of River and Main Tributaries

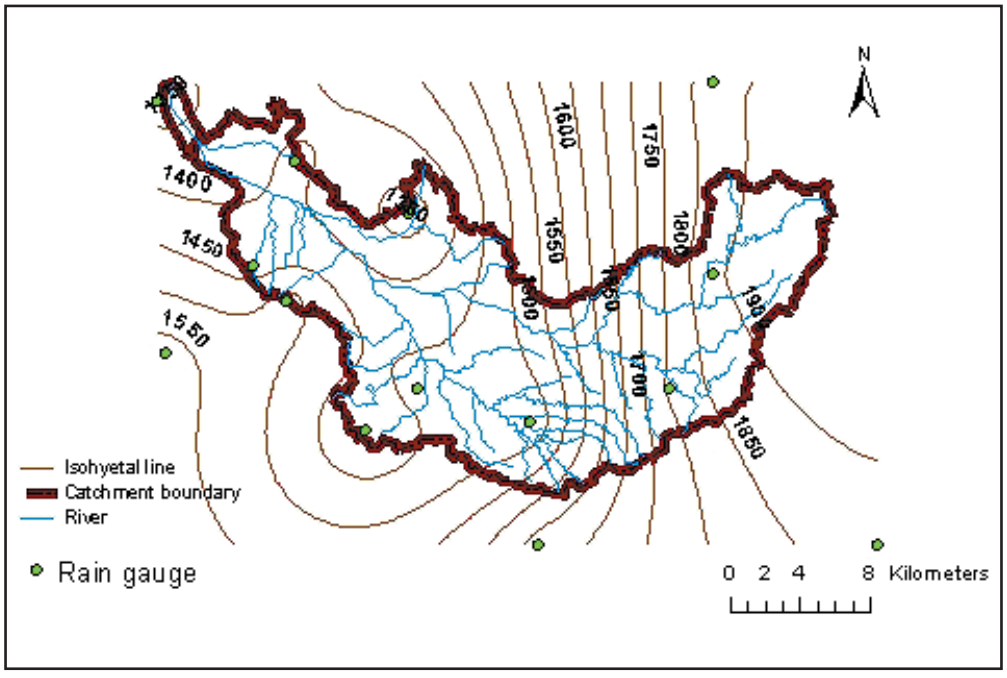
No.	Name of river	Length [km] Catchment area [km^2]	Highest peak [m] Lowest point [m]	Major Towns population	Land use [%]
1	**Soma River**	21.6 km 121.9 km^2	800 m Outlet: 157.0 m	Kouga & Kounan 31,841	Mixed
2	**Yasu River**	65.3 km 382.4 km^2	Mt Goizaisho 1,235 m Outlet 153.6 m	Tsuchiyama & Minakuchi 47,501	Mainly forest

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)]
1	**Gamou**	128	N 35° 03' 36" E 136° 11' 36"	1976 - 2000	1,409	DS, P, T, W
2	**Otsu**	86	N 34° 59' 18" E 135° 54' 54"	1989 - 2000	1,562	DS, P, T, W
3	**Tsuchiyama**	263	N 34° 55' 42" E 136° 18' 00"	1976 - 2000	1,641	DS, P, T, W
4	**Hikone**	87	N 35° 16' 24' E 136° 14' 48'	1976 - 2000	1,587	DS, P, T, W, EB
5	**Shigaraki**	265	N 34° 54' 36" E 136° 05' 00"	1976 - 2000	1,528	DS, P, T, W

