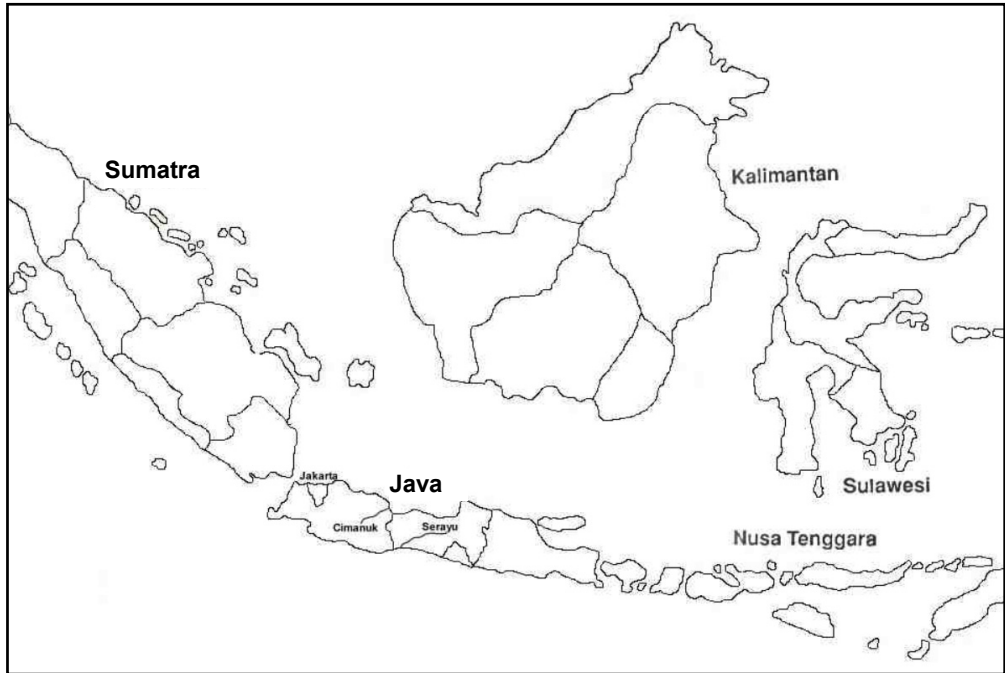


Indonesia

Indonesia 7: Cimanuk

Indonesia 8: Kali Serayu



Introduction

The Indonesian archipelago situated in Southeast Asia consists of five main islands (Sumatra, Kalimantan, Sulawesi, Java and Irian Jaya) and some 13 667 other smaller islands with a total land area of 1.9×10^6 km². Geographically, Indonesia is located between the latitudes of 6° 08' N ~ 11° 15' S, and longitudes of 94° 45' E ~ 141° 05' E. The total population according to the 1995 inter-census was estimated at 194.75 million with an annual growth rate of about 1.6 %. Population distribution is uneven throughout the country. Java Island has the highest population density that almost reaching 1 000 people/km² whereas the other islands have very much lower densities.

Politically, Indonesia is divided into 27 Provinces, 241 districts, 55 urban municipalities, 3 625 sub districts and 67 033 villages. Most of the rivers are short, steep and productive in sedimentation. Indonesia is a tropical country affected by tropical monsoon rainfall having two distinct dry and wet seasons. In the wet season, it experiences heavy rainfalls and annual rainfall ranges from 2 500 to 6 000 mm. In the dry season it is very dry, especially during a 2 month period typically between July and September.

The two rivers catalogued in this volume are the Cimanuk and Serayu, both are located in Java Island. They are the representative rivers of the salient characteristics indicated above, that are floods, urbanized, megalopolis, industrial development and agricultural area, respectively.

Acknowledgements

A working group was established for the preparation of the catalogue, and a number of Institutes and individuals collaborated. The working group chaired by Dr. Badruddin Machbub as Director of Research Institute for Water Resources Development consisted of:

Joesron Loebis (Senior Hydrologist), Sutjipto, Srimulat Yuningsih and Conny Amalia (Experimental Station for Hydrology),
Dyah Rahayu Pangesti (Head), Darjanta Budihardja, Syaifuddin, Rahardjanto and Sudarta (Experimental Station for River and Sabo),
Nana Terangna Ginting (Head) and Armaita Sutriati (Experimental Station for Environmental and Water Quality).

