Image picture ②

Image picture ③

Japan Commission on Large Dams
http://www.jcold.or.jp

Image picture ④

Image picture ⑤

Sources :
1) : “Circumstances of dams in Japan (effective use of existing dams) 2006 (in Japanese)”, Japan Commission on Large Dams
2) : Prepared based on the data of Japan Commission on Large Dams
3) : Prepared based on “ Dam Almanac 2005 (in Japanese) ”, The Japan Dam Foundation 2005. 3
4) : Webpage of the Ministry of Land, Infrastructure, Transport (http://www.mlit.go.jp/river/dam/main/shinngikai/kondankai/dam/pdf2/17-27.pdf) (in Japanese)
5) : Prepared based on “Electric Utility Manual (fiscal 2008) (in Japanese) ”, the Federation of Electric Power Companies in Japan (in Japanese)
6) : Water Resources in Japan (fiscal 2008), Ministry of Land, Infrastructure and Transport p. 76(in Japanese)
7) : Water Resources in Japan (fiscal 2008), Ministry of Land, Infrastructure and Transport p. 90(in Japanese)
8) : Prepared based on references 6) and 7) (in Japanese)
9) : Webpage of the Ministry of Education, Culture, Sport’s Science and Technology (http://jcsepa.mri-jma.go.jp/outreach/20070324/Presentations/P2_Yamamoto.pdf) (in Japanese)
10) : Webpage of the Chuo Mitsui Trust Holdings, Inc. (http://www.chuomitsui,jp/invest/pdf/repo0503_4.pdf#search=’ Industrial water and industrial production index) (in Japanese)
11) : “Earth Dams in Sanuki (in Japanese)”, the prefectural government of Kagawa (March, 2000) (in Japanese)
12) : Prepared based on the webpage of the University of Tokyo (http://park.ecc.u-tokyo.ac.jp/irrigationwater/nakashima_071029.pdf) (in Japanese)
13) : Webpage of Oki/Kanae Laboratory of the Institute of Industrial Science of the University of Tokyo (http://hydro.iis.u-tokyo.ac.jp/Open House) (in Japanese)
14) : Problems of sand flushing at sedimentation facilities (in Japanese), Electric Power Engineering No. 318, p. 3
15) : Webpage of the Kansai Electric Power Company, Inc. (http://kepco.co/jp/info/hokuriku/contents/dashi/sougou.htm) (in Japanese)
16) : Webpage of Hatsutabara Dam (http://www. cgr.mlit.go.up/hattabara/damsite/facility/keep/keep.htm) (in Japanese)
17) : Webpage of the Japan Water Agency (http://www/water/go/jp/honsya/honsya/) (in Japanese)
18) : Webpage of Shikoku Regional Development Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (Http://www/skr/mlit.go.jp/kansen/kanri/dam/hozen/html) (in Japanese)
19) : Provided by the Kansai Electric Power Company, Inc .(in Japanese)
20) : Provided by the Ministry of Land, Infrastructure, and Transport (in Japanese)
21) : Source: The first meeting of the review committee on inadequacy related to water rights for hydropower (in Japanese), River Bureau, Ministry of Land, Infrastructure, and Transport (September, 2007) (in Japanese)
22) and 23) : Webpage of the Center for Climate System Research of the University of Tokyo (http://ccsr.u-tokyo.ac.jp/openhouse/2005poster/20050H-K-1/2--5-H-K-1.htm) (in Japanese)
24) : Webpage of the Environmental Restoration and Conservation Agency of Japan (http://www/erca/go.jp/ondanka/stop/kikou.html) (in Japanese)
25) : Water Resources in Japan (fiscal 2005), Ministry of Land, Infrastructure, and Transport (in Japanese)
26) : Prepared based on ”TEPCO ILLUSTRATED FY2000” (in Japanese)
27) : Prepared based on Reservoir Sediment Control in Japan (in Japanese) by Tetsuya Sumi, pp. 108, Fig. 8, 2003
28) : “Evaluation of Power Generation Technologies based on Life Cycle CO_2 Emissions”, the Central Research Institute of Electric Power Industry (in Japanese)
29) : Survey by the Agency for Natural Resources and Energy (March 31, 2007) (in Japanese)
30) : Prepared based on IEA databases WEC (2004) for hydropower potential (in English)
Image picture ① : Provided by Toden PR Company, Inc . (in Japanese)
Image picture ② : Webpage of Onyado Kawasemi (http://hisuinosato.com) (in Japanese)
Image picture ③ : Webpage of Kurobe Dam (http://iwww.kurobe-dam .com/photo_museum/index.html) (in Japanese)
Image picture ④ : Webpage of the prefectural government of Akita (http:www.pref.akita.lg.jp) (in Japanese)
Image picture ⑤ : Webpage of Onyado Kawasemi (http://hisuinosato.com) (in Japanese)

Dam and Hydropower

The Roles of Dams and Hydropower

How Dams and Hydropower Prevent Global Warming.

