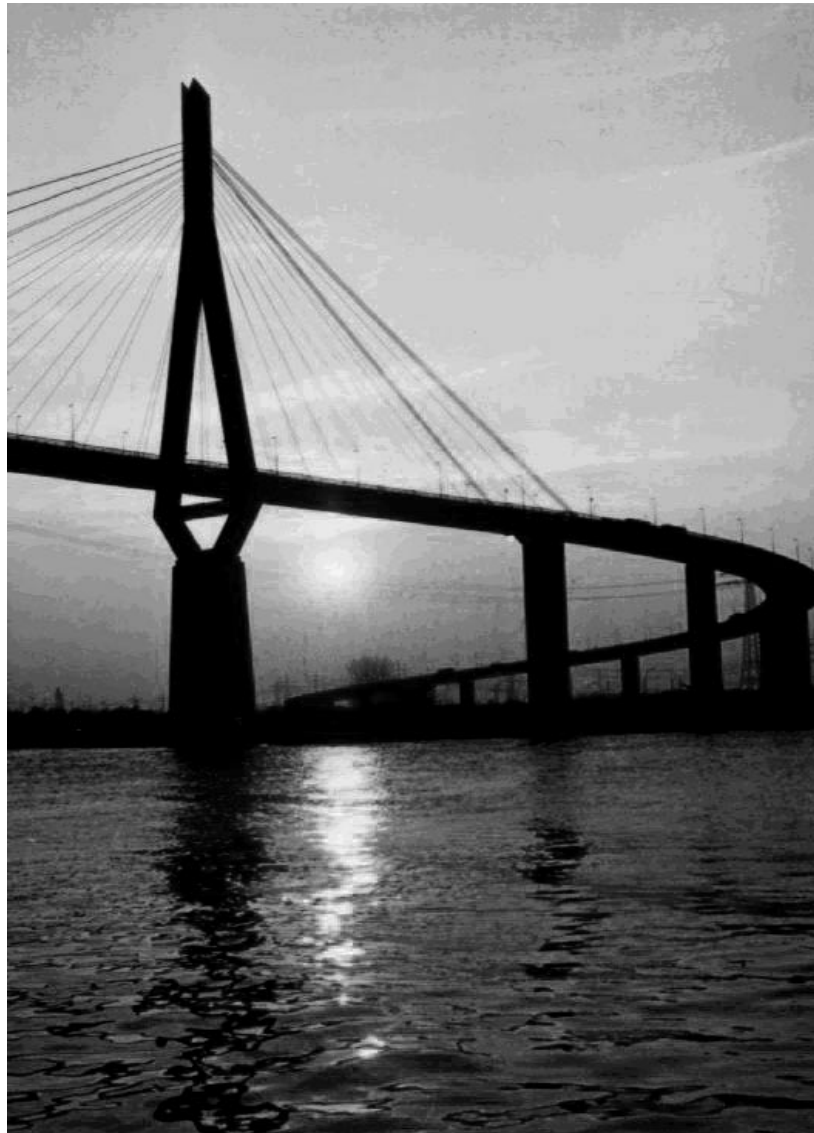


Observed historical discharge data from major rivers for climate model validation



Lydia Dümenil Gates
Stefan Hagemann
Claudia Golz

Max-Planck-Institut für Meteorologie, Hamburg

MPI - Report No. 307

Foreword

Due to the large demand we have decided to publish an updated version of our joint GRDC (Global Runoff Data Centre) and MPI (Max-Planck-Institute for Meteorology) Report which was first published in 1993 by Dümenil et al. The data have been improved over the last few years, and the efforts of GRDC, headed by Dr. Grabs, lead to a considerable extension of their database. The data from river discharge gauging stations represent a valuable tool for the study of long-term climate variability - even on decadal time scales - and also for the validation of climate model simulations at regional scales.

In several applications, these observations have been used to validate the results from numerical schemes that compute river discharge from simulated surface runoff and drainage over a catchment. In off-line mode, such schemes provide useful information about the mean annual cycle of hydrological processes at the regional, i.e. catchment, scale. Combined with ocean models they provide the required freshwater input at the interface between the atmosphere, the land and the oceans.

While the data compiled here only represent a sub-set of monthly mean data for large catchments, GRDC holds a wider range of products including gauge data for small river catchments at daily time resolution. Grabs et al. (1996) present a summary of these discharge data describing continental freshwater fluxes into the world oceans. Some of the observed discharges used in our report were also taken from the Global River Discharge Database constructed by Vorösmarty et al. (1998).

This report is also available on the internet at the MPI site (<http://www.mpimet.mpg.de/deutsch/Sonst/Reports/HTMLReports/>). The discharge data can be obtained from the GRDC (<http://www.bafg.de/grdc.htm>).

References

Dümenil, L., K. Isele, H.J. Liebscher, U. Schröder, M. Schumacher and K. Wilke, 1993, Discharge data from 50 selected rivers for GCM validation, Max-Planck-Institut für Meteorologie Report No. 100, Hamburg

Grabs, W., T. de Couet and J. Pauler, 1996, Freshwater fluxes from continents into world oceans based on data of the global runoff data base, Global Runoff Data Centre Report No. 10, Koblenz

Vorösmarty, C.J., B.M. Fekete, and B.A. Tucker, 1998, Global River Discharge Database (RivDIS v1.1), published on CD-ROM, The Oak Ridge National Laboratory (ORNL), Distributed Active Archive Center (DAAC)

