CHAPTER12

Water Resources Management in Omona Gawa Basin, Akita Prefecture, Japan

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Omono Gawa Basin

Physical Characteristics

The Omono Gawa basin is in the Akita Prefecture, about 500 kilometers north of Tokyo, lying between 39–40° North and 140–141° East with a surface area of approximately 4,952 square kilometers. It is the thirteenth largest basin in Japan. The two main branches of the Omono Gawa rise in the central ridge of Honsu with a watershed of up to 2,200 meters above sea level. The mountains and foothills are extensively forested and the dominant land use is forests and homesteads that cover about 85 percent of the catchment. On the valley floor and flood plains, paddy lands are d hemes have been undertaken in the basin. These include irrigation, drainage and flood control components, in addition to improvement of roads and other infrastructure. Existing irrigation and drainage systems have been incorporated into the new LID areas and farmers included in the LID organizations.

Omono Gawa is well endowed with water resources. Even in years of severe drought, such as 1994, a considerable volume of water is discharged by the river system. Until the development of flood protection schemes as a component of the Land Improvement projects, reduction of agricultural production occurred more frequently as a result of floods than of droughts, with flooding on six occasions between 1960 and 2000. The extent and severity

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of flood impacts have been reduced as the LID expanded with the construction of two large flood-control reservoirs in the upper catchments.

Social Characteristics

The population of the Omono Gawa basin is about 690,000, with the urban population representing about 70 percent of the total, and a population growth rate of approximately zero. Although agriculture is a more important industry in the north of the Honshu Island than in the more industrialized southern areas, expanding opportunities for other sources of income now mean that agriculture is a secondary activity. A common problem in agriculture is the difficulty in securing successors for the aging farming population. Agriculture is becoming a less attractive career for the younger generations due to limited income potential and the greater potential in industry and the public and commercial sectors.

Agricultural Characteristics

Agriculture involves about 51,150 families in the basin. Many farms now constitute a secondary source of income, with other urban and industrial sources being more significant. However agriculture, and particularly rice cultivation, has a strong tradition.

The northerly location of the basin restricts the growing season to the summer months (May to September) and allows only a single crop of rice. The restricted availability of land (typically 1.1 ha per holding), opportunities for off-farm income and the relative abundance of water resources (see section on Water Accounting) make maximizing land productivity important.

Average yields for paddy rice have reached 7 tons/ha with highly mechanized agriculture being the norm. Low temperatures and the short growing season have led to production of rice seedlings in “poly-tunnels.” Mechanized cultivation with mechanical transplanting and harvesting is widespread. Other field crops, notably vegetables and fruit orchards, are present in the basin but cover only about 10,000 hectares.

Water Accounting

Omono Gawa is well equipped with monitoring stations for both rainfall and river flows. Records for nine river gauging stations (table 1), with records available for the period 1967-1997, were analyzed. The record for the most downstream station, Omono Gawa at Tsubaki Gawa, Station Number 20329, was selected as the downstream boundary for water accounting. This station has a catchment area of 4034.9 km^2, about 81.5 percent of the total basin area. Eight rain gauge stations, with over 20 years of records available, were analyzed to obtain basin rainfall estimates, based on weighted averages of three zones within the basin, table 2.

Crop water requirements were estimated for each of the four major land surface covers (table 3) to determine maximum depletion rates by agriculture. Depletion rates for domestic and municipal use were taken as 40.8 million cubic meters (MCM) based on authorized abstraction licenses, population estimates and estimated wastewater return flows.

Table 1. Summary of gauging sites in the Omono Gawa basin.

Rain-Gauge Station	Latitude	Longitude	Stream Gauge	Catchment Area (km^2)
407 Iwami-Sannai	39° 42.3'	140° 17.5'	20329 Tsubaki Gawa	4,034.9
466 Kakunodata	39° 36.0'	140° 33.6'	20323 Jinguji	3,336.5
476 Tazawa lake	39° 41.8'	140° 44.1'	20317 Omagari Bashi	1,882.1
496 Daisyoji	39° 31.5'	140° 14.3'	20313 Omonogawa Bashi	1,240.0
551 Ohmagari	39° 29.3'	140° 30.0'	20303 Yanagida Bashi	475.6
596 Yokote	39° 19.1'	140° 33.5'	20301 Kawai	145.0
691 Yuzawa	39° 11.1'	140° 28.0'	20321 Nagano	1,088.0
771 Yunotai	38° 57.4'	140° 32.0'	20315 Yokote	216.2
			20306 Mato	255.0

Table 2. Rainfall and streamflow in the Omono Gawa basin.