Japan Commission on Large Dams

Image picture ①

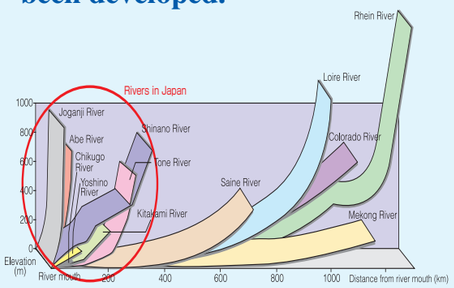
Roles of Dams and Hydropower Today and in the Past

Served as Foundations of Economic Growth and National Land Conservation in Japan

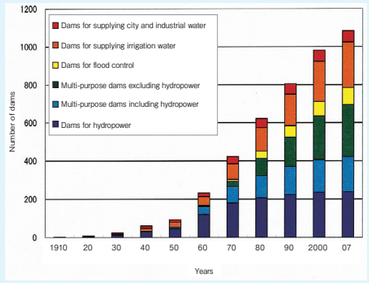
*Since the years of the latest data available differ by reference, the values are cited here.

History of Dam Construction

In Japan, because of the steep topography, the nation's rivers are also very steep. So that the precipitation immediately runs off land into the rivers, and which causes floods in a short time as well as rapid water recession. Therefore, dams store the flood water and this role is inherently effective in mitigating flood damage and utilizing the water in the season with little rain.
Dams have been constructed for mainly water use such as hydropower since the Meiji era, and after WWII multipurpose dams for flood control and water use have been developed.



Gradients of major rivers in Japan and the world [1]



Changes in the number of dams according to purpose [2]

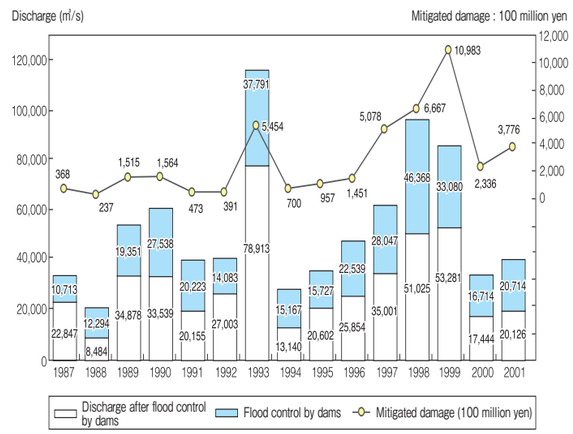
Flood Control

Dams have prevented flood damages and land slides in their lower regions by temporarily storing flood water and discharging it in a controlled way.

Number of dams constructed and flood control capacity [3]

Year of construction	Number of dams constructed			Flood control capacity (million m³)		
	Single-purpose dams	Multi-purpose dams	Total	Single-purpose dams	Multi-purpose dams	Total
1926~1945	0	2	2	0	10	10
1946~1955	0	17	17	0	240	240
1956~1965	2	50	52	1	770	771
1966~1975	21	62	83	54	860	914
1976~1985	26	76	102	67	849	916
1986~1995	13	80	93	34	709	743
1996~2004	14	84	98	21	747	768
Total	76	371	447	177	4,185	4,362

As of fiscal 2004, there are 447 dams in Japan for flood control (excluding dams for agricultural land disaster prevention), which have a total flood storage capacity of about 4.4 billion m³.