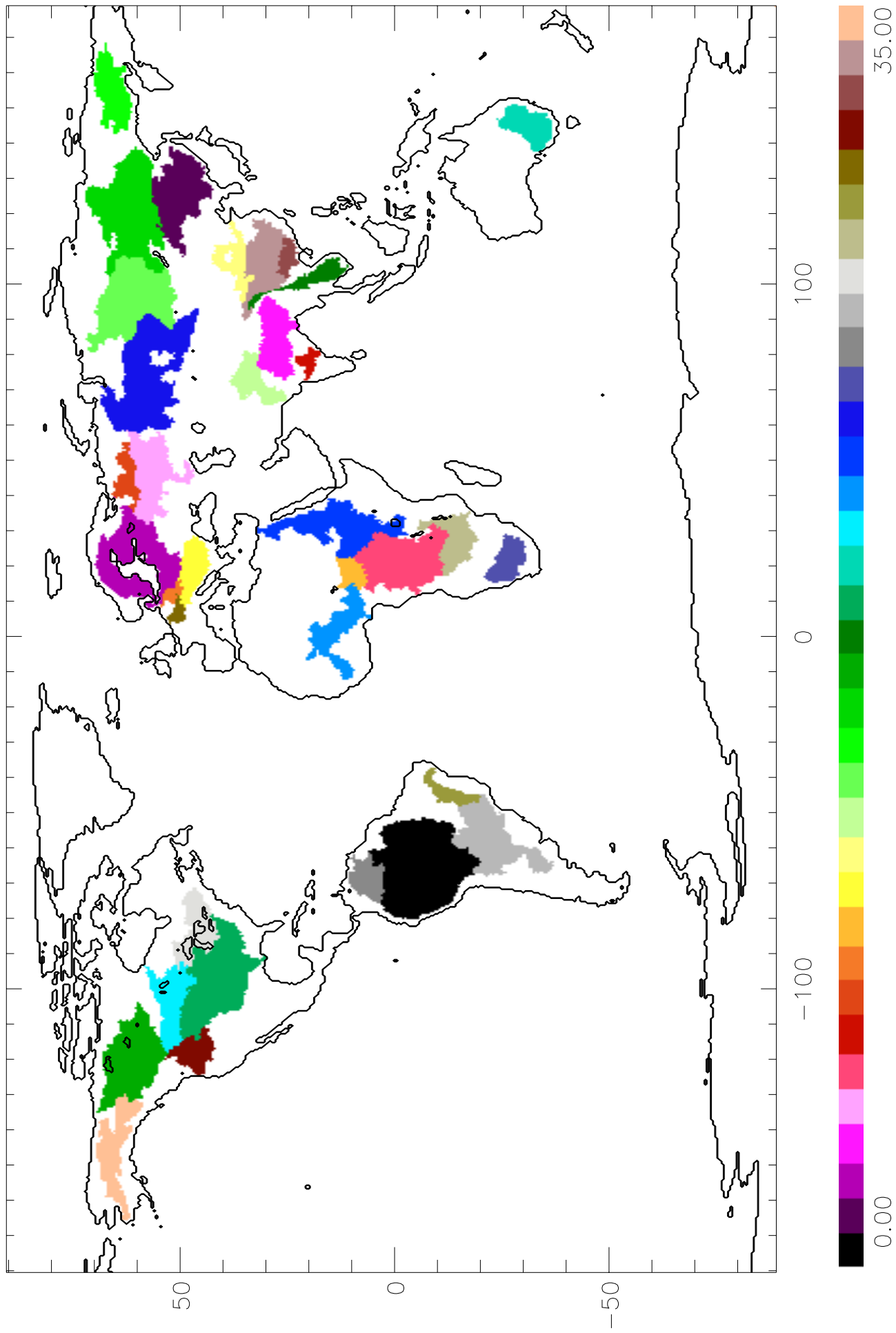
1. Overview of all utilized rivers

<i>River</i>	<i>Station</i>	<i>Coordinates</i>		<i>Catchment Area [km²]</i>	<i>Availability of Data</i>
Amazonas	Obidos	01.90 S	55.50 W	4640300	1928-1989
Amu-Darya	Chatly	42.28 N	59.70 E	450000	1931-1973
Amur	Komsomolsk	50.63 N	137.12 E	1730000	1933-1984
Angermanalven	Solleften	63.16 N	17.26 E	30640	1965-1984
Brahmaputra	Bahadurabad	25.18 N	89.67 E	636130	1969-1992
Brahmaputra	Pandu	26.13 N	91.70 E	405000	1956-1979
Bravo (R. Grande)	Matamoros	25.90 N	97.52 W	459902	1976-1979
Changjiang	Datong	30.77 N	117.62 E	1705383	1923-1986
Changjiang	Hankou	30.58 N	114.28 E	1488036	1865-1979
Changjiang	Yichang	30.66 N	111.23 E	1010000	1877-1983
Chari	N'Djamena	12.12 N	15.03 E	600000	1933-1991
Churchill	Granville Falls	56.15 N	100.45 W	230000	1966-1984
Colorado	Lees Ferry, Ariz.	36.87 N	111.58 W	289562	1911-1984
Colorado	Limite Internat. N.	32.72 N	111.72 W	631960	1976-1979
Colorado	Yuma, Ariz.	32.73 N	114.63 W	629100	1965-1975
Columbia	The Dallas, Oreg.	45.60 N	121.17 W	613830	1878-1988
Danube	Ceatal Izmail	45.18 N	28.80 E	807000	1921-1990
Danube	Orsova	44.70 N	22.42 E	576232	1840-1988
Don	Razdorskaya	47.50 N	40.67 E	378000	1891-1984
Ebro	Tortosa	40.82 N	00.52 E	84230	1913-1984
Elbe (Labe)	Decin	50.78 N	14.22 E	51104	1851-1984
Elbe (Labe)	Neu-Darchau	53.23 N	10.88 E	131950	1965-1988
Euphrates	Hit D.S.	33.83 N	42.72 E	264100	1964-1971
Fraser	Hope	49.38 N	121.45 W	217000	1912-1984
Ganges	Farakka	25.00 N	87.92 E	935000	1949-1973
Ganges	Hardinge Bridge				1985-1992
Ganges	Paksey	24.08 N	98.03 E	846900	1969-1975
Garonne	Mas D'Agenais	44.42 N	00.23 E	52000	1920-1979
Godavari	Polavaram	16.92 N	81.78 E	299320	1901-1979
Göta-Vänern	Vänersborg	58.38 N	12.32 E	46830	1807-1984
Guadalquivir	Alcala del Rio	37.52 N	05.98 W	46995	1913-1984
Guadiana	Pulo do Lobo	37.80 N	07.63 S	60683	1973-1984
Huanghe	Huayuankou	34.92 N	113.65 E	730036	1946-1988
Indigirka	Vorontsovo	69.58 N	147.35 E	305000	1937-1984
Indus	Attock	33.90 N	72.25 E	265122	1973-1979
Indus	Kotri	25.37 N	68.37 E	832418	1973-1979
Jenissei	Igarka	67.48 N	86.50 E	2440000	1936-1984
Kolyma	Kolymkaya	68.73 N	158.72 E	526000	1978-1988
Kolyma	Sredne-Kolymsk	67.37 N	153.67 E	361000	1927-1984
Lake Victoria	Oyea Res.	00.46 N	33.11 E	269000	1973-1982

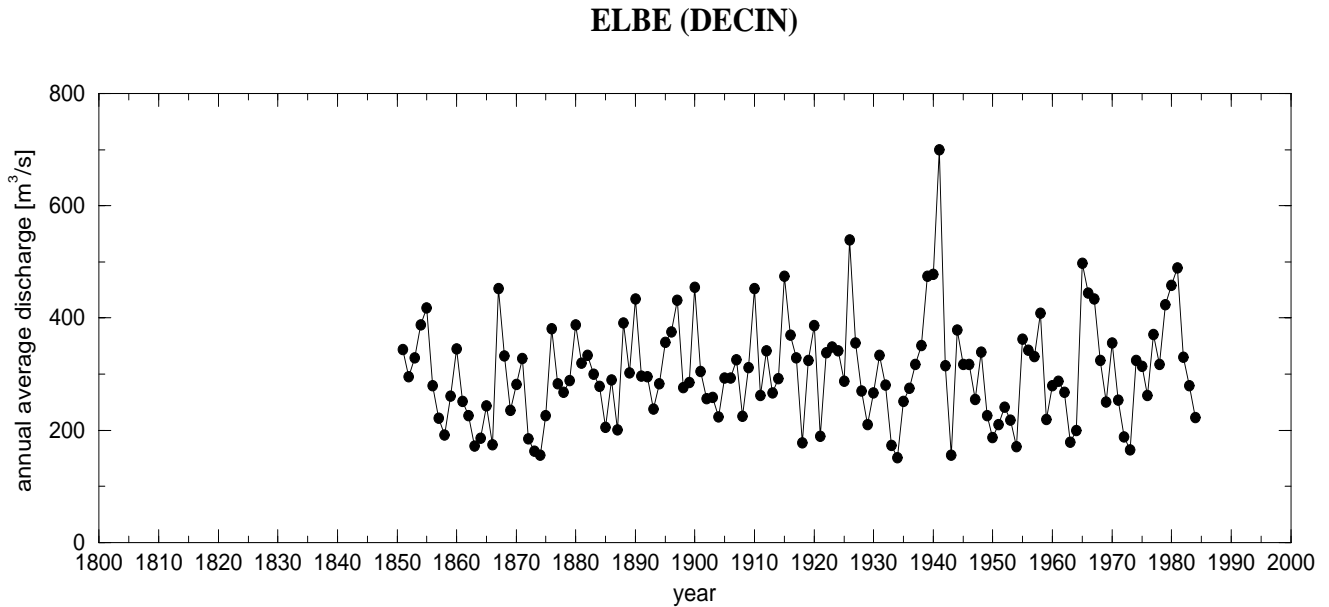
<i>River</i>	<i>Station</i>	<i>Coordinates</i>		<i>Catchment Area [km²]</i>	<i>Availability of Data</i>
Lena	Kusur	70.70 N	127.65 E	2430000	1935-1984
Limpopo	Chokwe	24.50 S	33.00 E	342000	1976-1979
Loire	Montjan	47.38 N	00.83 W	110000	1863-1979
Lulealven	Boden Waterworks	65.83 N	21.61 E	24490	1965-1984
Mackenzie River	Arctic Red River	67.46 N	133.74 W	1660000	1972-1992
Mackenzie River	Near Fort Provid.	61.27 N	117.53 W	970000	1966-1975
Mackenzie River	Norman Wells	65.28 N	126.85 W	1570000	1966-1984
Magdalena	Calamar	10.26 N	74.91 W	257438	1971-1979
Mekong	Mukdahan	16.53 N	104.73 E	391000	1947-1987
Mekong	Pakse	15.12 N	105.80	545000	1980-1991
Mississippi	Alton, Ill.	38.88 N	90.18 W	444185	1927-1984
Mississippi	Tarbert Landing	31.02 N	91.62 W	3923799	1965-1984
Mississippi	Vicksburg	32.31 N	90.90 W	2964254	1965-1982
Missouri	Herman, Mont.	38.72 N	91.43 W	1357677	1897-1988
Murray	Lock 9 Upper	34.18 S	141.60 E	991000	1965-1984
Nelson River	Above Bladder R.	54.77 N	97.92 W	1000000	1966-1984
Neman	Smalininkai	55.02 N	22.52 E	81200	1812-1984
Neva	Novosaratovka	59.80 N	30.72 E	281000	1859-1984
Niagara	Queenston	43.15 N	79.05 W	686000	1860-1984
Niger	Gaya	11.88 N	03.40 E	1000000	1952-1990
Niger	Koulikoro	12.87 N	07.55 E	120000	1907-1988
Niger	Malanville	11.87 N	03.38 E	1000000	1952-1992
Nile	Aswan Dam	23.96 N	32.90 E	1900000	1869-1984
N. Saskatchewan	Prince Albert	53.20 N	105.77 W	131000	1910-1984
Northern Dvina	Ust-Pinega	64.10 N	42.17 E	348000	1881-1985
Ob	Salekhard	66.57 N	66.53 E	2950000	1930-1984
Odra	Gozdowice	52.77 N	14.32 E	109729	1900-1987
Ohio	Metropolis , Ill.	37.15 N	88.73 W	525770	1928-1984
Oranje	Aliwal North	30.68 S	26.71 E	37075	1964-1986
Oranje	Violsdrif	28.76 S	17.73 E	850530	1964-1986
Orinoco	Puente Angostura	08.15 S	63.59 W	836000	1923-1989
Parana	Corrientes	27.97 S	58.85 W	1950000	1904-1983
Parana	Guaria	24.07 S	54.25 W	802200	1920-1979
Petchora	Ust-Tsilma	65.47 N	52.25 E	248000	1932-1984
Po	Pontelagoscuro	44.88 N	11.65 E	70091	1918-1979
Red River	Alexandria, Lous.	31.31 N	92.45 W	174825	1928-1982
Red River	Emerson	49.00 N	97.22 W	104000	1912-1984
Rhein	Rees	51.78 N	06.58 E	159680	1939-1984
Rhone	Beaucaire	43.92 N	4.67 E	95590	1920-1979
Rhone	Givors	45.58 N	04.80 E	51080	1973-1979
Rhone	La Mulatiere	45.75 N	04.83 E	50200	1900-1972
Rio Grande	Laredo, Texas	27.50 N	99.50 W	352178	1900-1972
Sao Francisco	Juazeiro	09.42 S	40.52 W	510800	1929-1979
Sao Francisco	Traipu	09.96 S	36.98 W	622600	1977-1979
Seine	Paris	48.83 N	02.27 E	44300	1928-1979