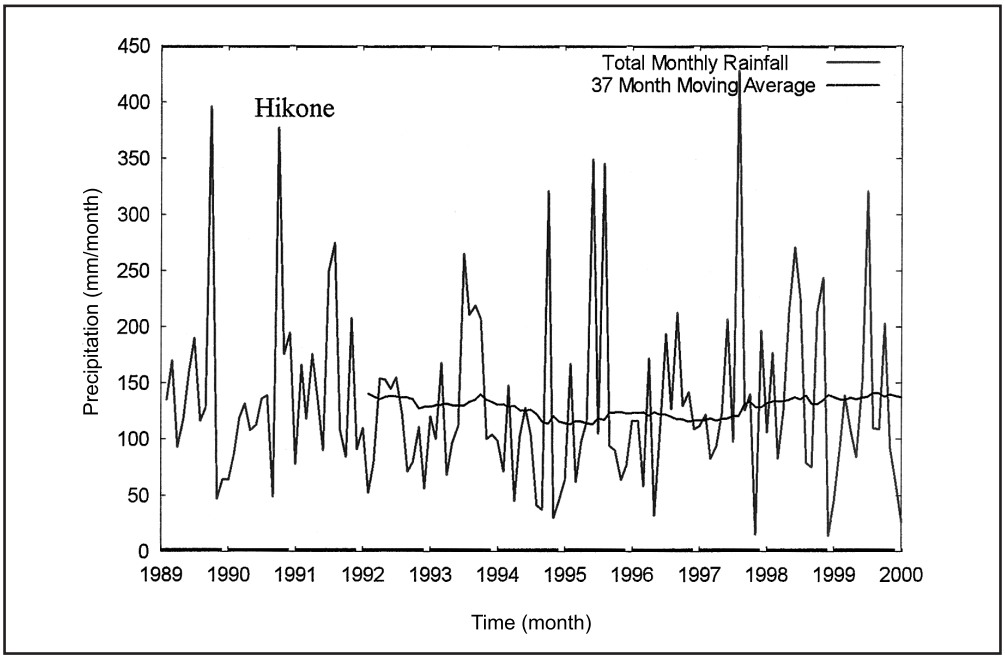
Source : MLIT data processed at DPRI lab Kyoto University

[1)] DS: Duration of sunshine, P: Precipitation, T: Air temperature, W: Wind velocity and wind direction. EB: Energy balance including net radiation, air pressure, dew point, vapour pressure and relative humidity

3.3 Monthly Climate Data (Observation Station: Hikone)

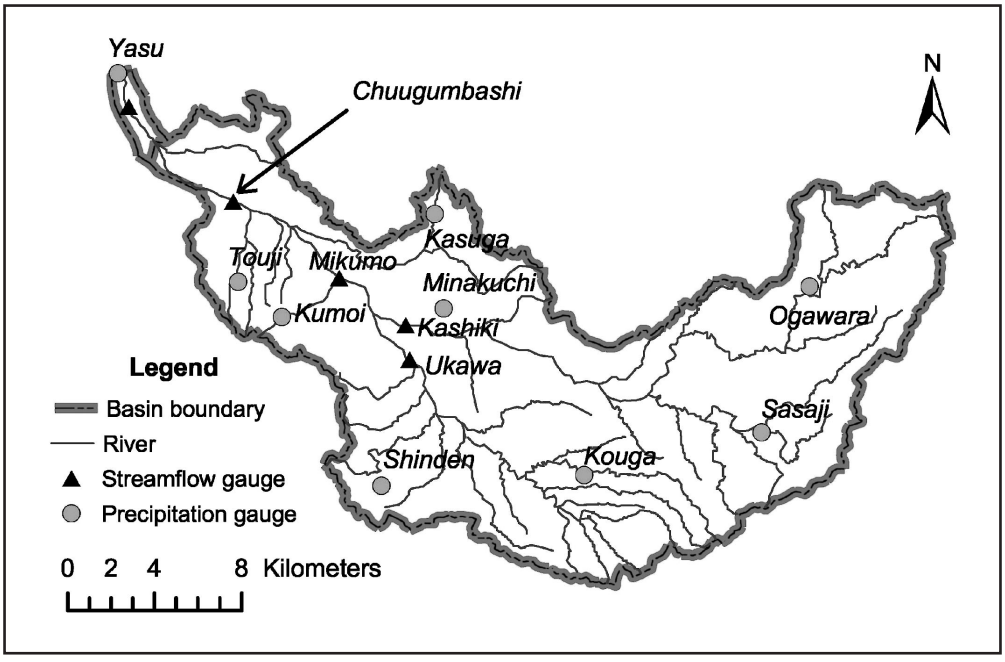
Observation item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	4.3	4.0	7.5	12.6	17.4	21.4	25.5	26.7	22.7	15.9	10.6	6.0	14.6	1989 - 2000
Precipitation [mm]	118	115	128	116	161	227	155	100	150	157	132	133	1,699	1989 - 2000
Solar radiation [MJ/m^2/d]	7.9	10.0	13.2	15.9	17.3	15.4	16.7	17.1	12.7	11.1	8.1	6.5	12.7	1989 - 2000
Duration of sunshine [hr]	118	109	165	178	186	139	174	208	149	158	132	115	1,835	1989 - 2000