Year	Annual Rainfall		Streamflow at Gauge Station Tsubaki Gawa
	(mm)	(MCM)	(MCM)
1977	1,716	8,495	7,534
1978	1,606	7,952	6,796
1979	2,260	11,192	9,272
1980	1,884	9,329	7,951
1981	2,209	10,939	8,968
1982	1,754	8,687	7,114
1983	1,679	8,314	7,228
1984	1,630	8,070	8,094
1985	1,741	8,624	7,033
1986	1,654	8,190	7,425
1987	1,909	9,456	8,094
1988	2,887	14,296	6,650
1989	1,610	7,970	5,901
1990	2,049	10,147	8,020
1991	2,069	10,245	8,656
1992	1,665	8,247	6,127
1993	2,010	9,953	8,061
1994	1,478	7,319	6,239
1995	2,250	11,144	9,104
1996	1,682	8,331	7,823
1997	2,008	9,944	7,580

Annual water accounts for the years 1990–1997 are summarized in table 4. Forests and irrigated agriculture are the largest consumers of water in the Omono Gawa river basin. Figures 1 and 2 illustrate the water accounting for this river basin for 1991 and 1994, respectively. The depleted fraction amounts to only about 21 percent of the gross rainfall volume falling on the basin, with a productive fraction of between 4 and 5 percent.

Table 3. Annual consumptive demand for major land covers in the Omono Gawa basin.

Month	Crop Evapotranspiration (mm)
Paddy	693
OFC	588
Pasture	364
Forest	474

Table 4. Summary of annual water accounts and indicators.

Year	Annual Rainfall (MCM)	Depleted Water (MCM)	Depleted Fraction (DF_{net})	Depleted Fraction ($PF_{depleted}$)	Depleted Fraction ($PF_{available}$)	Paddy Production (kg/m^3 ET)
1990	10,147	1,968	0.19	0.23	0.04	0.97
1991	10,245	1,968	0.19	0.23	0.05	0.91
1992	8,247	1,968	0.24	0.23	0.05	1.00
1993	9,953	1,967	0.20	0.23	0.05	0.83
1994	7,319	1,911	0.25	0.20	0.04	1.21
1995	11,144	1,967	0.17	0.23	0.04	0.91
1996	8,331	1,967	0.23	0.23	0.05	1.01
1997	9,944	1,968	0.20	0.23	0.04	1.00

A severe drought occurred in 1994. The rainfall analysis indicates this to be the driest year in the available record. This drought triggered the implementation of the Emergency Drought Management Committee. This drought was widespread across Japan. The impact of the drought management regulations is evident in the abstractions at the Naruse and Minase barrages. Abstractions for irrigation were severely curtailed after the 17 July 1994 instigation of the drought committee, with abstractions at Minase of only 74 percent of the authorized seasonal diversion. The estimated productivity of water in paddy cultivation during the 1994 drought reached 1.21 kg/m^3, considerably higher than the already high average productivity achieved in the basin of 0.98 kg/m^3 of consumptive use. (The yield is given in milled rice rather than in paddy.)

The Nana Taki LID is typical of established locally managed irrigation systems in the Omono Gawa basin. The system is located on the alluvial fans at the points where the Omono Gawa tributary streams enter the valley plain. The LID serves about 1,608 hectares, operating four storage reservoirs (1,128 MCM, 0.75 MCM, .405 MCM and 0.196 MCM), an interbasin transfer tunnel (858 m long with a design discharge of 1 m^3/sec.) and one river headwork. In addition, about 24 groundwater pumps and natural springs are developed for irrigation purposes.

Figure 1. Water accounting diagram for the Omono Gawa river basin (MCM) Japan, 1991.