<i>River</i>	<i>Station</i>	<i>Coordinates</i>		<i>Catchment Area [km²]</i>	<i>Availability of Data</i>
Selenga	Mostovoy	52.00 N	107.33 E	440200	1980-1991
Senegal	Bakel	14.90 N	12.45 E	218000	1904-1984
Senegal	Dagana	16.52 N	15.50 W	268000	1903-1974
Shebele (Jubba)	Afgoi	02.17 N	45.09 E	278000	1951-1978
Snake	Clarkston, Wash.	46.43 N	117.17 W	267300	1915-1972
S. Saskatchewan	Saskatoon	52.13 N	106.65 W	141000	1911-1984
St. Lawrence	Cornwall, Ont.	45.00 N	74.78 W	774410	1966-1984
St. Lawrence	Ogdensburg, N.Y.	44.70 N	75.50 W	764600	1860-1972
Susquehanna	Harrisburg, Pa.	40.25 N	76.88 W	62419	1890-1987
Syr-Darya	Tyumen-Aryk	44.05 N	67.05 E	219000	1930-1984
Tejo	Almourol	39.45 N	8.37 W	67490	1976-1984
Tejo	V.V. de Rodao	39.66 N	7.67 W	59267	1913-1968
Tocantins	Itupiranga	05.13 S	49.35 W	727900	1976-1981
Ural	Kushum	50.85 N	51.28 E	190000	1915-1984
Uruguay	Concordia	31.95 S	58.04 W	249312	1969-1979
Volga	Volgograd	48.77 N	44.72 E	1360000	1879-1984
Volta	Senchi	06.20 N	00.10 E	394100	1936-1979
Vuoksi	Imatra	61.15 N	28.77 E	61275	1847-1984
Western Dvina	Daugavpils	55.88 N	26.68 E	64600	1965-1984
White Nile	Jebel Aulia Dam	15.23 N	32.50 E		1973-1982
White Nile	Malakal	09.58 N	31.62 E	1080000	1912-1982
Wisla (Vistula)	Tczew	54.10 N	18.82 E	194376	1900-1987
Xun Jiang, Pearl R.	Wuzhou	23.48 N	111.30 E	329705	1915-1984
Yukon	Pilot Station	61.93 N	162.88 W	831390	1975-1993
Zaire	Kinshasa	04.30 S	15.30 E	3475000	1903-1983
Zambeze	Matundo-Cais	16.15 S	33.58 E	940000	1976-1979

35 of the largest catchments of the world at 0.5 degree resolution

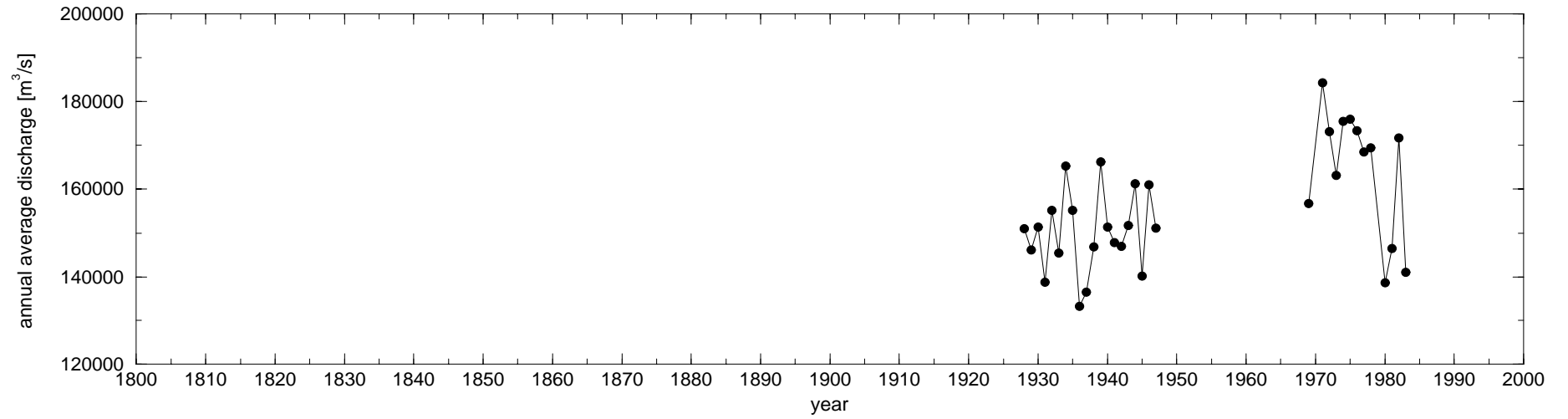


2. Time series

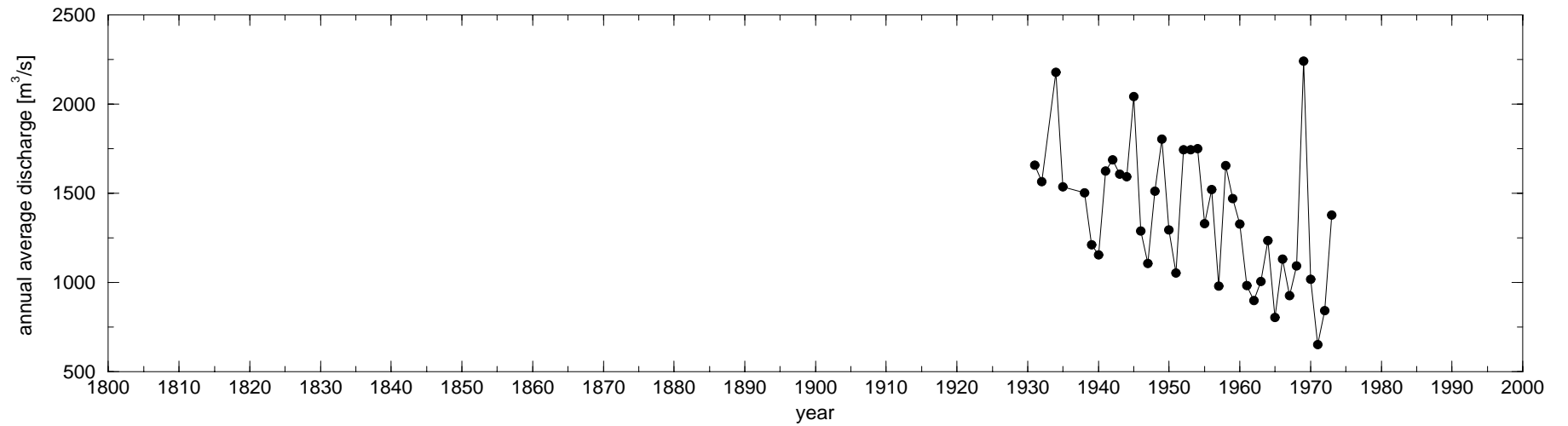


This section shows the observations as time series of annual mean discharge. In the following figures, all time series are displayed for the same time range of 1800 – 2000, because the earliest data were measured 1806 in Vänern for the Göta Vänern river and the most recent data of some rivers are from the early 1990s. The time series for individual rivers generally represent interannual and decadal variability. In some cases the variation in time is subdued by river regulation.

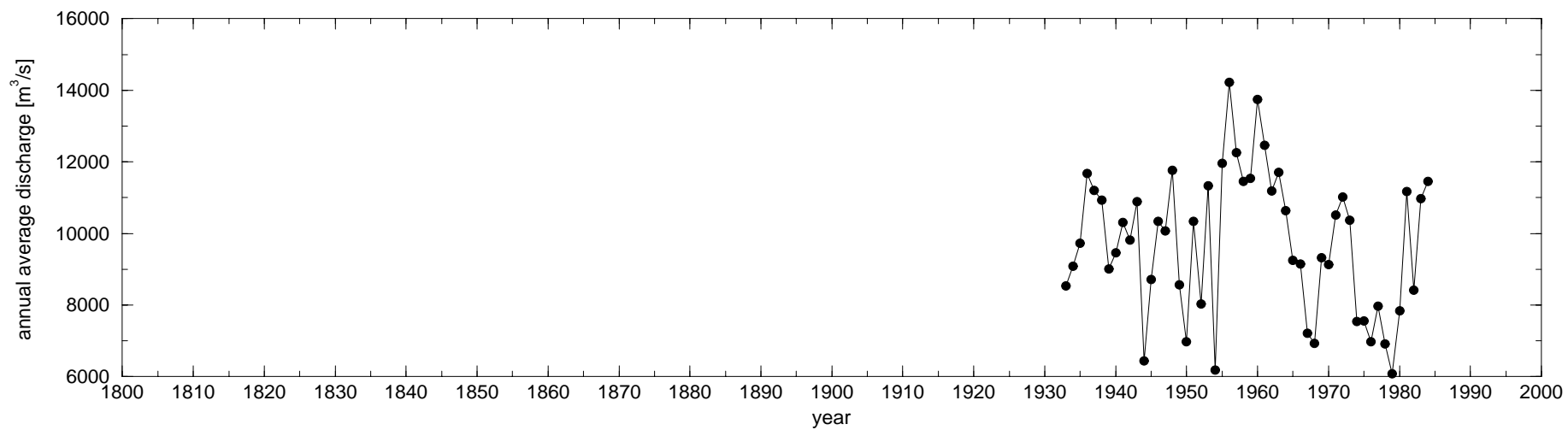
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AMU-DARYA (CHATLY)