3.4 Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1 Map of Streamflow Observation Stations



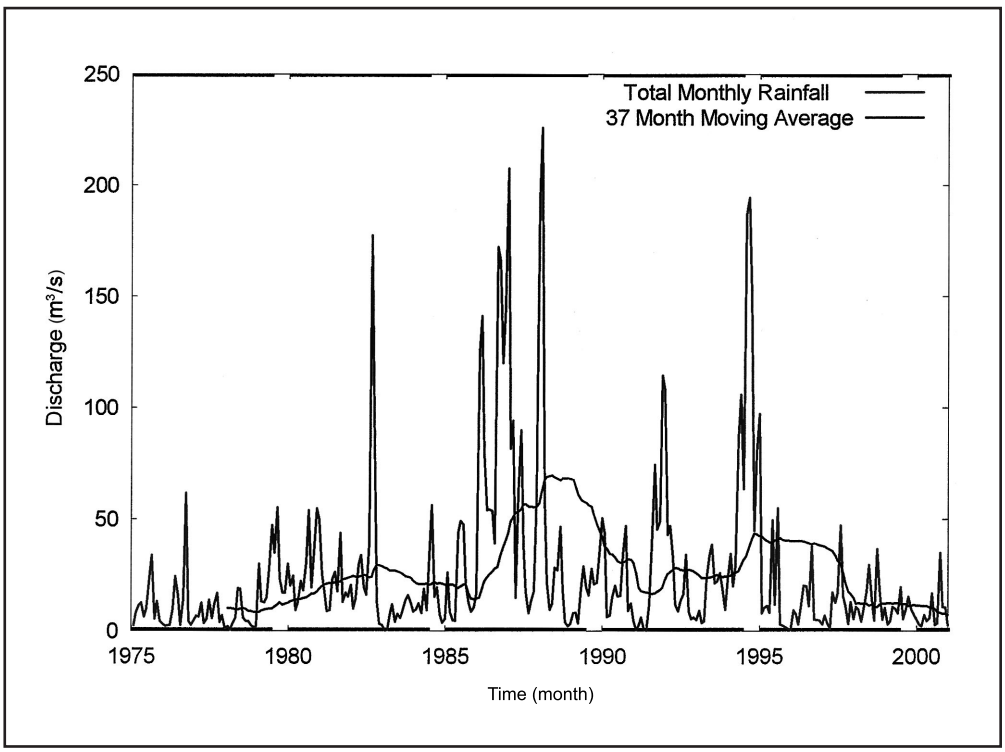
4.2 List of Hydrological Observation Stations

No.[1]	Station	Location from river mouth [km]	Catchment area [km^2]	Observation period	Observation items[2] (frequency)
60408	**Ukawa**	25.0	117.0	1989~present	H, Q(daily)
60040	**Kashiki**	26.3	155.0	1978~present	H, Q(daily)
60413	**Yasu**	River mouth	377.4	1975~present	H, Q(hourly)