The organizations that have contributed include:

Badan Penelitian dan Pengembangan Pekerjaan Umum (Agency for Research and Development of Public Works),
Badan Pertanahan Nasional (National Board for Land Administration),
Badan Meteorologi dan Geofisika (Agency for Meteorology and Geophysics),
Badan Perencanaan dan Pembangunan Daerah (Provincial Development Planning Board),
Direktorat Geologi (Directorate of Geology),
Kantor Statistik Propinsi Jawa Tengah (Central Java Provincial Office of Statistics),
Kantor Statistik Propinsi Jawa Barat (West Java Provincial Office of Statistics),
Proyek Induk Pengembangan Wilayah Sungai Serayu (Serayu River Basin Development Project),
Proyek Induk Pengembangan Wilayah Sungai Cimanuk-Cisanggarung (Cimanuk-Cisanggarung River Basin Development Project).

Kali Serayu

Map of River

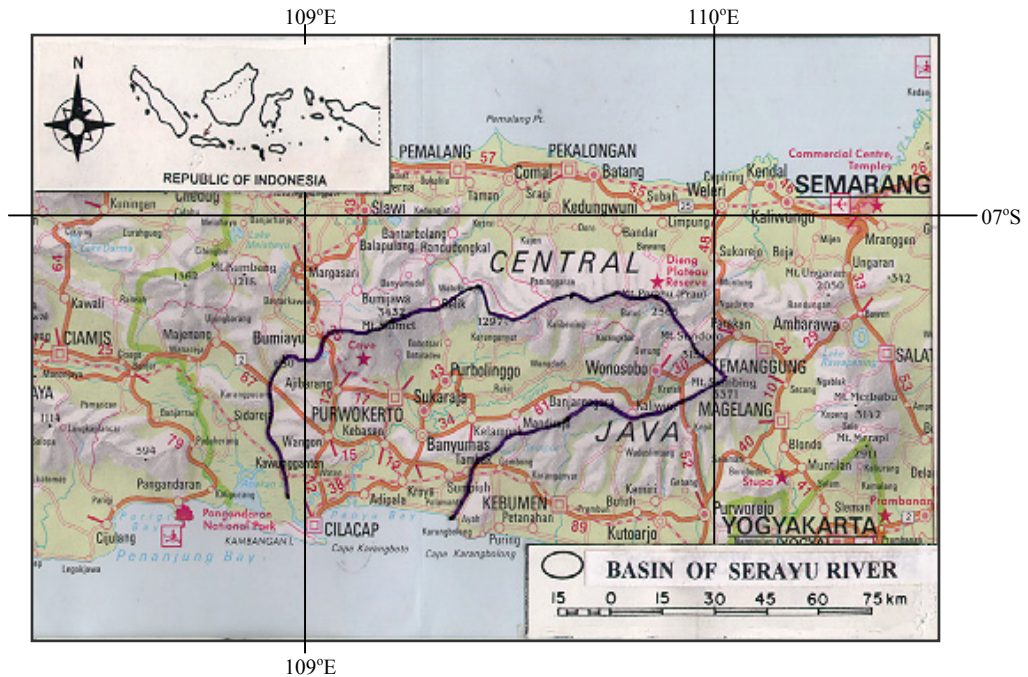


Table of Basic Data

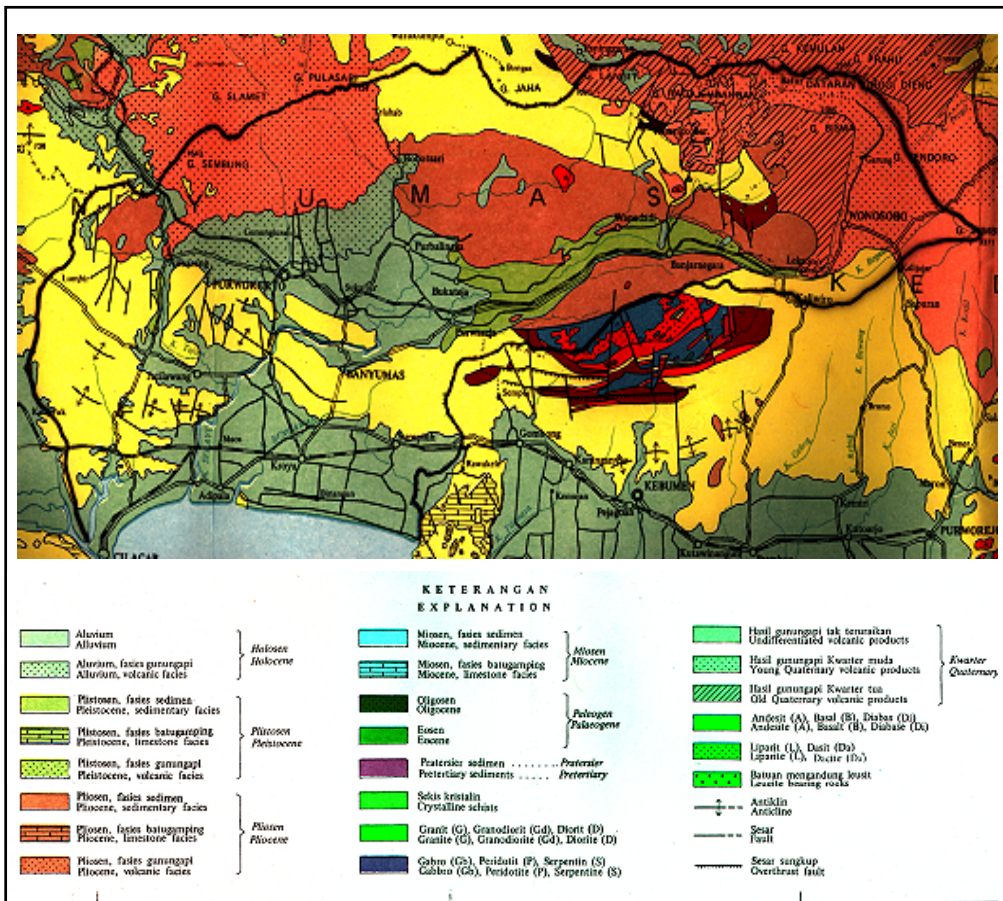
Name: Kali Serayu		Serial No.: Indonesia-8
Location: Central Java, Indonesia	S 07 ° 01' 52" - 07 ° 31' 54"	E 108 ° 50' 16" - 110 °04' 20 "
Area: 4 375 km ²	Length of the main stream: 180 km	
Origin: Mt. Prahu (2 565 m)	Highest Pt.: Mt. Slamet (3 432 m)	
Outlet: Indonesia Ocean	Lowest Pt. : River mouth (0 m)	
Main base rocks: Alluvium, Young quarternary volcanic product, and Miocene sedimentary fascias		
Main tributaries: Begaluh River (187.5 km ²), Merawu River (279.5 km ²), Klawing River (1 279 km ²), Logawa River (273 km ²)		
Main reservoirs: Pangsar Sudirman (141x10 ⁶ m ³ , 1983)		
Mean annual precipitation : 2 983 mm (Banyumas)		