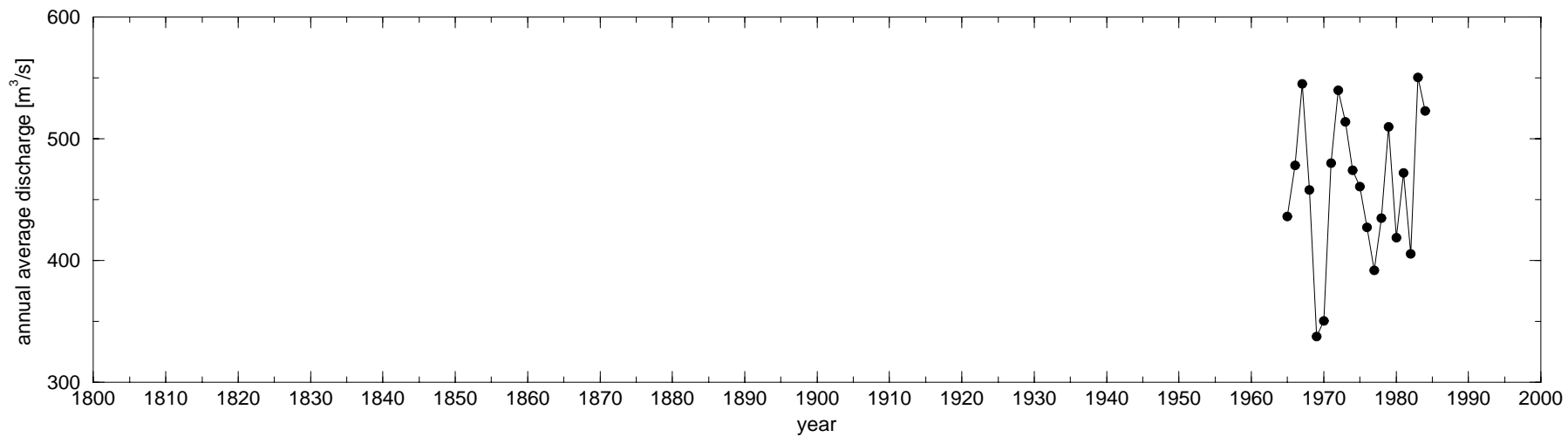


AMUR (KOMSOMOLSK)

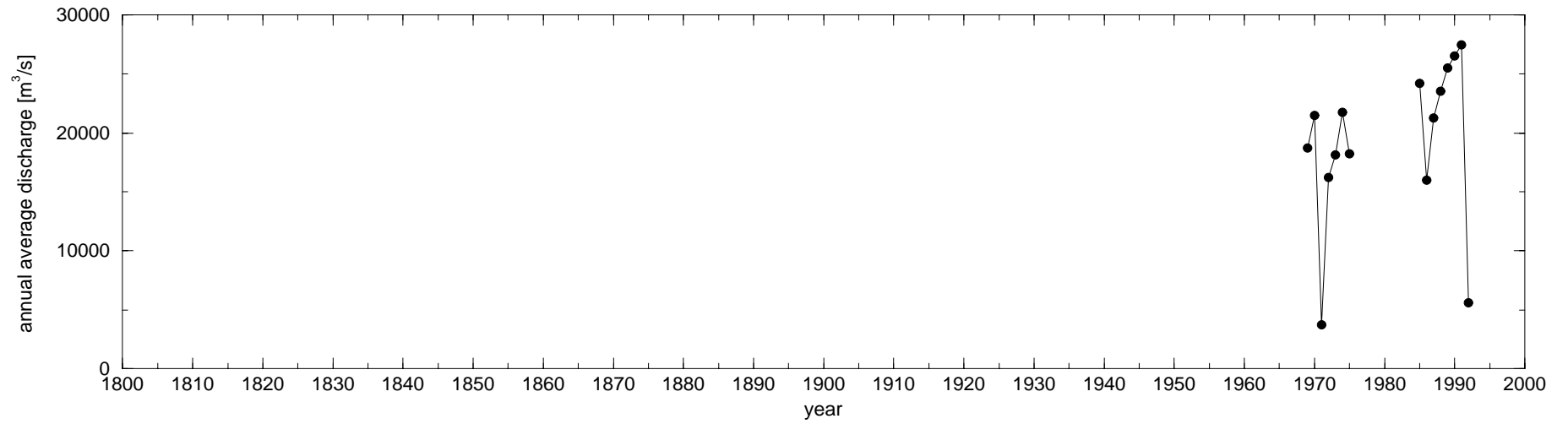


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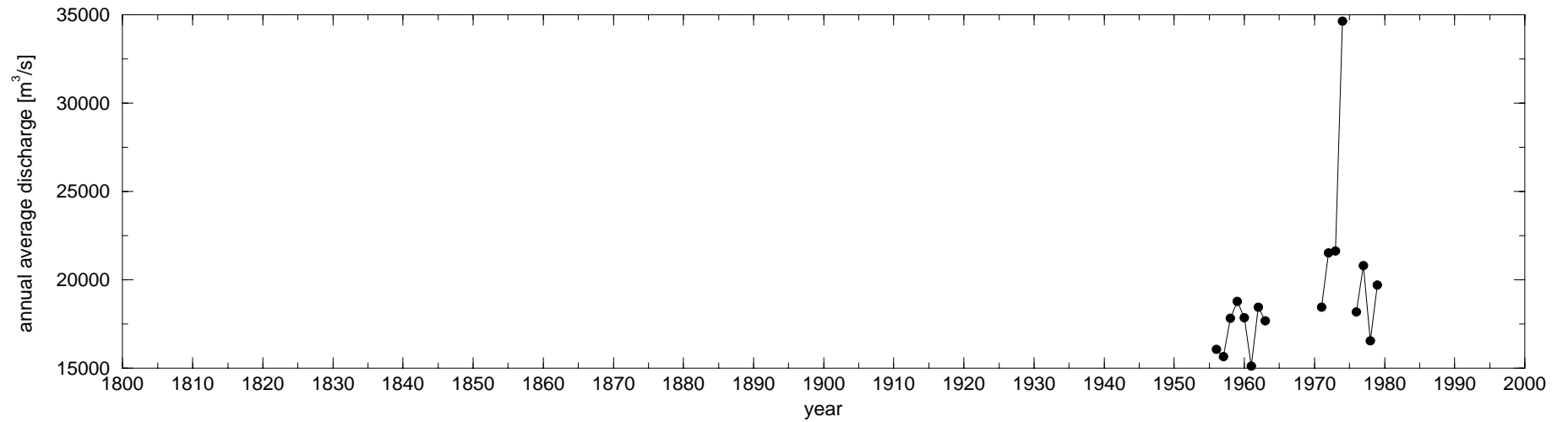
ANGERMANALVEN (SOLLEFTEN)