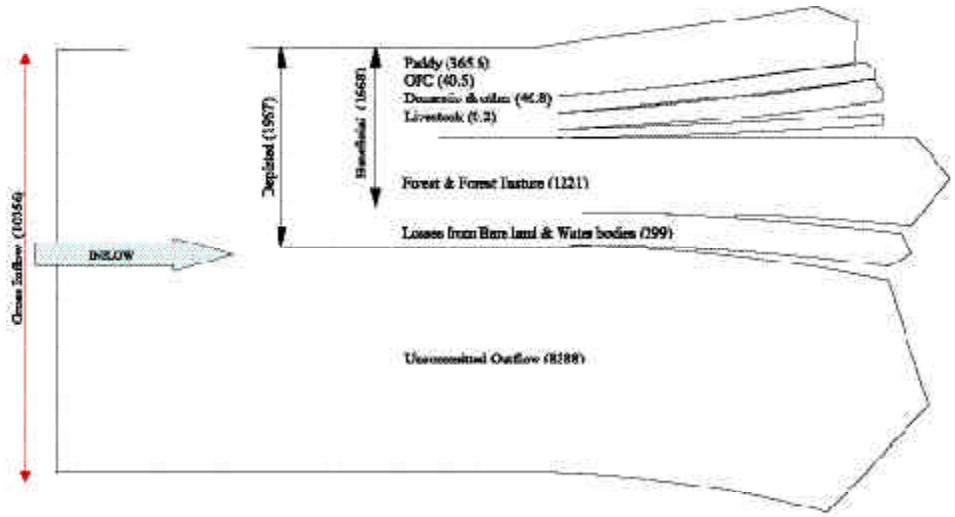
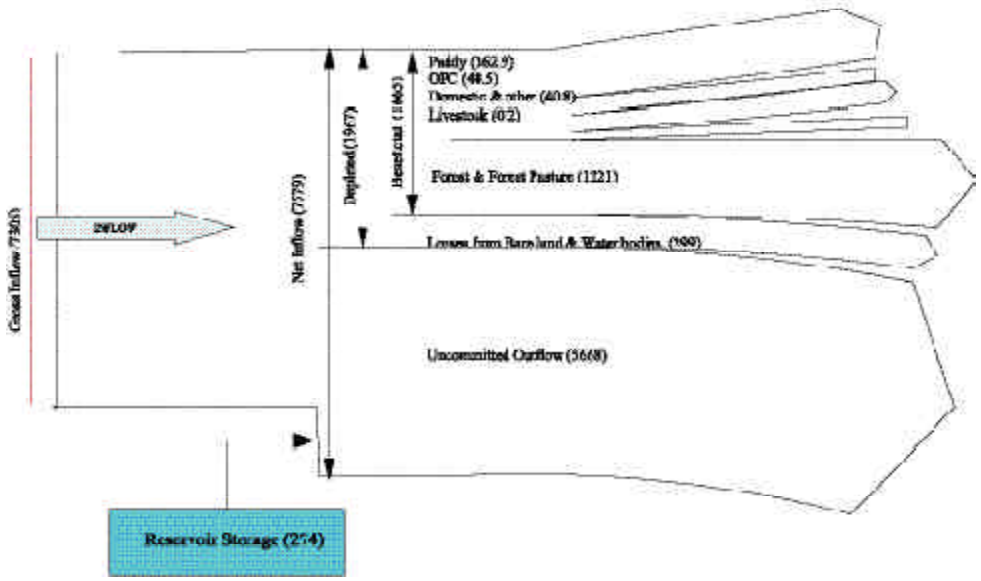


Figure 2. Water accounting diagram for the Omono Gawa river basin in (MCM) Japan, 1994.



Institutional Structure

Water is an important factor in Japanese society. The importance of rural communities and agriculture is embodied in the regulatory framework that controls water management in the country, the Rivers Act, first promulgated in 1897. This original act, and the Revised 1964 act specify firstly, the need for regulation of water to be vested in a single agency (Ministry of Construction), and secondly the principle of protecting traditional and existing uses.