Mean annual runoff : 57.16 m ³ /s at Banjarnegara (704 km ²), 273.41 m ³ /s at Rawalo (2 631 km ²) (1982~1995)		
Population: 3.5 x 10 ⁶ (1995)	Main cities : Purwekerto, Purbolinggo, Banyumas, Wonosobo, Banjarnegara, Cilacap	
Land use: Forest (17.00 %), Paddy field (24.62 %), Agriculture (35.64 %), Settlement (22.74 %) (1995)		

1. General Description

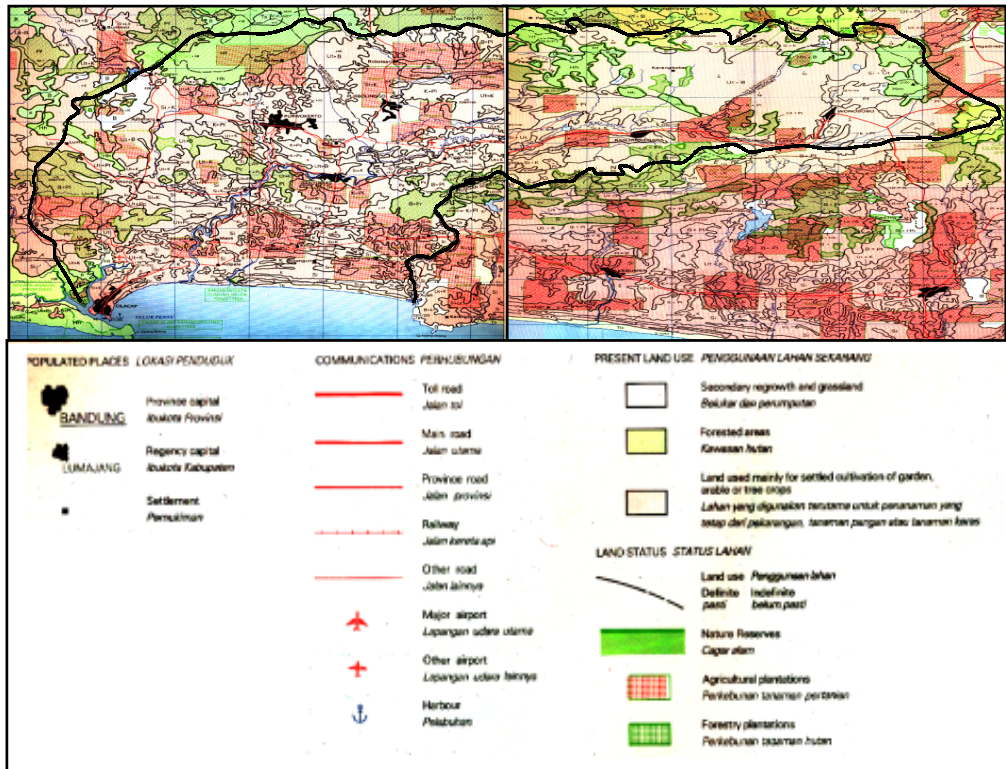
The Serayu River is one of the largest rivers in Java Island situated in central part of the island. The catchment is about 4 375 km² in area, and the main river is 180 km long with 11 tributaries. The river originates from the northwestern slope of Mount Prahu and flows out to the Indian Ocean. The Slamet mountain complex is located in the center of the basin. Several mountains, including Sumbing and Sundoro in the east, Walirang in the north, and a series of low hills along the southern part surround the basin, constitute the Southern Serayu Range. Tropical monsoon climate is predominant over the basin and is further characterized by distinct wet and dry seasons. The average annual rainfall in the basin reaches to around 4 000 mm and the mean annual discharge at Banjarnegara (704 km²) was 57.16 m³/s in 1995. The population of the Serayu River basin was 3.5 million in 1995. The Serayu River is used for irrigation, drinking water supply, industries, hydroelectric power, and others. Several dams, such as the Pangsar Sudirman Dam built in 1983 (capacity 141 million m³), Banjar Cahyana Weir (irrigating 6 550 ha), Tajum Weir (irrigating 3 200 ha) and Pesanggrahan Weir (irrigating 4 000 ha) have been built.