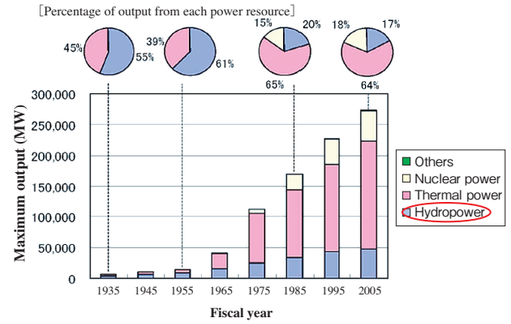


Actual flood control by dams and estimated reduction amount of mitigated damage [4]

As of fiscal 2001, there have been 93 dams constructed by the Ministry of Land, Infrastructure and Transport and the Japan Water Agency in Japan. These dams have controlled a total flood discharge of about 340 thousand m3/s in 15 years from 1987 to 2001 and it is estimated that the effective reduction amount totaled about 4.2 trillion yen.

Power Supply

Hydropower was first introduced in the Meiji era to produce power at spinning mills and mines as independent power sources. Since then, hydropower has enabled and increased energy to be produced domestically and supported its economic growth.



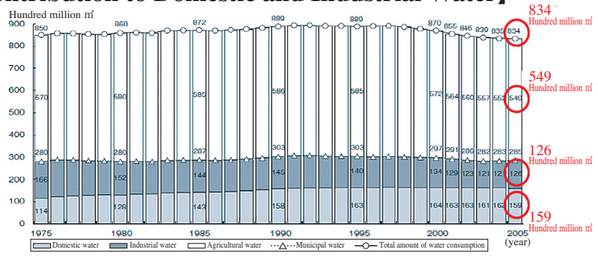
Transition in output from each power resource in Japan [5]

As of fiscal 2005, there are 1,162 hydropower plants in Japan, owned by the nine electric power companies such as TEPCO and J Power. The hydropower plants which supply 34.27 million kW (17% of the total capacity), play an important part in securing reliable power supply, cooperating with other power sources such as nuclear power plants (46.96 million kW, 23%) and thermal power plants (120.56 million kW, 60%).
The power generated by the hydropower plants, nuclear power plants, and thermal power plants account for 60.0 billion kWh (7%), 287.0 billion kWh (35%) and 462.2 billion kWh (57%), respectively.

Supply of Domestic, Industrial and Agricultural Water

Dams have supplied water of high quality and assisted immensely in improving people's living conditions and have respectively increased industrial and agricultural productions.

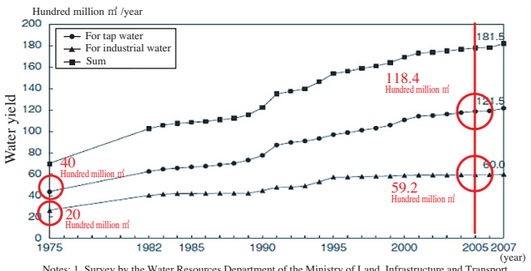
【Contribution to Domestic and Industrial Water】



Notes: 1. The values are the amounts of water intake estimated by the Water Resources Department of the Ministry of Land, Infrastructure and Transport and include the water that was returned to rivers after it was used.
2. Industrial water is the amount of fresh water supplied to establishments that had at least four employees. Water used for public utilities is not included.
3. The estimated amount of agricultural water for 1980 is used for years 1981 and 1982, the estimated amount for 1983 is used for years 1984 to 1988, and the estimated amount for 1989 is used for years 1990 to 1993.
4. The sum may not agree with the actual total due to rounding.

Water consumption in Japan [6]

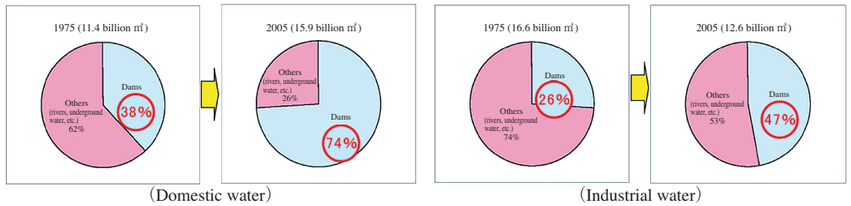
As of fiscal 2005, the total annual consumption of water in Japan (an estimate based on intake) accounts for 83.4 billion m³, of which 15.9 billion m³ (19%) is domestic water, 12.6 billion m³ (15%) is industrial water (to supply to water recycling systems), and 54.9 billion m³ (66%) is agricultural water.



Notes: 1. Survey by the Water Resources Department of the Ministry of Land, Infrastructure and Transport
2. The water yield (hundred million m3/year) was calculated by converting the water yield (m3/s) into its annual value and multiplying by a load factor (day mean supply / day maximum supply) of 5/6.