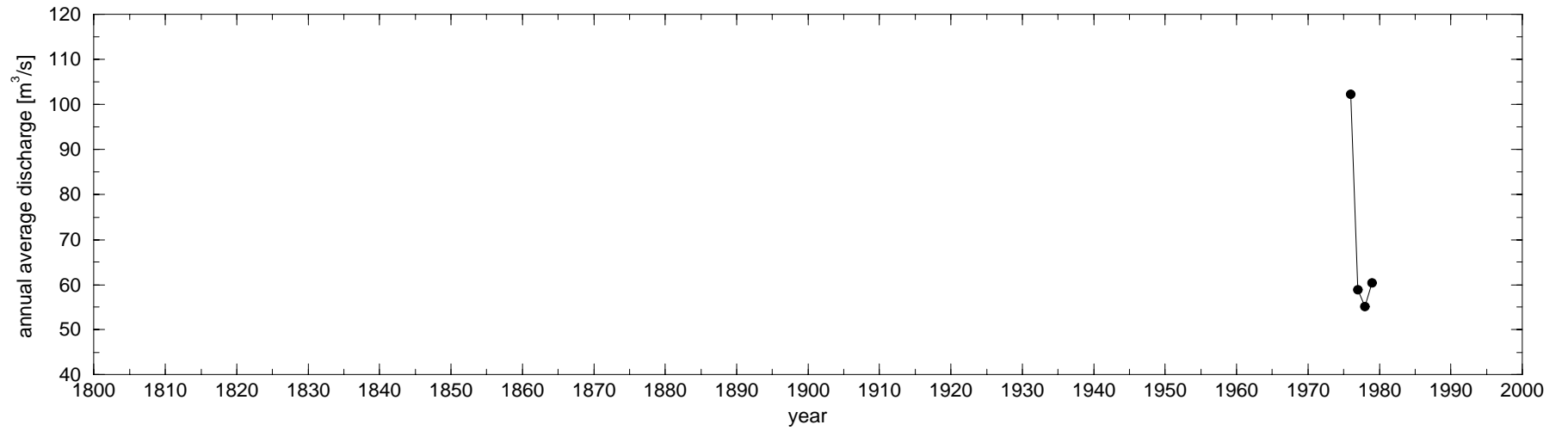
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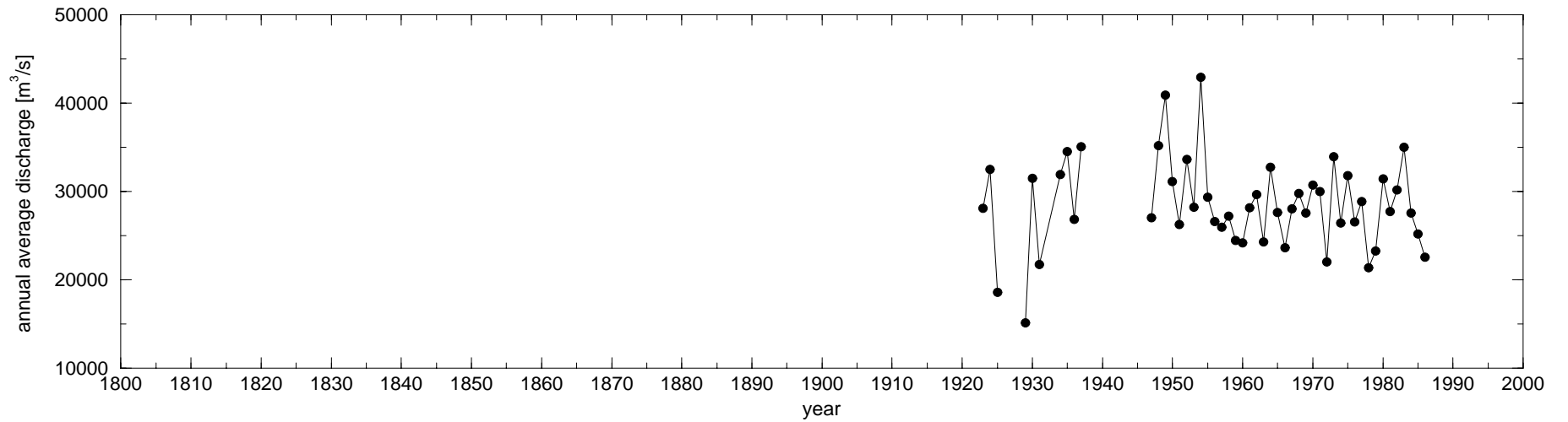
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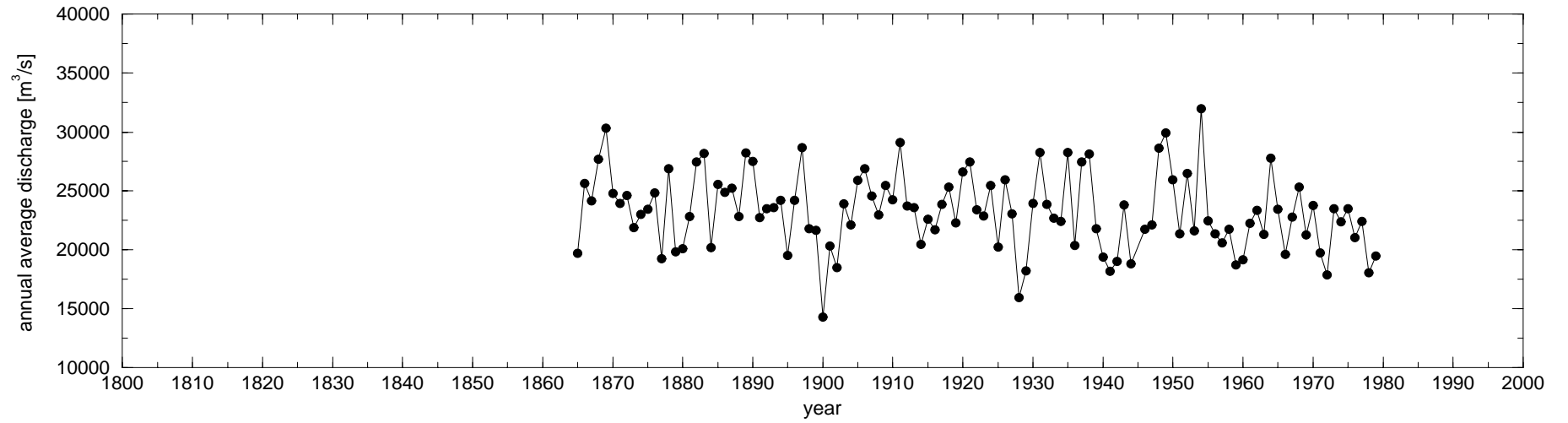
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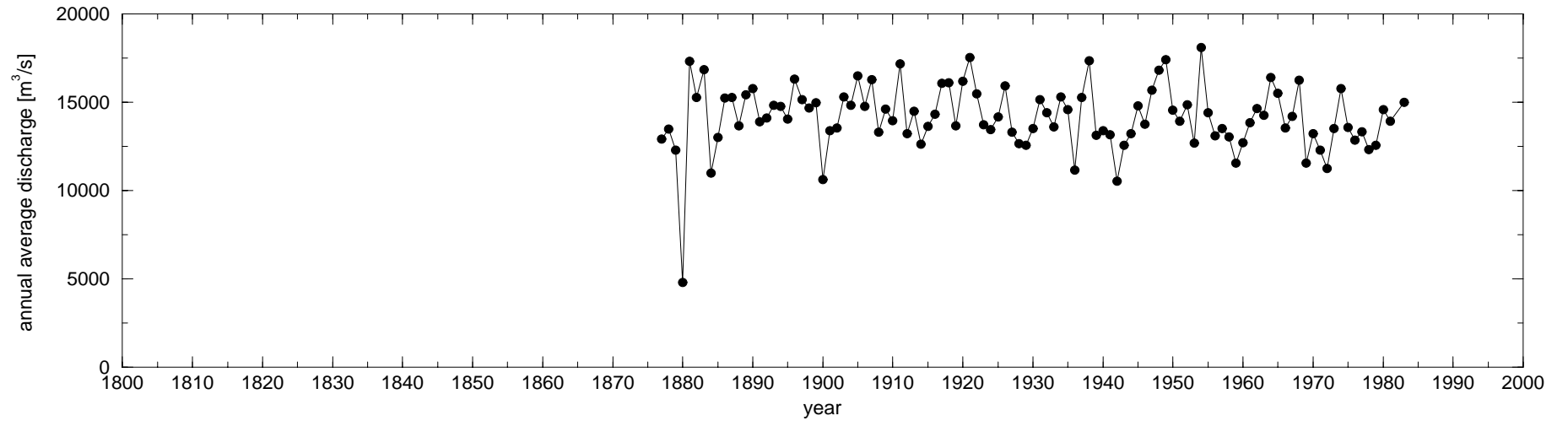
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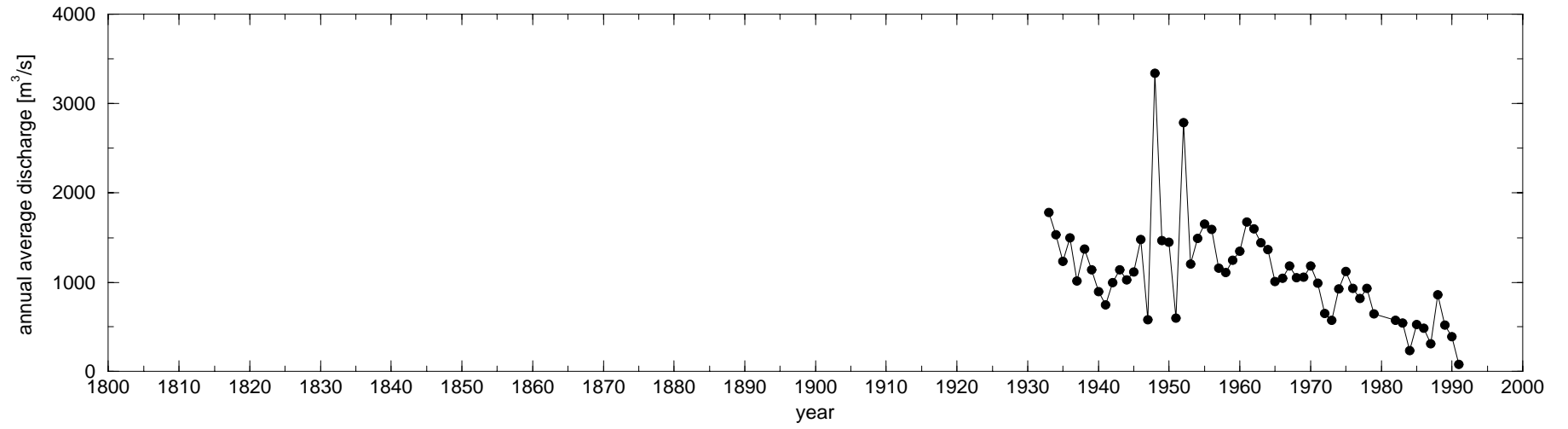
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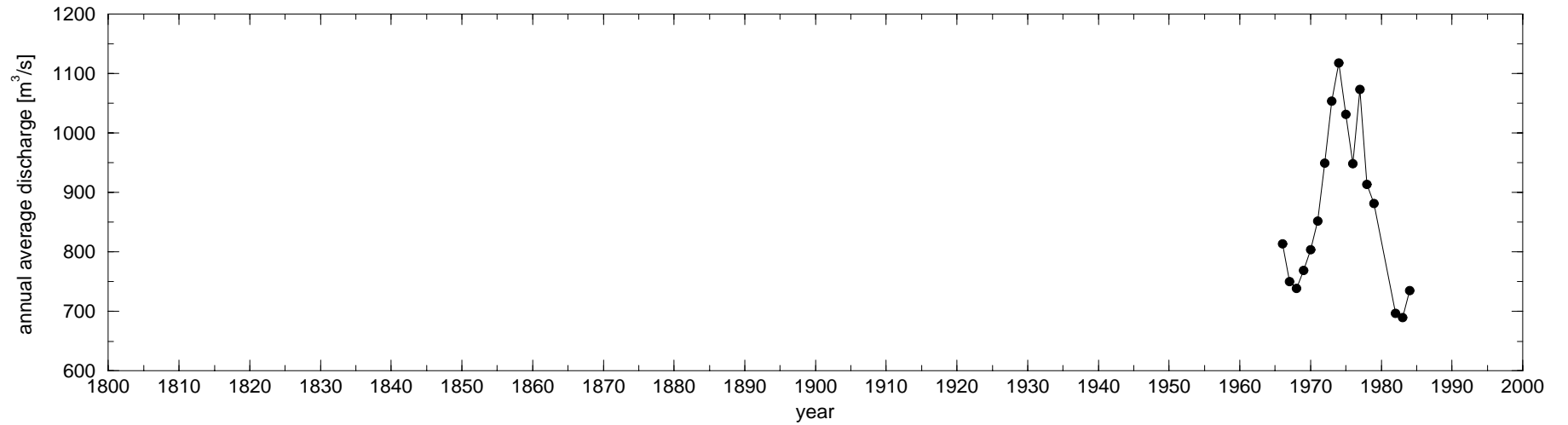
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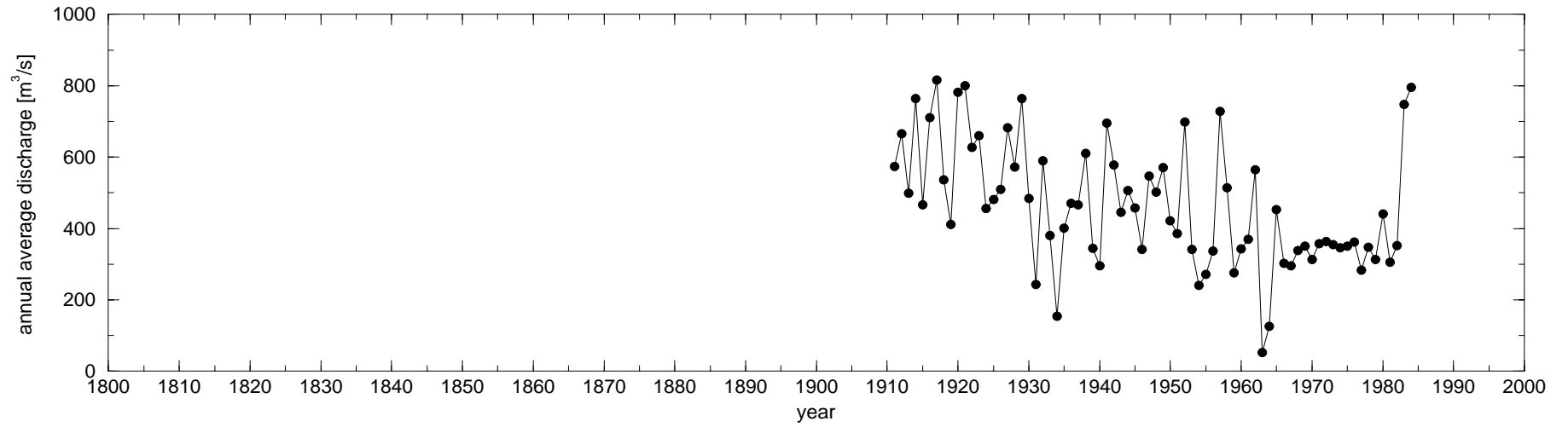
CHARI (N'DJAMENA)