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 (1995)	Land use [%]
1	Serayu (Main River)	158.4 3 383	Mt. Prahu 2 565 0	Purwokerto (209 005) Cilacap (212 119)	F (17.00)
2	Begaluh (Tributary)	24.6 188	Mt. Sumbing 2 200 410	Kretek (32 432)	P (24.62)
3	Mrawu (Tributary)	32.2 280	Mt. Petawangan 2 000 240	Garung (78 564)	A (35.64)
4	Klawing (Tributary)	50.3 1,279	Mt. Walirang 793 20 m	Purbolinggo (123 547)	S (22.74)
5	Logawa (Tributary)	21 273	Mt. Besar 925 20	Ajibarang (64 812)	

F: Forest; P: Paddy Field; A: Agricultural field (vegetable field, grass field); S: Settlement

3.2. List of Meteorological Observation Stations

No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation [mm]	Mean annual evaporation [mm]	Observation item ¹⁾
1	Singomerto	310	S 07°23'18" E109°43'25"	1975~1990	4 469	1 214	T,DS,E,P, SR
2	Merden	121	S 07°29'16" E109°32'06"	1977~1988	5 336	-	T,DS,P,SR
3	Purwokerto	-	S 07°25'54" E109°14'15"	1973~1992	4 338	1 082	T,DS,E,P, SR
4	Mungkung	-	S 07°25'18" E109°55'57"	1981~1989	5 114	1 074	T,DS,E,P, SR

1) DS: Duration of sunshine E: Evaporation P: Precipitation SR: Solar Radiation T: Temperature

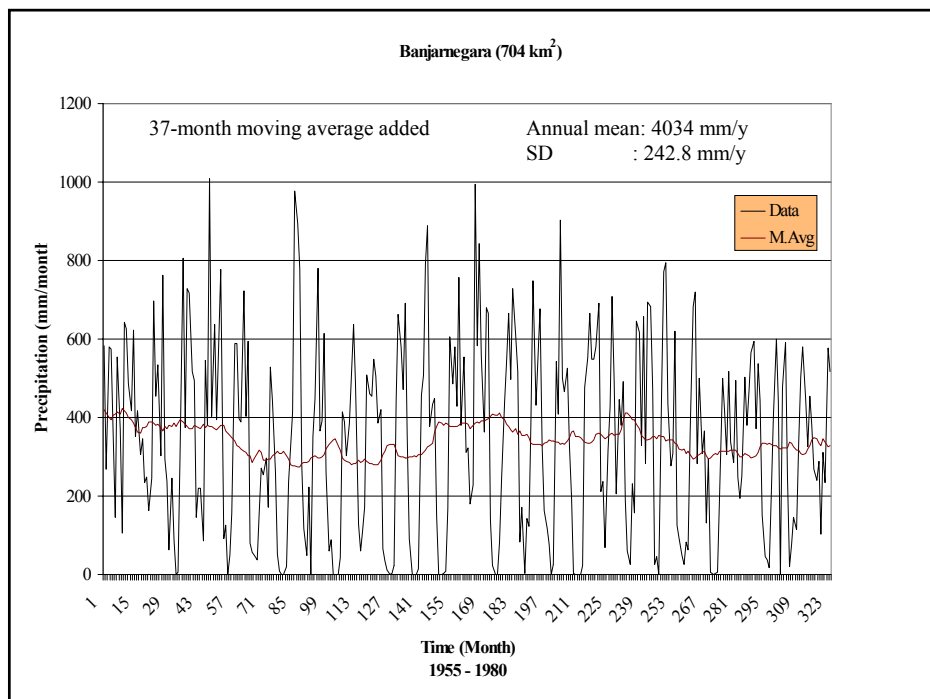
3.3. Monthly Climate Data

Station: Singomerto - Banjarnegara.