Water yield for municipal use by water resource development facirlities (the dams, etc.)[7]

The total water yield associated with dam construction by the end of fiscal 2005 was 11.84 billion m³ for domestic water and 5.92 billion m³ for industrial water.



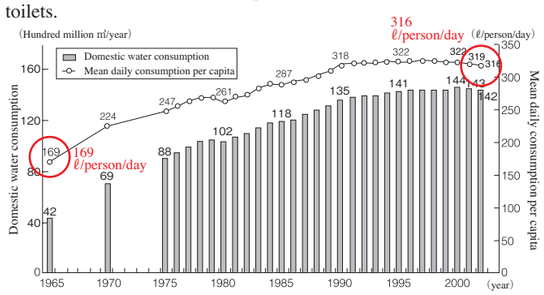
(Domestic water) (Industrial water)

As of fiscal 2005, water supply produced by water resource development facilities (the dams, etc.) accounted for 74% of domestic usage and 47% of industrial usage.

Changes in the contribution ratio of water resource development facilities (the dams, etc.) in industrial water (supplying to water recycling systems)and domestic water [8]

〔Improvement of Living Conditions〕

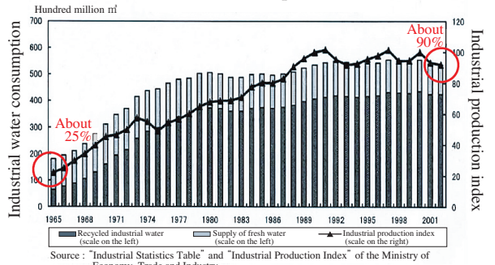
The domestic water consumption per capita was 169 ℓ/person/day in fiscal 1965 and 316 ℓ/person/day in fiscal 2003, showing a twofold increase, in the background of spread of water service and flush toilets.



Changes in domestic water consumption in Japan [9]

〔Increases in Industrial Production〕

The industrial production index was about 25% in fiscal 1965 and about 90% in fiscal 2001, marking an over threefold increase, with the increase of industrial water consumption.

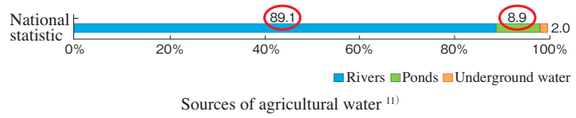


Source : "Industrial Statistics Table" and "Industrial Production Index" of the Ministry of Economy, Trade and Industry

Changes in industrial water consumption and industrial production index [10]

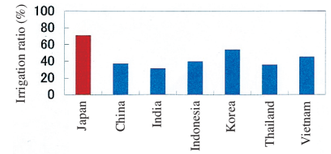
【Contribution to Agricultural Water】

According to 2000 data, 98% of agricultural water was taken from rivers and ponds.



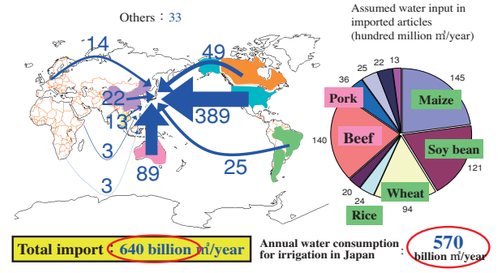
Sources of agricultural water [11]

Due to the supply of agricultural water, the irrigation ratio in Japan is the highest among rice cultivating nations in Asia.
On the other hand, Japan takes in a large quantity of water via food imports. The amount exceeds the annual quantity of water used for irrigation in Japan in a year. Secured supply of agricultural water by dams, etc. is important also from the perspective of water security.



Irrigation ratio in Asian nations [12]

Total assumed amount of imported water to Japan [13]



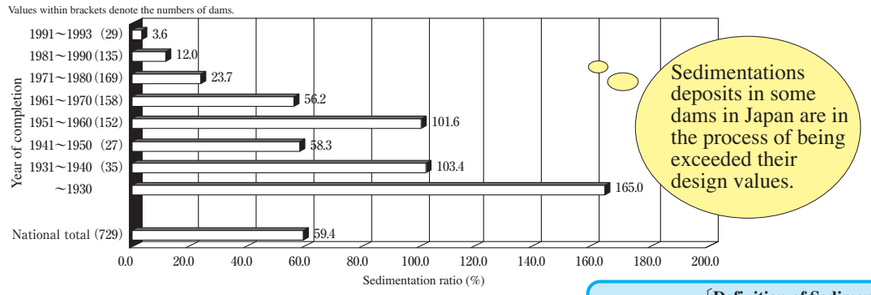
(Unit yield in Japan: calculated using the data in the food balance table of fiscal 2000)

To sustain the Roles of Dams and Hydropower, constant efforts have been made to mitigate resulting negative environmental impacts

The state of reservoirs involves following environmental issues. To keep fulfilling their roles in dams and hydropower, these issues should be tackled steadily.