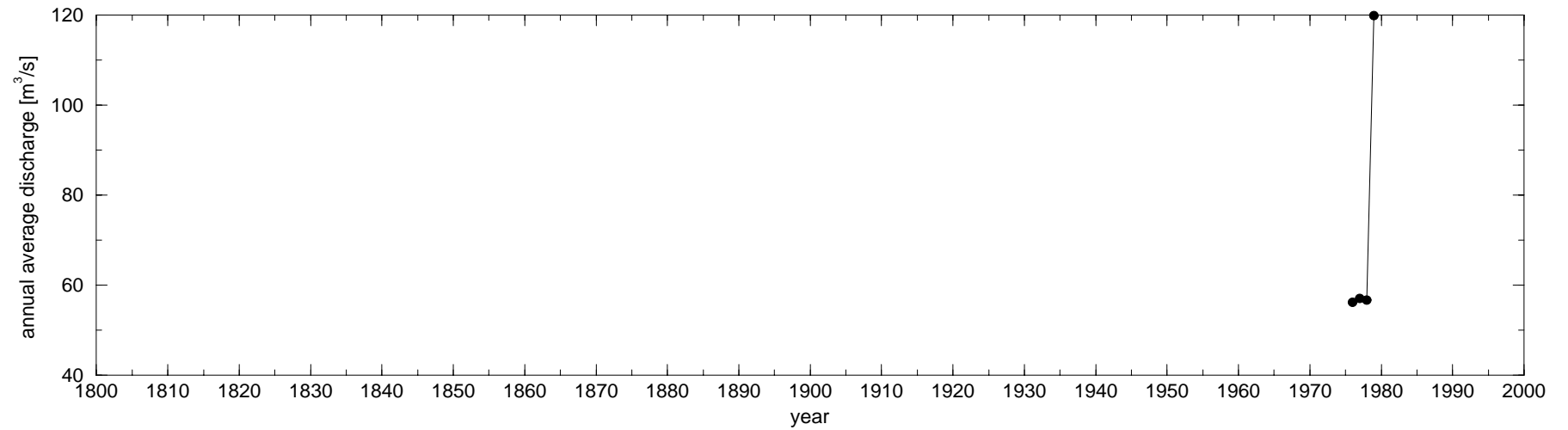
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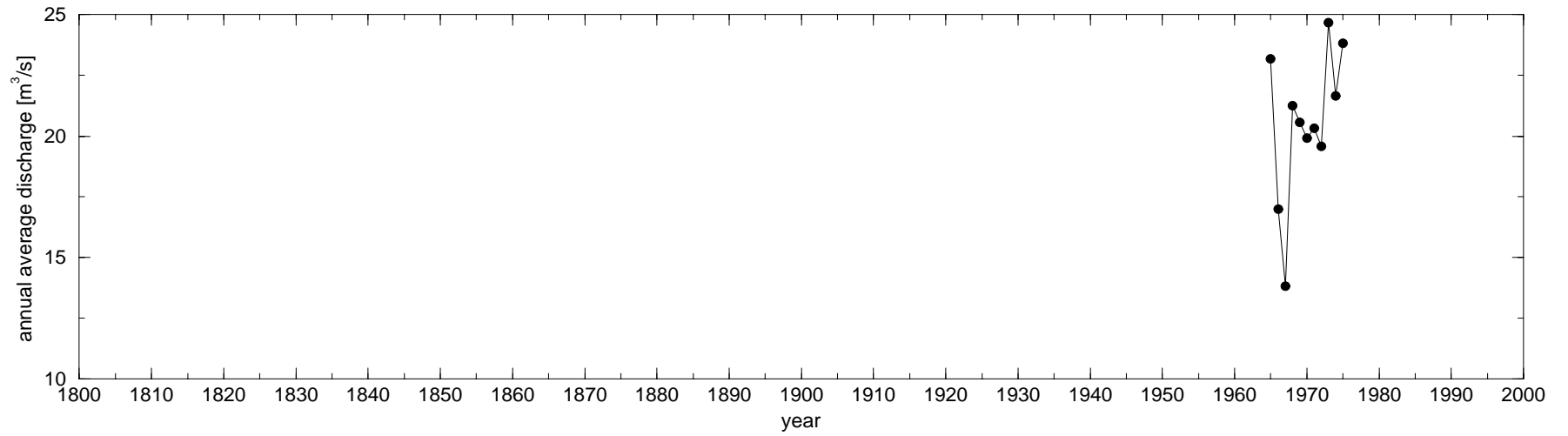
COLORADO (LEES FERRY, ARIZ.)



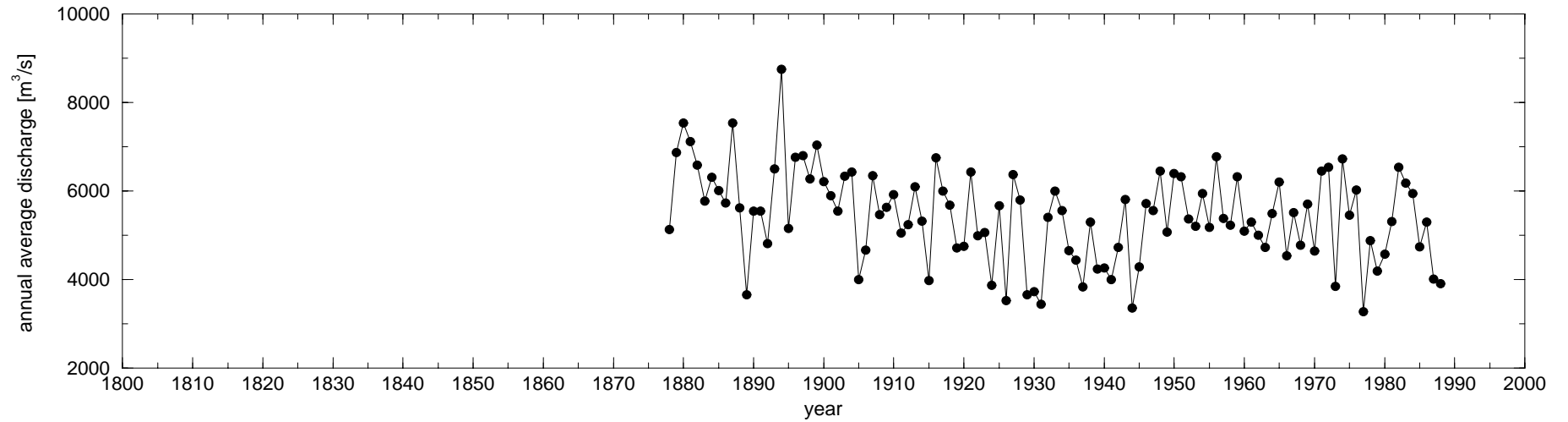
COLORADO (LIMITE INTERNACIONAL NORTE)