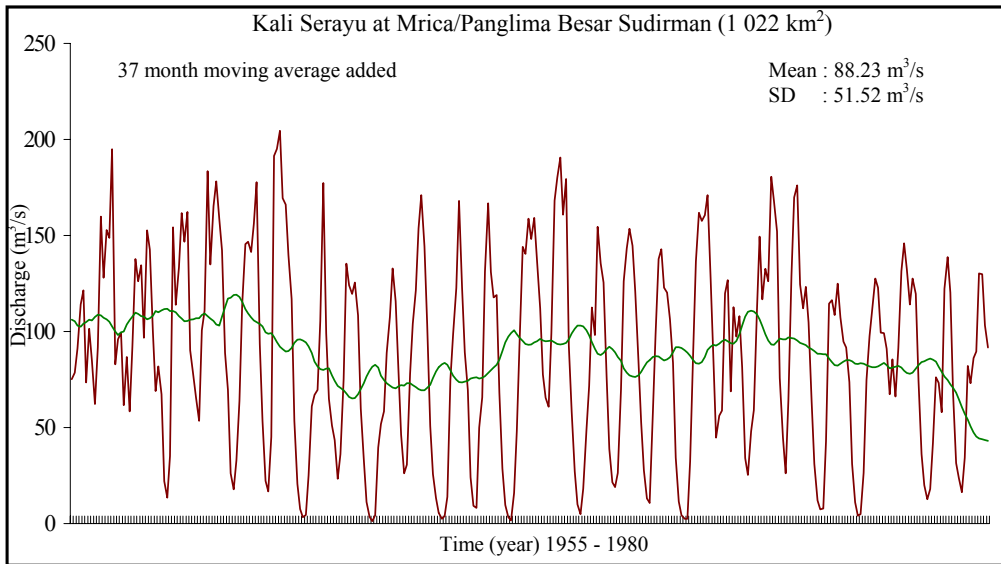
Observation Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [C°]	26.1	26.4	26.2	26.5	26.2	25.8	25.6	25.2	26.1	26.4	26.6	26.4	26.1	1975-1990
Precipitation [mm]	548	709	719	446	568	133	66	78	140	264	355	442	4468	1975-1990
Evaporation* [mm/day]	4.2	4.5	4.5	4.0	3.6	3.2	3.1	3.5	4.0	4.6	4.2	4.4	4.0	1975-1990

*Average Class A Pan

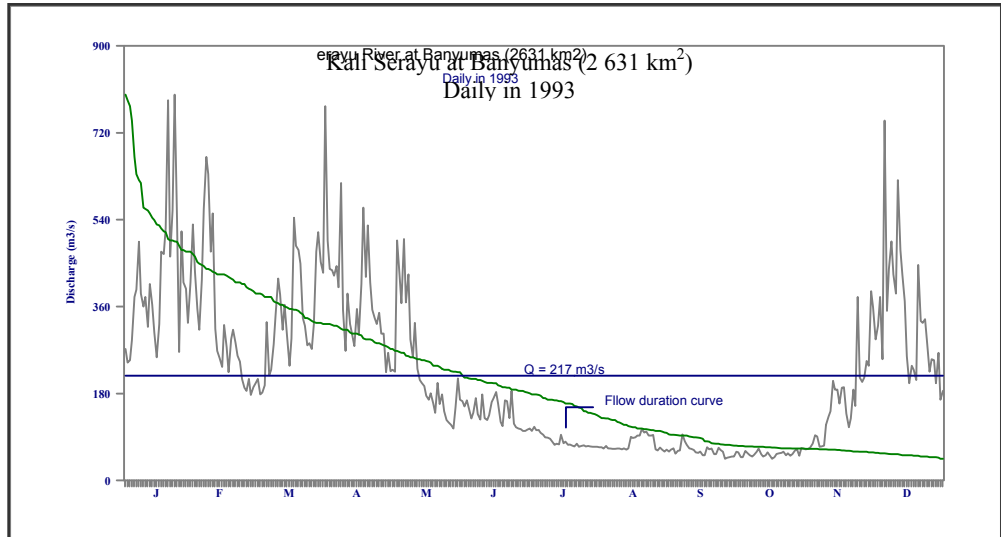
3.4. Long-term Variation of Monthly Rainfall Series