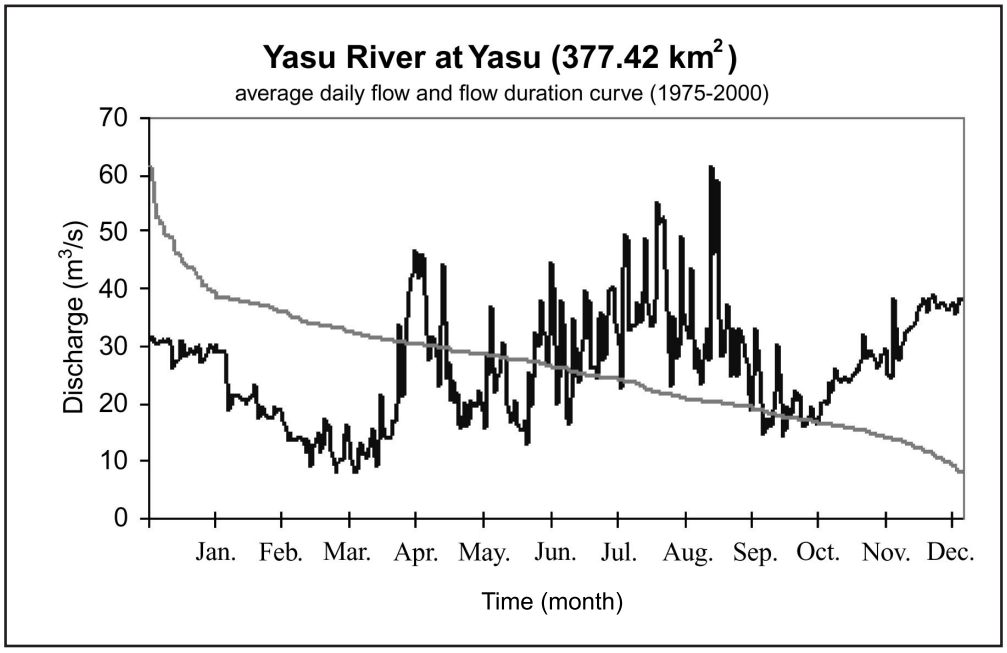
No.	$\overline{Q}$[3] [m^3/s]	Qmax[4] [m^3/s]	$\overline{Q}$max[5] [m^3/s]	$\overline{Q}$min[6] [m^3/s]	$\overline{Q}$/A [m^3/s/100km^2]	Qmax/A [m^3/s/100km^2]	Period of statistics
60408	5.96	491.30	183.17	0.0	5.09	419.9	1978 ~ 1998
60040	11.67	1269.05	380.35	0.0	3.09	336.2	1978 ~ 1998
60413	26.50	2198.0	827.09	0.0	7.02	582.4	1975 ~ 2000

[1] Serial Number used by Ministry of Land, Infrastructure and Transport.
[2] Discharge data is available on daily time step for all stations, water level data is available at hourly time step from 1975 to present (Yasu), 1976 to present at Mikumo and at daily time step from 1978 to present at Ukawa.
[3] $\overline{Q}$: Mean annual discharge.
[4] Qmax : Maximum discharge for those whole observation period.
[5] $\overline{Q}$max: Mean maximum discharge.
[6] $\overline{Q}$min: Mean minimum discharge.

4.3 Long-term Variation of Monthly Discharge



4.4 Annual Pattern of Discharge

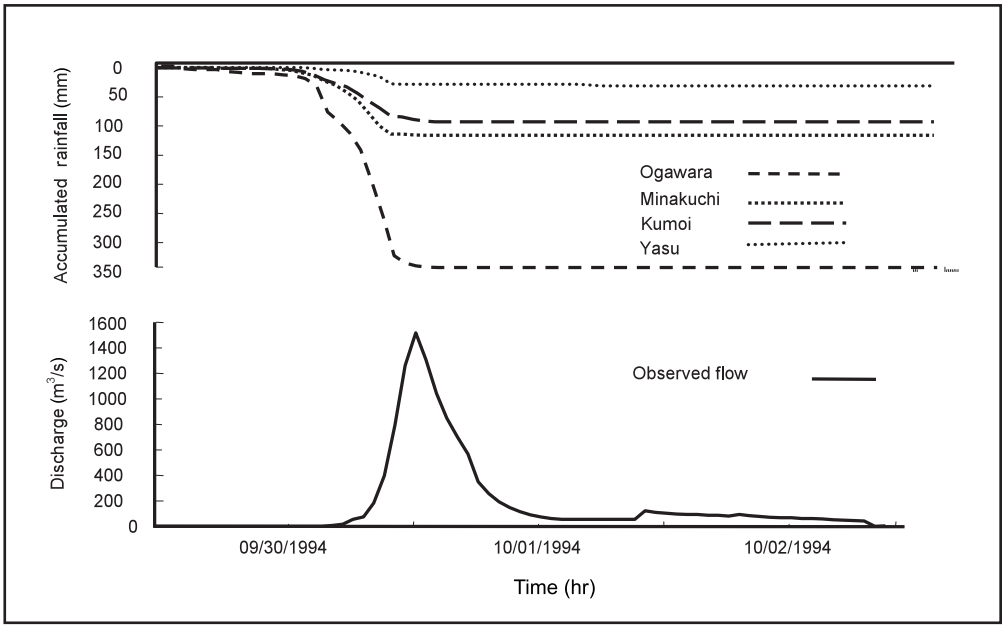


4.5 Unique Hydrological Features

The elevation in the Yasu River basin varies from 97 above sea level (masl) at the outlet (Yasu gauging station) to 1,235 on mountains located in the north eastern part of the basin (Kashiki sub catchment). Both tributaries (Kashiki and Ukawa) flow through steep terrain with average slopes of more than 1:40. In the last 50 km to the river mouth the slope fall sharply to only 1:250 and even further as it flows in the flat plains near Lake Biwa. The basin drains fast during heavy storms with maximum runoff occurring within 3 to 4 hours of the peak of the rainfall event.