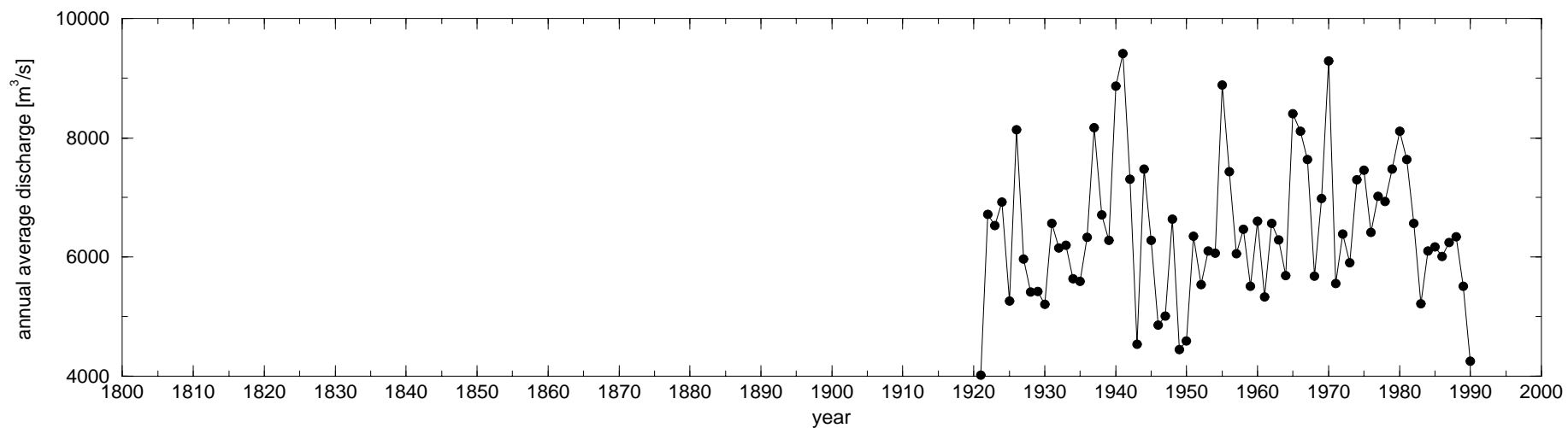
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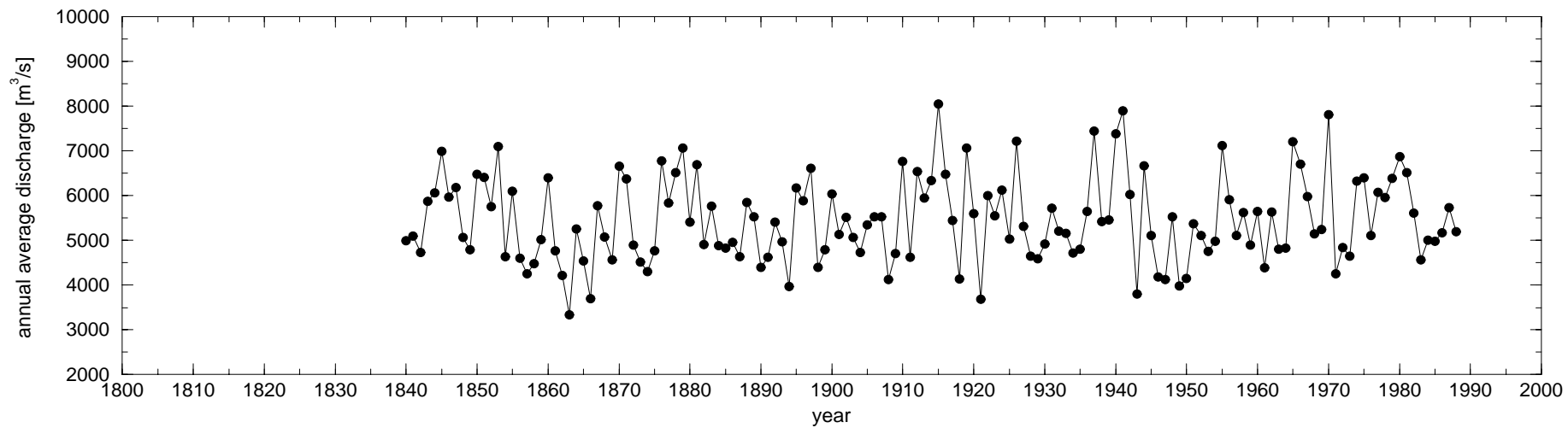
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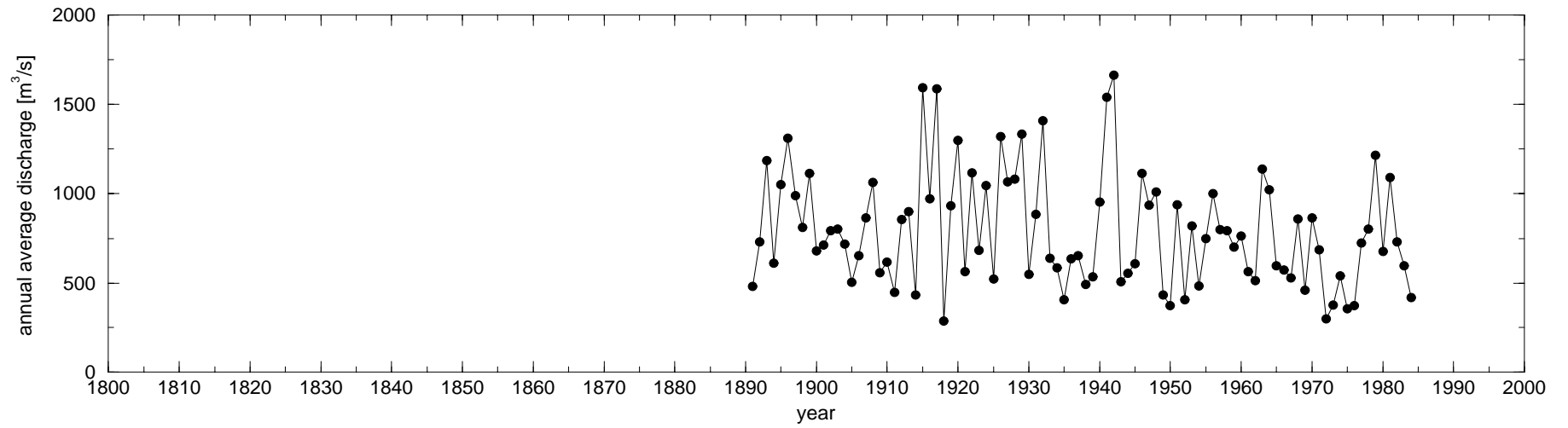
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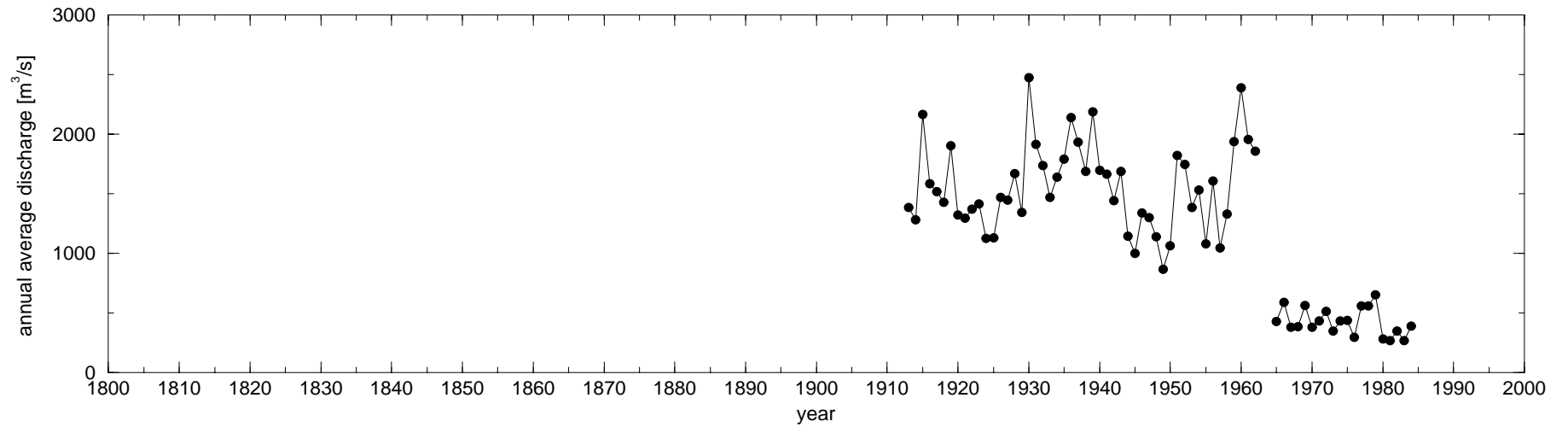
DANUBE (ORSOVA)