The LID system has become recognized as one of the more successful innovations in the region to support user involvement in management of irrigation and water resources schemes. The experience in Japan has some enlightening and useful facts of more general relevance. Farmers in the LIDs are involved in effective water use and wish to increase their income in response to the price signals for agricultural produce. Farmers have a sense of both ownership over the water and belonging to irrigation facilities. The sense of ownership and shared responsibility are essential trends in farmers' self-governance of irrigation and the in attaining effective, equitable and sustainable use of water.

However, the LID system has grown out of a long experience in communal management of land and water resources and it should not be forgotten that this experience has included many years of bitter and painful conflicts among farmers concerning water allocation. The prevailing system of water management has been developed gradually by farmers themselves, subsequently being formalized by the Land Improvement Act, promulgated in 1949.

By the early 1960s environmental concerns became evident and Japan focused on the deterioration of the environment and communities. A new Environmental Pollution Control Act was promulgated in 1967, followed by the establishment of the Environmental Agency in 1971. Aggravation of pollution from excessive use of agricultural chemicals led to the issuance of the Agricultural Chemical Control Act in 1970.

In common with many countries, there are many institutions with interests in management of water resources. In Japan, the Ministry of Construction has the predominant role in river basin development and management, a position that has been maintained for over 100 years. However, although the role of the public sector is central to water resources management, farmer groups have a well-established role based on participatory development and management of natural resources for protection of agricultural water resources. In many cases, it is the farmer groups that take the initiative to identify requirements and to specify development objectives. The institutions with defined roles in the management of water resources are summarized in table 5.

The central office of the Ministry of Construction nominally allocates water resources. However, in most cases, allocation is delegated to the local prefecture office as approved by the 1964 Rivers Act (GoJ 1964). Licenses for abstraction of water from the main rivers are issued, without charge, for periods of 10 years. The delegated authority allows the local Prefecture Office of the Ministry of Construction to allocate water resources in tributary streams, subject to maintaining agreed minimum discharges at the confluence with the main river stem. Allocations from the main river stem are made under delegated authority from the Ministry of Construction to the Governor of the Prefecture. These allocations confer rights to extract water to approved maximum rates and for defined periods, as summarized in table 6.

Table 5. Summary of institutions with water-management responsibilities.

Organization	Level	Institution
Irrigation Department	National	Construction Department, Ministry of Agriculture, Forestry and Fisheries
	Provincial	Akita Prefecture Agricultural Policy Department
Water Resources Board		Water Resources Development Public Corporation
Environment	National	Nature Conservation Bureau of Environment Agency
	Provincial	Akita Prefecture Dept. of Life & Environment
Agriculture	Provincial	Akita Prefecture Agricultural Policy Department
Agrarian Services	Provincial	Akita Prefecture Agricultural Policy Department
Agricultural Development	Provincial	Akita Prefecture Agricultural Policy Department
Inland Fisheries	Provincial	Institute of Fisheries and Fisheries Management–Akita Prefecture Agricultural Policy Department
Water User Organizations	National	National Federation of Land Improvement Associations
	Provincial	Akita Prefecture Federation of Land Improvement Associations
	Omono Gawa	99 Land Improvement Districts serving about 73,000 ha of irrigation, drainage and flood control schemes.

Table 6. Summary of allocation of water rights in Omono Gawa (1999).

Sector	Allocation (m^3/s)
Agriculture	143.0
Municipal and domestic	2.27
Industrial	3.40
Total	148.67

In addition to the decentralized authority over water exercised by the various ministries with water-related responsibilities, water users as represented by the Land Improvement Associations also play a significant part in the administration of water. At the Prefecture level, the Federation of LID associations adjudicates water-related disputes among the member associations. The federation and member organizations have played an important role in the development and management of the basin, originally in the development of the major infrastructure over a period of 50–60 years. This was followed by second-stage development of terminal irrigation facilities in the service areas, and included land consolidation to facilitate mechanization of agriculture and improvements to canals, drains and roads. In the third stage, development of sewage and water treatment facilities has been undertaken in collaboration with the municipal authorities.