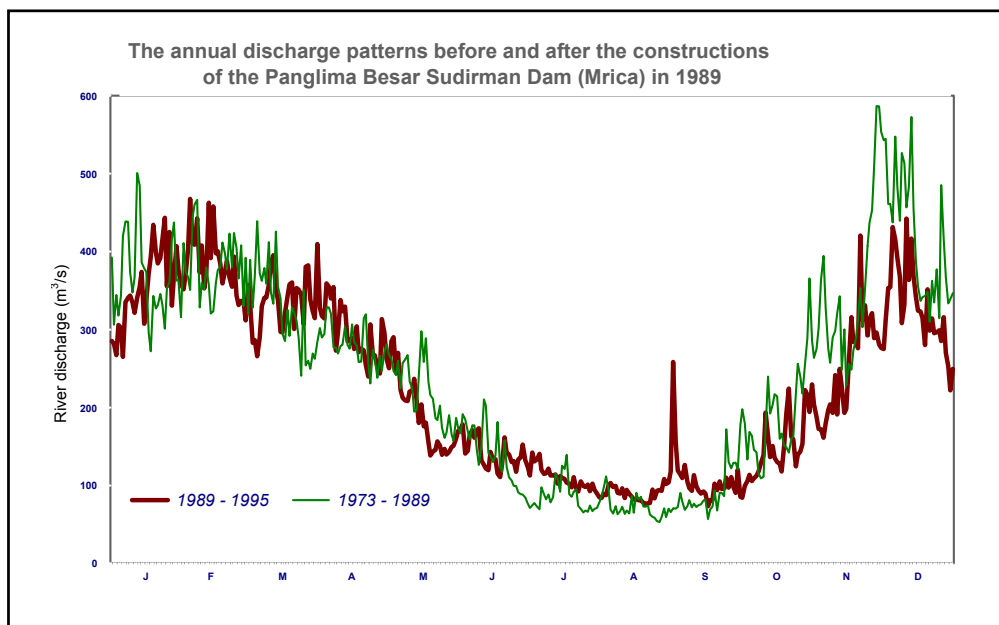
4.3. Long-term Variation of Monthly Discharge Series