The spatial distribution of the mean annual rainfall shows a clear trend with elevation. Rainfall in the lower part of the basin around Lake Biwa is about 1,300 mm and increases to 1,900 mm in the upper mountainous part. Most of the rainfall occurs in summer (June-July) and in the typhoon season (August-September). Typhoon events account for a higher proportion of mean annual rainfall in the mountainous parts (Ogawara station) compared with summer rains while the lower areas receive most of the annual rainfall during the summer season. Most floods in the basin are caused by typhoon events and they originate from the Kashiki sub catchment which receives high rainfall totals during such events and has steep slopes.

Yasu River is highly regulated in the lower reaches with several irrigation schemes and weirs which divert water from the natural river courses. The main use of water is for irrigation of paddy fields and water supply to towns located in the basin. The water used for irrigation of paddy fields is returned to the river through drainage channels. In general both water quality and quantity are highly influenced by artificial controls which need to be well understood for effective water resources management.



A typical flood event caused by typhoon in the Yasu River basin and distribution of rainfall.

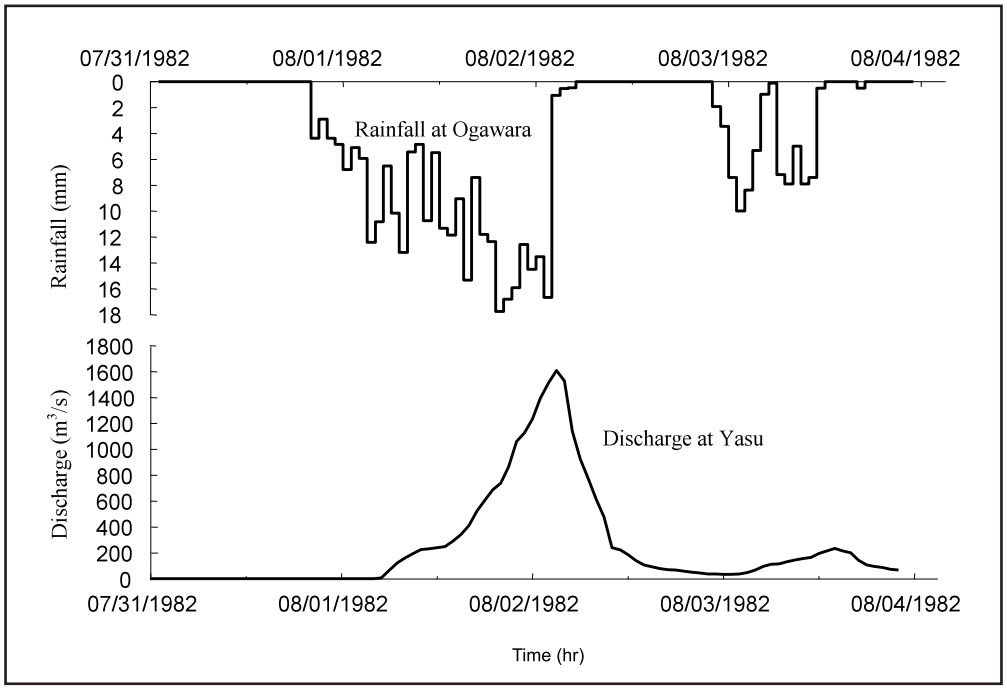
4.6 Annual Maximum and Minimum Discharges