Sedimentation

Storing water in a reservoir allows for the capture of sedimentation from the upper regions. Sedimentation reduces the amount of water that can be stored in the reservoir capacity (designed dead storage) and may affect coast formation around the estuarial regions.



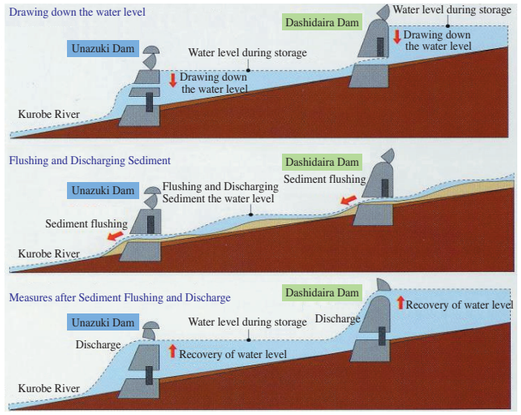
Sedimentation conditions [14]

〔Definition of Sedimentation ratio〕
(Sedimentation amount ／ The designed dead storage)×100(%)

《Example of Improvement》

Coordinated sediment flushing to restore the effective capacity and river's environment in the lower regions

The Dashidaira Dam and the Unazuki Dam, which is about 7 km downstream across the Kurobe River, flush and discharge sediments in a mutually coordinated manner. The sediment that flowed and was deposited into the Dashidaira Dam during the floods is discharged into the lower regions through the Unazuki Dam. This coordinated sediment flushing is implemented by following the methods and the rules that were formulated with the purpose of mitigating impacts on the environment in the lower regions. An investigation to evaluate the effects has been ongoing.



Mechanism of coordinated sediment flushing and discharge [15]

<Drawing down the water level>
The water level is lowered in the both dams.

<Flushing and Discharging Sediment>
The river is allowed to flow naturally through both the dams to discharge sediment from the Dashidaira Dam to the lower regions through the Unazuki Dam.

<Measures after Sediment Flushing and Discharge>
The sand flush gates of the dams are closed to recover the water level. Water from the upper regions is discharged for a predetermined period of time.

Eutrophication

Reservoir becomes eutrophic via the inflow of domestic sewage, etc. which may affect the quality of drinking water, etc.

《Example of Improvement》

①Purifying Water by Using an Aerating Circulation Facility

Hattabara Dam across Ashidagawa River [16]

②Stopping Expansion of Water bloom by Installing a Cutoff Barrier

Seirenji Dam across Seirenjigawa River [17]

Prolonged Turbid Water

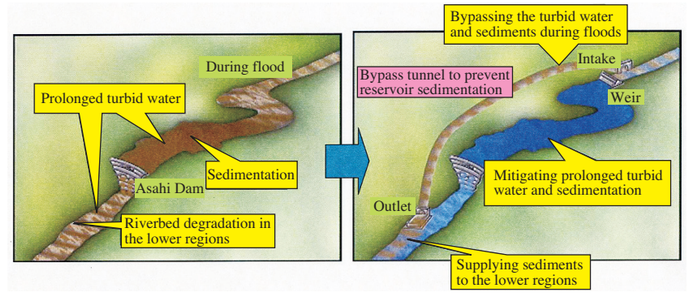
Inflow of sedimentation during floods with prolonged suspended solids causes turbid water. Discharge of the turbid water may affect the quality of water in the lower regions.