4.4. Annual Pattern of Discharge



4.5. Unique Hydrological Features

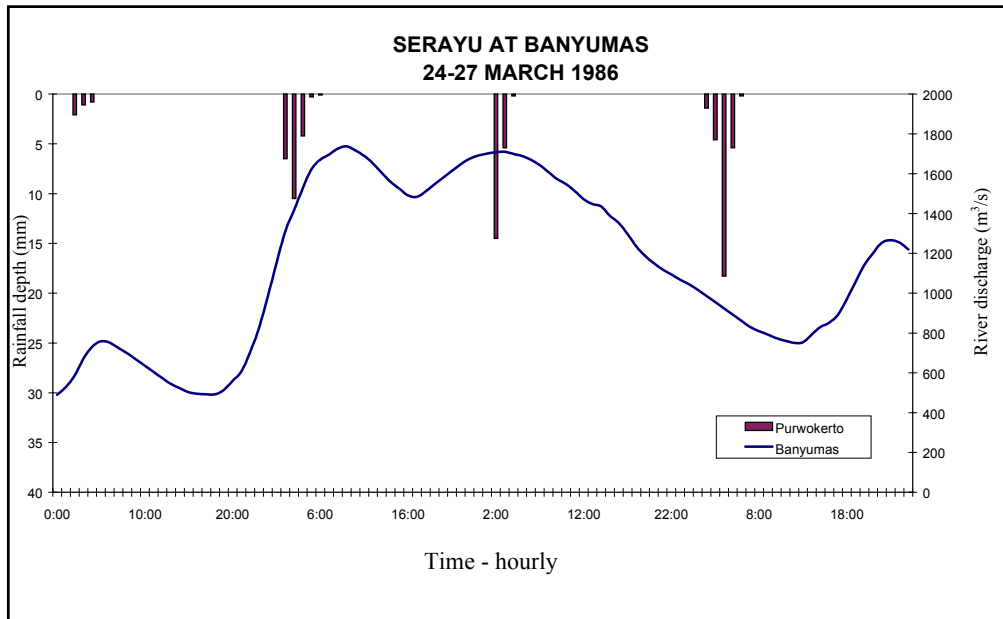


4.6. Annual Maximum and Minimum Discharges at Banyumas (2 631 km²)

Year	Maximum		Minimum		Maximum		Minimum		
	Date	Discharge ¹⁾ [m ³ /s]	Month	Discharge ²⁾ [m ³ /s]	Year	Date	Discharge ¹⁾ [m ³ /s]	Month	Discharge ²⁾ [m ³ /s]
1973	12.11	1 284	09	70.0	1984	01.02	1 598	08	43.7
1974	04.10	1 254	07	61.0	1985	01.12	1 056	08	56.4
1975	07.12	1 173	08	58.0	1986	25.03	1 760	08	55.6
1976	21.03	1 195	09	19.0	1987	27.01	1 301	09	44.4
1977	11.02	1 076	10	16.0	1988	03.11	1 433	09	36.7
1978	13.12	1 108	08	64.0	1989	22.02	1 110	09	39.2
1979	05.06	1 141	09	45.8	1990	06.12	1 061	10	45.7
1980	28.11	1 394	07	25.5	1991	19.01	1 549	06	52.8
1981	09.12	1 101	09	26.5	1992	31.08	1 900	08	63.0
1982	07.02	1 228	08	19.6	1993	05.12	1 255	09	25.0
1983	23.05	1 002	09	22.5	1994	29.01	1 159	10	21.0

^{1),2)} Instantaneous observation by recording chart

4.7. Hyetographs and Hydrographs of Major Floods

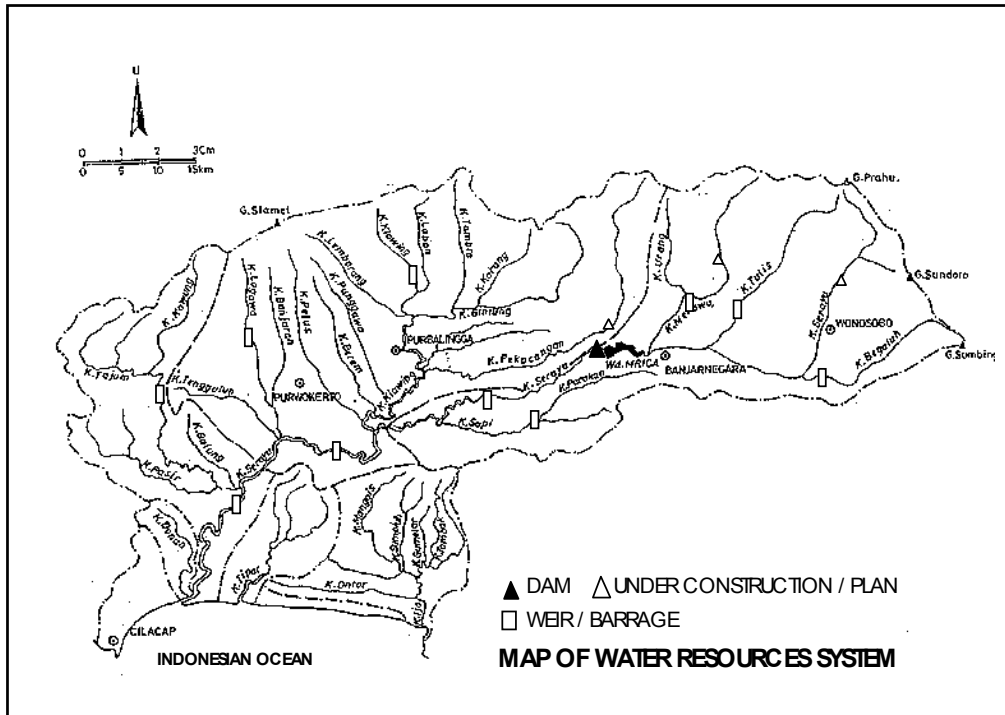


5. Water Resources

5.1. General Description

The Serayu River basin with about 4 375 km² of area or 3.30 % of the entire area of Java Island consists of Serayu, Ijo, Tipar and Donan catchments. In general, the upstream areas of Serayu River basin are hilly and mountainous with slopes ranging between 50 and 70 %. In 1983 Panglima Besar Sudirman reservoir, with an inundated area of 10.5 km², was built in the upstream Serayu River. It is used for hydropower generation and has a capacity of 180 MW. Based on sediment and discharge measurements observed in 1989 to 1993, the sedimentation in the reservoir was about 2.345 ~ 3.555 x 10⁶ m³/year. The function of the reservoir is also to mitigate floods and provide domestic water supply. Since 1974, irrigation facilities for some 132 000 ha were provided in the Serayu River basin. Infrastructure development has taken place since 1995 covering an irrigated area of 68 679 ha. According to research findings in 1974, it was estimated that a discharge of 7.12 x 10⁶ m³/year would be needed to develop the water resources until 2020. The estimated water needs for the upstream Serayu is 2.50 x 10⁶ m³/year, the middle Serayu is 2.58 x 10⁶ m³/year and the lower Serayu is 2.04 x 10⁶ m³/year. Considering the fact that until recently, the volume of water wasted to the sea is about 8.62 x 10⁶ m³/year, water demand for irrigation, domestic, urban and hydropower can be met until the year 2020. The water needs for the rural areas are generally derived from shallow groundwater wells, so that to utilize the available water resources the infrastructures of rural irrigation of 63 321 ha in the basin can be improved further technically.