Although water user rights are protected by licenses (issued by the National Government, Ministry of Construction) during periods of severe drought these rights may

have to be overridden in the public interest. Article 53 of the Rivers Act (GoJ 1964)) makes provision for the establishment of Emergency Coordination Committees with representatives from the water-related stakeholder ministries and line agencies. Representatives of the Ministry of Construction head each committee and they have the authority to adjudicate in the event of conflicting demands for limited water. Coordination Committees are established when drought conditions are declared.

For example, in 1994 the Cabinet of the Government of Japan declared a severe drought condition on 15 July, forming a National Coordination Committee drawn from 13 ministries, headed by the National Land Agency. Eight subregional coordination committees were also established with representatives from the relevant branch offices of the ministries. Of the 47 prefectures 29 were moderately or severely affected by water shortages and implemented emergency coordination committees, referred to as Special Commissions. These committees adopted seven measures to ameliorate the severity of the drought impacts on domestic, industrial and agricultural sectors:

1. Minimum level of power generation was guaranteed.

2. Dead storage water was extracted from reservoirs.

3. Pumping equipment was made available on lease, from municipal authorities, to farmers whose land was out of command due to the drought.

4. New groundwater wells were sunk and existing wells revived.

5. Treated sewage and industrial wastewater was used for agriculture.

6. Desalination plants were established for domestic supplies in the most severely affected coastal cities.

7. Water was imported from Vietnam and Korea for industrial use.

In 1994, the Shikoku Island received less than 40 percent of the mean annual rainfall. As a result, the Kagawa Irrigation Land Improvement District (KILID) in the Kagawa Prefecture worked with the local LIDs to maximize the benefit derived from the sharply reduced inflows (20% of normal flows) to the main distribution system. The LIDs reinstated traditional forms of water distribution, originally superceded following construction of the main intake channel. These earlier distribution systems were based on local irrigation tanks and ponds. Rotation of supply proceeded from upstream to downstream areas, with priority being given to longer-established paddy lands over newly reclaimed land. The *Bansui* and *Hashiri Mizu* forms of rotation were used by different LIDs in response to the preferences of their members. In the *Hashiri Mizu* form of rotation, literally “Running Water,” paddy fields are not inundated with ponded water but water is allowed to flow from lot to lot continuously. For *Bansui* rotation, water is rotated between terminal-area farmer groups, by time in proportion to relative areas served. Terminal areas remote from the source may be abandoned to minimize conveyance losses.

In the Omono Gawa basin, abstractions at the Minase and Naruse barrages for the Omono Gawa-Suji project were reduced and became more variable than in other years as

the impacts of the drought conditions became more evident. However, the drought was less severe in the basin than elsewhere, such as the Shikoku Island, and even in this year significant volumes of water were discharged from the basin.

Environmental Conservation

During the third quarter of the twentieth century the need for the economy to recover from the devastation of the Second World War resulted in the pursuit of shorter-term policies than in earlier times. These policies led to a strong focus on increased agricultural and industrial production and promotion of a strong economy. The pursuit of these goals, almost inevitably, resulted in an increase in the exploitative use of resources to achieve immediate gains.

The period of economic recovery contrasts with established Japanese cultural values that place great value on tradition and ancestral ties. The importance of rural communities and agriculture is embodied in the regulatory framework, the Rivers Act first promulgated in 1897, that controls water management in the country. This original act and the revised 1964 act specify, first, the need for regulation of water to be vested in a single agency (Ministry of Construction) and, second, the principle of protecting traditional and existing uses.

By the early 1960s, the economic renaissance of Japan became focused on the deterioration of the environment and communities. A new Environmental Pollution Control Act was promulgated in 1967, followed by the establishment of the Environmental Agency in 1971. Aggravation of pollution from excessive use of agricultural chemicals led to the issuance of the Agricultural Chemical Control Act in 1970.

A remarkable consequence of the recognition of existing water use by the 1897 Rivers Act, even after a period of a strong focus on production and consumerism, is the continuation of traditional water allocations to irrigated agriculture. During this study it was reported that in 2000, traditional irrigation water allocations, i.e., those that predate the 1897 Act, still account for about 60 percent of the total agricultural use (table 7).

The existence of a clearly enunciated policy and its implementation over an extended period, coupled with (now largely superceded) protectionist policies, has enabled the preservation of agricultural rural communities in northwest Japan. The protection of traditional values has preserved agricultural communities and extensive forest areas, and has provided the basis for the reinstatement of water quality.