《Example of Improvement》

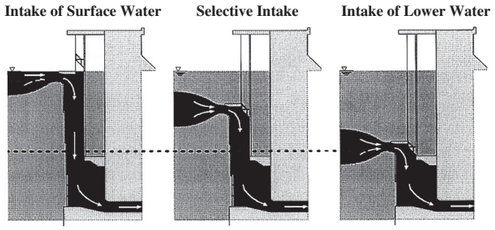
①Forestation of Sediment Sources in the Upper Regions

Sameura Dam across Yoshinogawa River [18]

②Bypass tunnel to restrict the inflow of sediments (and supply sediments to the lower regions to prevent the riverbed from degrading and the coastline from recessing)

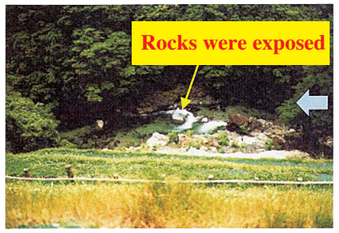


③Selected intake gate to prevent discharge of turbid water



Hitotsuse Dam across Hitotsusegawa River,
Matsubara Dam across Chikugogawa River, etc. [20]

Prior to bypass operations



Subsequent to bypass operations

Changes in the riverbed at the downstream of the bypass tunnel of Asahi Dam [19]

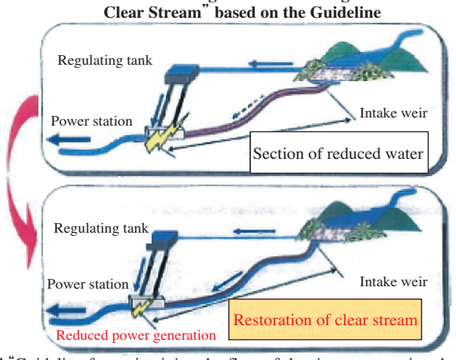
River Environment in the Lower Regions

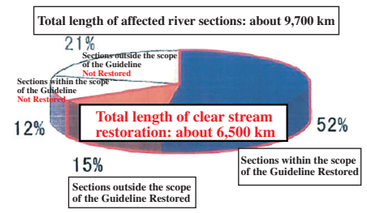
Hydropower sometimes take in river water in its entirely, which adversely affects the habitats of organisms, water quality scenery, etc. in the lower regions.

《An Improvement Example》

①Appropriate flow at the downstream of the dam to be secured; stated in the Hydropower Guideline * [21]

Schematic Diagram of "Restoring the Clear Stream" based on the Guideline





67% of the affected sections have been restored

Restoration of clear streams in affected sections
Number of power stations : 699 (52%) out of 1,295
Length of affected sections : about 6,500 km (67%) out of about 9,700 km

②Revising the Term of Validity of Water Rights

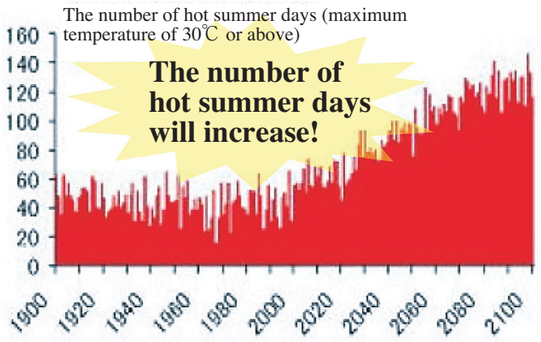
On April 1, 2009, the term of validity of the water rights for power generation was revised from 30 years to 20 years (10 years for those that have passed 100 years since the initial permission was granted) in principle. It is also required to submit necessary reports every 10 years to evaluate the utilization of river water which will be revised for every fixed period of time from the perspective of public benefits, such as conservation of the river's surrounding environment.

*"Guideline for maintaining the flow of the river at renewing the water rights for power generation" enacted by the Ministry of Construction in 1988

Global Warming Increases the Importance of Securing Reservoir Capacities and Hydropower

Predicted Impacts of Global Warming

According to a future climate forecast made by the collaborate study team for the Center for Climate System Research (CCSR), University of Tokyo and National Institute for Environmental Studies (NIES), Japan Agency for Marine Earth Science and Technology (JAMSTEC), using a global simulator based on the climatic data in the past 100 years, the number of heavy rain days and hot summer days on which the temperature is 30℃ or above will increase and snow depth will decrease in Japan. Based on the forecast, future river flows at dam sites were estimated and compared with present values. As the result of the estimations, the number of heavy rain days will increase but the flow of the rivers will drop in general, and the peak of snowmelt discharge will appear in earlier spring than today, the flow during the wintertime will increase while the flow during the summertime will drop (From reference [22)〜25)]). For effective utilization of rainfall and snow all year round, the results show the increasing importance of securing reservoir capacities.