Station: Yasu (377.42 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	7.4	668	1.6	0	**1988**	8.16	1,680	3.18	0
1976	9.9	1,004	1.4	0	**1989**	8.27	808	1.21	0
1977	9.9	262	3.19	0	**1990**	9.20	2,237	2.11	0
1978	6.23	321	1.21	0	**1991**	8.31	962	1.22	0
1979	10.19	345	1.30	0	**1992**	8.20	566	3.18	0
1980	8.27	317	1.3	0	**1993**	9.9	1,091	1.8	0
1981	10.9	429	3.4	0	**1994**	9.30	1,517	2.22	0
1982	8.2	1,645	4.28	0	**1995**	5.12	1,495	1.5	0
1983	9.28	324	1.9	0	**1996**	6.21	136	1.16	0
1984	7.21	1,193	5.12	0	**1997**	7.26	937	2.17	0
1985	7.1	1,024	2.9	0	**1998**	9.22	753	1.1	0
1986	7.10	880	3.25	0	**1999**	8.11	322	5.22	0
1987	10.17	228	1.24	0	**2000**	9.11	361	4.30	0

1), 2) Instantaneous observation values.

4.7 Hyetograph and Hydrograph of a Major Flood Event



5. Water Resources

5.1 General Description

Both ground and surface water sources of the Yasu River basin are heavily utilized. Surface water diverted from the river is the main source for irrigation while the main use for ground water is for industrial and domestic supply. Ground water utilization is concentrated in the lower part of the basin and major users include beverage industries and water supply authorities for towns located in this area. The total ground water extraction load exceeds 10,000 tons per day distributed almost evenly among the different users. The river flow at Yasu is highly seasonal and may vary from almost zero flow in December-January to more that 1,000 m^3/s during typhoon events in September.

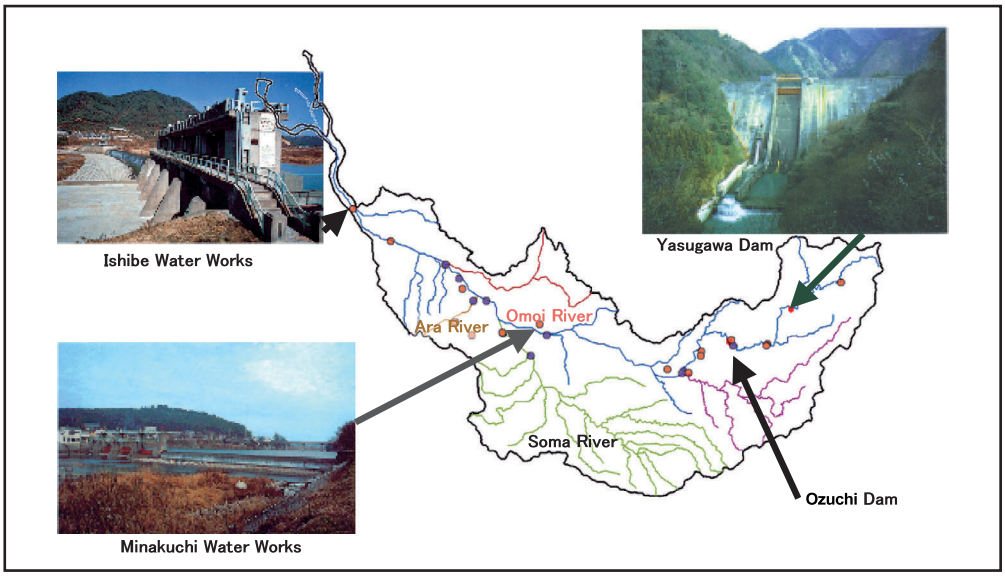
Thirty years of ground water monitoring indicate that some parts of the basin have tendency for declining ground water table. These are areas located away from the influence of Lake Biwa which seems to control the ground water levels in the vicinity of its shore line.

Reservoirs in the basin provide only a small capacity for regulating flows. The storage is basically insufficient to augment flows and water shortages can occur during years with below average rainfall. Also, control of floods is minimal making it necessary to protect the lower reaches of the river with dikes and various river improvement schemes.