5.2. Map of Water Resources System



5.3. List of Major Water Resources Facilities

Major Reservoirs

Name of river	Name of dam	Catchment area [km ²]	Gross capacity [10 ⁶ m ³]	Effective capacity [10 ⁶ m ³]	Purpose ¹⁾	Year of completion
Serayu	Panglima Besar Sudirman	1 022	141	73.8	Hydropower	1989

Major Diversions and Canals

Names of rivers	Location	Maximum capacity [m ³ /s]	Purpose ¹⁾
Serayu	Singomerto	10	A
Merawu	Clangap	2	A
Serayu	Panglima Besar Sudirman	10	A,P,F,N
Sapi	Gumelem Piasa	5	A
Logawa	Logawa	1	A
Serayu	Kebasen	10	A
Serayu	Gambarsari	30	A,F,N
Tajum	Tajum	5	A
Serayu	Pesangerahan	12	A,F,W,I,N

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

5.4. Major Floods and Droughts

Major Floods at Rawalo (2 631 km²)

Date	Peak discharge [m ³ /s]	Rainfall [mm] Duration	Meteorological cause	Major damages (Districts affected)
31.8.1992	1 900	162	Thunderstorm	Rawalo, Cilacap
30.1.1994	1 586	-	Long duration rainfall	Rawalo, Cilacap

Major Drought

Period	Affected areas	Major damages and counteractions
8-10. 1997	Banyumas, Rawalo, Cilacap	Water supply, Agriculture, Fisheries

5.5. Groundwater and Water Quality

River Water Quality at Serayu River in 1986

Date	06 August ¹⁾	07 August ²⁾
pH	7.2	7.0
DO [mg/l]	6.4	7.3
BOD [mg/l]	2.0	1.2
COD [mg/l]	6.1	4.3
SS [mg/l]	42	51
E-Coli* [colonies/100 ml]	21 000	11 000
Discharge [m ³ /sec]**	119.15	32.09

¹⁾Located at Banyumas; ²⁾Located at Leksono; * Membrane filter method; ** Discharge on the water quality observation date

5.6. Other Notable Water Resources Features

Water Uses at Major Reservoirs

Name of dam	Hydropower capacity [MW]	Agricultural use [km ²]	Fisheries use [10 ⁶ m ³]
Panglima Besar Sudirman	180	65.50	141

6. Socio-cultural Characteristics

Serayu River is situated in Central Java, the center of Javanese Culture which is oriented to the royal tradition of the palaces of Yogyakarta and Surakarta. Purwokerto is a major city passed by the Serayu River and plays as an entry point to a famous tourist destination named Baturaden, which is located 14 km to the north of Purwokerto and downhill slope of Mount Slamet. Not far from Baturaden, there is a hot spring called 'Sendang Pitu' as it flows into seven showers and a beautiful cave named Goa Lawa or Goa Batujajar which is the longest cave 'Goa' in Indonesia and situated at the slope of Mount Slamet

at 900 m above sea level. A large opening at the roof of the cave sheds bright light and bring about refreshing air to the cave. There is also a spring in the cave that forms clean and cool water pool. The Cave has been considered as a sacred place surrounded by stalactites and stalagmites which were formed naturally thousands of years ago. In the front wall of the cave there are statues of animals and humans of legendary story called Kamandaka. It was believed that in ancient time the cave had been used as a place to meditate for people expecting prosperity.

Another important site of socio-cultural interest is the Dieng Highland where a large caldera is formed at an altitude of 2 093 m above sea level, close to the peak of Mount Prahur where the origin of Serayu River begins. The Dieng Plateau is located 26 km north of Wonosobo City. To express its natural beauty, Dieng plateau has been predicated as the Garden for Gods and the Goddesses, and the Government has declared it as a National Natural Reserve.

7. References, Data-books and Bibliography

- Dept. PU, (1995): Rencana Induk Pengembangan Sumber Air Daerah Pengaliran Sungai Serayu, Proyek Irigasi Serayu, Desember 1995.
- IOH-DPMA, (1983): Flood Design Manual for Java and Sumatra, DPMA.
- Joesron Loebis, (1988): Banjir Rencana Untuk Bangunan Air, Badan Penerbit PU.
- Puslitbang Air - PU, (1989): Pengukuran Sedimentasi Untuk Waduk PLTA Mrica, Laporan No. 90/HI-18/1989.
- SMEC Consultant, (1974): Serayu River Basin Study. Feasibility Report, September 1974.
- Srimulat Yuningsih and Soewarno, (1995): Pengaruh Erosi DPS Serayu Hulu Terhadap Pendangkalan Waduk PLTA PB Sudirman, Jurnal Litbang Pengairan No. 34 Th.10-KW I.