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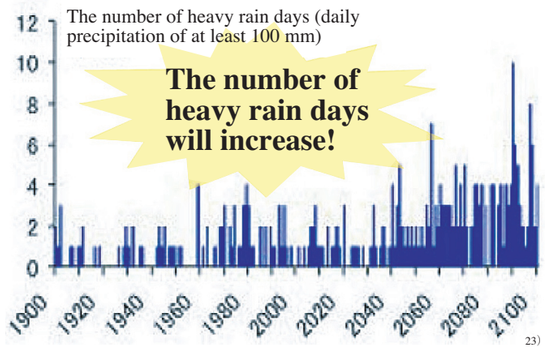

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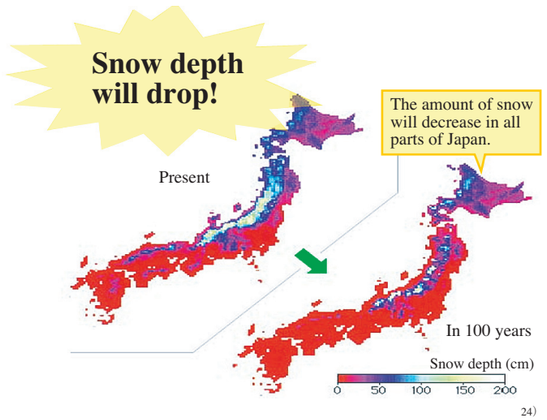

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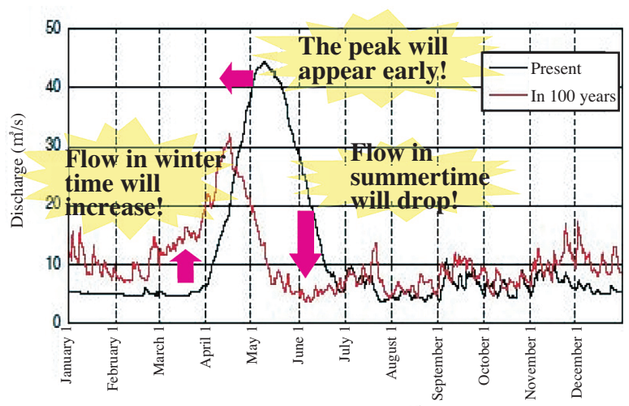
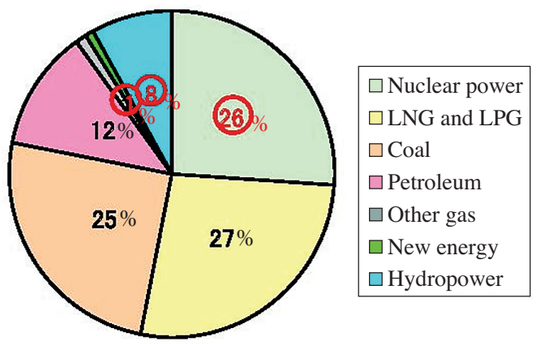


Flow at Yagisawa Dam [25)]

Goals for Preventing Global Warming

Based on the G8 Summit in 2008 (held in Toyako, Hokkaido), Japan set a goal to increase the production of zero emission energy (renewable energy, nuclear power generation, etc.) so as account for 50% of the total power generation by 2020. Today, as of fiscal 2007, the ten electric power companies in Japan produce a total of 1030.3 billion kWh, of which 353.0 billion kWh (35%) are zero emission power. Of this, 78.4 billion kWh (8%) is produced from hydropower, all the more revealing its importance.

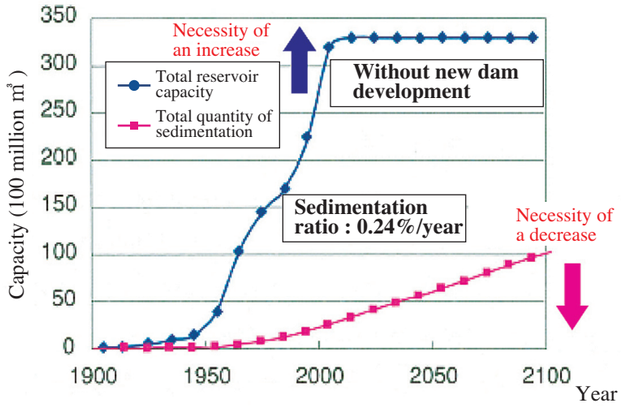


Energy sources of power production by the ten electoric power companies in Japan (fiscal 2007) [26)]