5.2 Major ground water users in Yasu River basin

User	Use of Water use	Depth of well	Pumping rate (m^3/day)
Oshima Fiber Industry Co. LTD Moriyama Plant	Cooling	150	3,800
Moriyama Town	Agricultural uses	100	4,000
Nicchitu Acetate Company-Moriyama Plant	Industrial processes	66	4,000
Kyoshin Construction Company	Industrial processes	100	4,000
Ueda Fish Farm	Fish farming	220	4,000
Moriyama Town Authority	Domestic supply	120	4,300
South Lake (Biwa) Sewerage Department	Sewerage	95	4,464
Moriyama Town Water Supply department	Sewerage	150	4,700
Moriyama Town Water Supply Department	Domestic Supply	100	5,000
Gunze K.K Moriyama Plant	Industrial uses	90	6,336

Map of Water Resource Systems



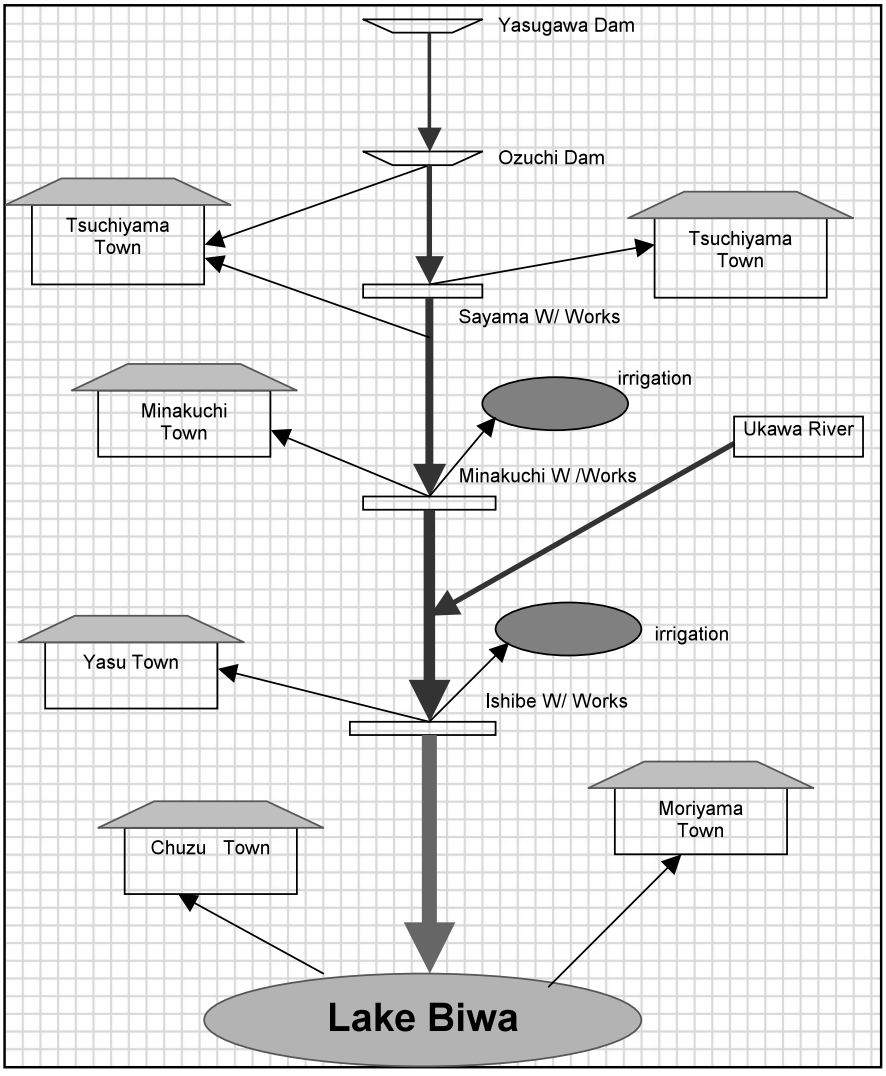
5.3 List of Major Water Resources Facilities

Major Reservoirs

Name of river	Name of dam (reservoir)	Catchment area [km^2]	Gross capacity [$10^6 m^3$]	Effective capacity [$10^6 m^3$]	Purpose[1)]	Year of completion
Yasu	**Yasugawa**	37.75	8.50	7.28	A	1951
Yasu	**Ozuchi**	63.75	7.30	6.60	A, I, W	1987
Soma	**Oohara**	12.53	2.00		A, W	1965