Table 7. Summary of traditional water rights as a percentage of current agricultural water allocations (2000).

Basis	Current Use (%)
Area	50
Volume	60
Number of Intakes	80

Water Quality

Individual LID management organizations are responsible for the day-to-day operation, maintenance, and development of the irrigation and drainage systems in the area of operation. These organizations are responsible for the quantitative measurement of water abstractions and also for measurements of the water quality. Consolidated records of water quantity are submitted to the Ministry of Construction each season to demonstrate compliance with approved licenses. The LID and the municipal authorities monitor the water quality to regulate the quality of return flows from municipal areas to agriculture and vice versa.

The Ministry of Agriculture, Forestry, and Fisheries set the standards of water quality for agriculture The LID can force municipalities or industrial users to construct and operate water-treatment plants if discharges are not within the approved standards. Standards of municipal water intake are higher than those set for agriculture. The LID has not had many difficulties in ensuring acceptable quality of return flows, although standards for pesticides in water are becoming more stringent and may impinge on agricultural practices in the near future.

The Tama Gawa and Naruse branches of Omono Gawa receive highly acidic flows that enter the watercourses from subsurface vents. These flows have resulted in the acidification of sections of the river. In the Tama Gawa subbasin, amelioration of the impacts has been implemented by addition of $CaCO_3$ through a treatment works near the Tama Gawa lake.

Conclusions

In considering the transfer of the Omono Gawa river basin institutions to other river basins, the socioeconomic conditions of Japan must be fully considered. There can be little dispute that, even after the recent turmoil in Japanese and other Asian economies, Japan is the most powerful economy in the region. This economic base, combined with a shared sense of traditional values and a moderate climate, creates a special environment that has nurtured the implementation of effective river basin management.

Specifically, since the early 1960s, a general and expanding popular demand to redress the detrimental practices of the previous 10 to 15 years, when the focus was increased production at almost any cost, led to a rapid development of water and environmental regulations. A long history of comprehensive river basin management under the Ministry of Construction, mandated by the 1897 Rivers Act, and the acceptance of rule of law by society in general, have provided the basis for effective management of water resources. The economic resources of Japan, due to its strong international trade, enabled deployment of advanced systems to support the implementation of the basin management philosophy. The widespread acceptance of the rule of law and a recognition of the intrinsic value of the natural environment, linked to the perception of cultural value of agriculture and rural societies have enabled the maintenance or restoration of the basin conditions. The economic base of the country has provided the capacity to implement the necessary infrastructure to address the needs to increase flood protection and to provide responsive irrigation systems.

The Omono Gawa basin is not short of water. Only about 20 percent of the mean annual discharge is consumed within the basin. Two large reservoirs perform both flood control and

water supply functions. These have ameliorated some of the worst water-related problems in the basin. The area of paddy rice has been reduced over the past 20 years as the impacts of reduced consumption took effect, as the nation became more wealthy and reduced subsidies.

Where the quality of the river water has been degraded due to natural inflows from acidic vents, the basin authorities have been able to implement water treatment works to ameliorate the impacts of these flows. Where domestic, industrial or agricultural return flows adversely affect water quality, the effective implementation of the existing regulations provides a mechanism to require the polluting party to treat the effluent. Both municipal and agriculture sectors, and the LID associations, have the necessary technical skills to confirm the compliance of the other sectors with the appropriate regulations.

The important lessons for other basins are the following:

Administration of a water-surplus basin does require positive management to ensure that drainage and flood-control structures are operated and maintained correctly. Also, even in water surplus basins, during times of drought there needs to be a well-documented and effective system available to manage revision of water allocations to ensure that basin-scale impacts are minimized.

Water-quality issues can be dealt with effectively when the sectors involved are able to monitor and evaluate compliance of the other sectors.

Water-management agencies focused on agricultural water management, such as the LIDs in the Omono Gawa basin, have a major role to play in the management of water resources. With appropriate delegated authority and support these agencies can be highly effective.

Literature Cited

GoJ (Government of Japan). 1964. *Rivers Act.*

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