Proposals toward the Future

Development of New Dams

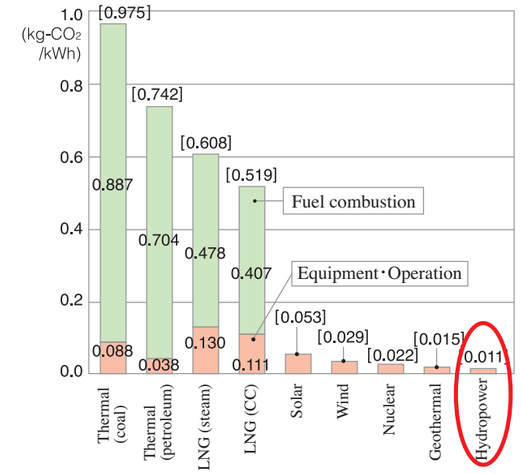
Global warming is predicted to increase droughts and floods. In Japan the total reservoir capacity is diminished at a mean ratio of 0.24% a year. To maintain the present reservoir capacity level, new dams need to be developed while taking measures against sedimentation of existing reservoirs, such as sand flushing described as an improvement example



Reservoir capacity of dams in Japan and losses in capacity [27)]

Roles of Hydropower

The CO_2 emissions from hydropower are emitted only for construction and facility repair. Hydropower dose not emit CO_2 to during operations.
Approximately 70 million tons of CO_2 was reduced via the use of hydropower in fiscal 2006. Without power supply from hydropower, the CO_2 emissions in Japan would have been about 6% more compared to the level in fiscal 1990.*
To prevent global warming the Japanese Government sets an aim to cut CO_2 emission by 25% by 2020 respect to1990 levels.
Hydropower is viewed as a clean and renewable energy that emits zero CO_2 and is an effective resource.

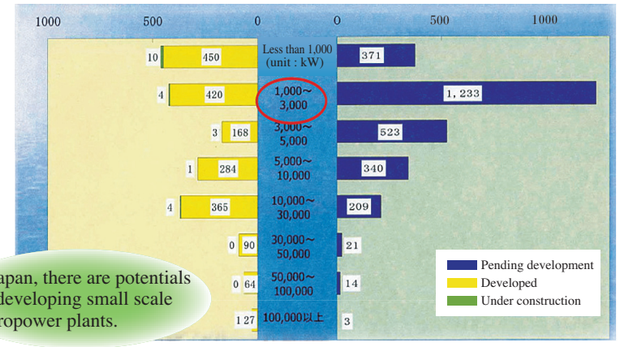


CO_2 emissions per 1 kWh [28)]

*Interim Report of Hydropower Study Group (July 2007), Agency for Natural Resources and Energy

Development of New Hydropower

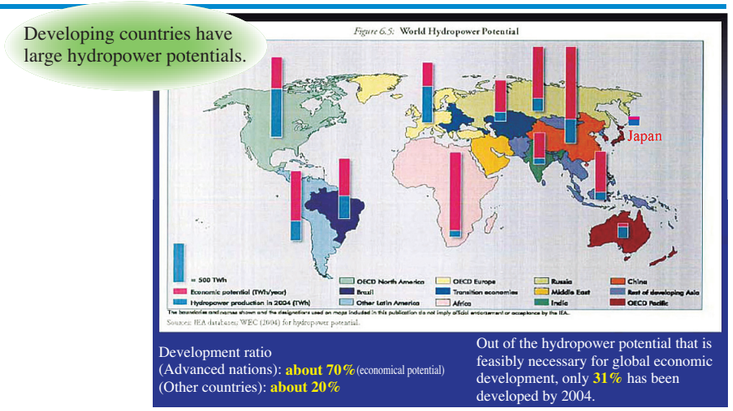
For preventing global warming, hydropower is as important as solar and wind. The development of new hydropower with newly being developed dams is also effective.



Hydropower output distribution (number of points) [29)]

Closing Remarks

In developing countries, the spread of electricity is indispensable for their growth. Power development projects are requested to take into consideration global warming and other environmental issues. In Japan, not only given that present ongoing measures but also Kyoto Mechanism, which are supplementary measures, have been implemented to achieve the goals of the Kyoto Protocol. CDM(Clean Development Mechanism) projects utilizing hydropower via Japan's advanced and abundant hydropower technologies will be required to contribute to build a global sustainable society. (*Emissions from methane and other greenhouse gases should be taken into account in certain tropical regions.)



Hydropower potential feasible for economic development in the world [30)]