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

Major Water Transfer



5.4 Major Floods and Droughts

Major Floods at Yasu

DATE	Peak discharge [m^3/s]	Rainfall [mm], Duration				Meteorological cause	Dead and missing	Major damages (Districts affected)
		Ogawara	Minakuchi	Kumoi	Yasu			
1982.8.2	1,645	306 (36h)	203 (24h)	299 (28h)	161 (1d)	Typhoon No.10	N. A	N. A
1994.9.30	1,517	350 (12h)	125 (12h)	100 (12h)	34 (12h)	Typhoon No.26	N. A.	N. A
1995.5.12	1,495	0	15 (4d)	199 (1d)	164 (1d)	Low pressure front	N. A.	N. A

Major Droughts

Year	Rainfall - Lake Biwa catchment area (mm/month) (ratio to the average monthly precipitation in %)						Lake Biwa Lowest water mark
	Jul	Aug	Sep	Oct	Nov	Dec	
1984	183 (78)	57 (37)	98 (47)	70 (53)	45 (45)	133 (113)	- 95 cm Jan. 26
1986	360 (154)	31 (20)	95 (45)	95 (73)	60 (60)	133 (113)	- 88 cm Dec. 14
1990	176 (75)	86 (55)	450 (214)	168 (128)	234 (234)	128 (108)	- 69 cm Sept. 12
1994	25 (11)	65 (42)	305 (145)	37 (28)	53 (53)	88 (75)	- 123 cm Sept. 15

5.5 River Water Quality

Water quality in Yasu River basin is regularly monitored. The quality parameters are generally higher as compared to rivers downstream of Lake Biwa. Water quality data at Hattori station shows that all quality parameters including BOD, COD, pH and SS are higher from May to August corresponding with high flow season.

River Water Quality at Hattori in 2002

Date	1/9	2/6	3/8	4/4	5/10	6/7	7/3	8/9	9/4	10/4	11/6	12/2
pH	7.4	7.5	7.5	7.6	7.4	7.8	7.6	7.6	8.0	7.6	7.6	7.4
BOD [mg/l]	0.5	0.7	1.4	0.9	1.2	1.5	0.7	1.0	0.7	0.7	0.6	0.5
COD_{Mn} [mg/l]	1.9	2.3	3.2	2.5	2.2	2.1	2.3	1.8	2.1	2.7	2.2	2.2
SS [mg/l]	1.2	2.3	4.8	2.5	2.7	3.1	1.9	0.9	2.0	2.3	1.3	1.5
DO [mg/l]	13.4	12.0	11.5	11.4	9.5	9.7	9.3	9.2	9.3	8.2	11.6	12.4
T-P [mg/l]	0.012	0.021	0.030	0.016	0.016	0.016	0.027	0.019	0.018	0.035	0.015	0.01
T-N [mg/l]	1.21	1.25	1.22	0.84	0.95	0.72	0.91	0.79	0.61	1.13	0.94	1.01

6. Socio-cultural Characteristics

The closest city to Yasu River basin is Ootsu, the capital of Shiga Prefecture. During 1960's and 1970's many industries were relocated to Shiga prefecture to utilize ample land space and abundant water resources as compared to Osaka and Kyoto cities which are comparatively crowded. As transportation improved between Shiga and the surrounding areas more people moved to Shiga preferring to live in a natural environment and commute daily to work in Osaka or Kyoto. As a result of this the population of Shiga Prefecture increased from 800,000 in 1970 to 1,500,000 in 1990. The percentage of the population employed in agricultural pursuits fell from 50% in 1950 to only 5.1% in 1995. These changes indicate a major shift in economic activities through industrialization of the area around Lake Biwa and mechanisation of agriculture. Industries attracted population to the area and provided alternative employment while the mechanisation of agriculture replaced manual labour with machines freeing people to work in other sectors of the economy.

The impact of these changes on water resources is mainly increased demand and pollution. Both industrial and agricultural pollutants are believed to have increased with the economic changes in the basin. Recent studies also indicate that land use changes have affected rainfall runoff relationships with an increase in flood peaks at the most down stream gauging station.

The Yasu River basin is very popular for golf courses. According to 1997 land use data golf courses occupy 2.3% of the total area of the basin. The basin also is a home to the Japanese traditional ceramic sculpture industry. The improved transportation network across the basin seems to be attended with increased urbanisation in the basin following the pattern of the communication network and gradually increasing from the lower part to the upper reaches. River improvement plans in the lower part around Yasu gauging station have provided nice recreational areas suitable for picnicking. Recreational fishing can also be done in specially designated areas near Yasu gauging station.

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