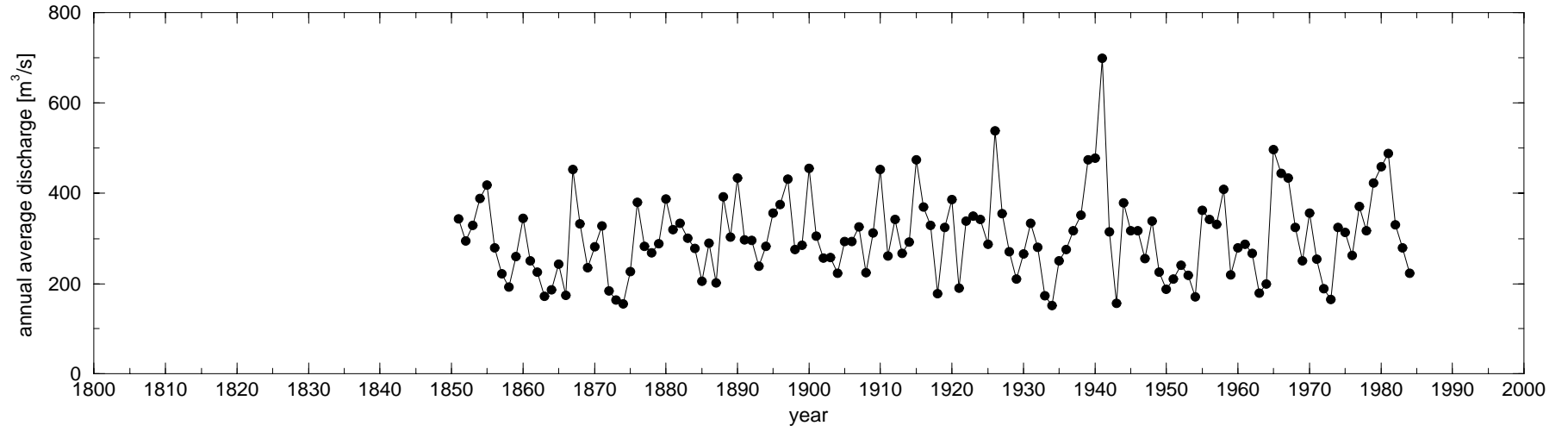
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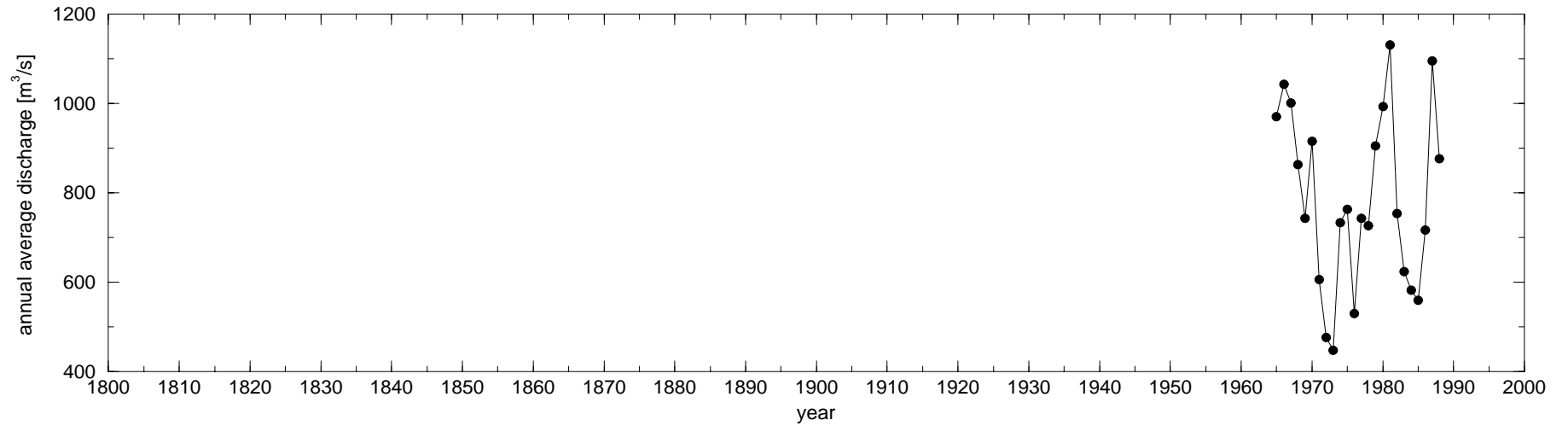
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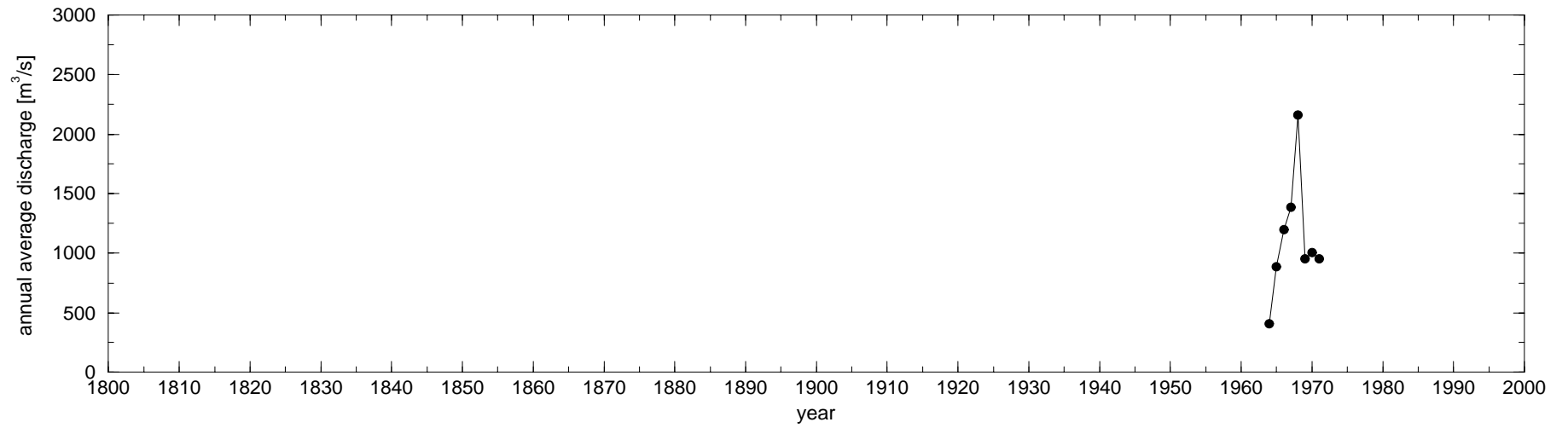
ELBE (DECIN)



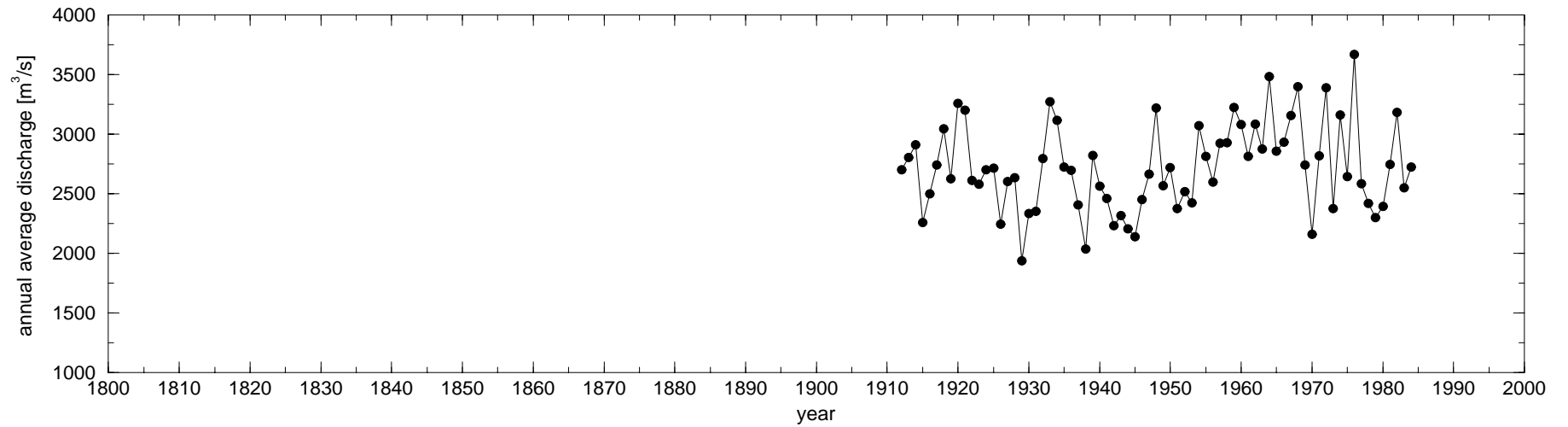
ELBE (NEU-DARCHAU)



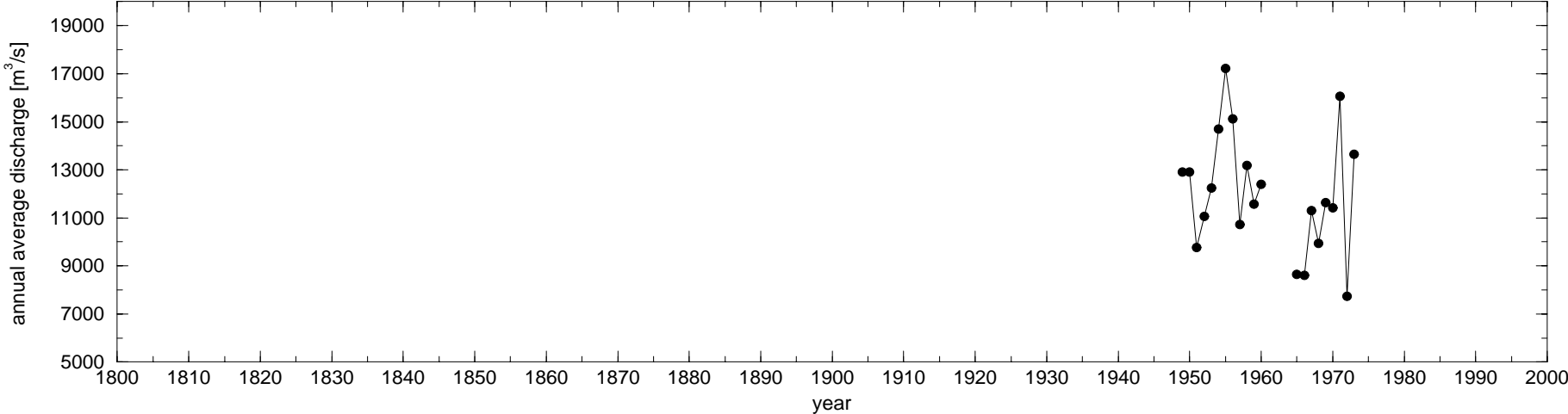
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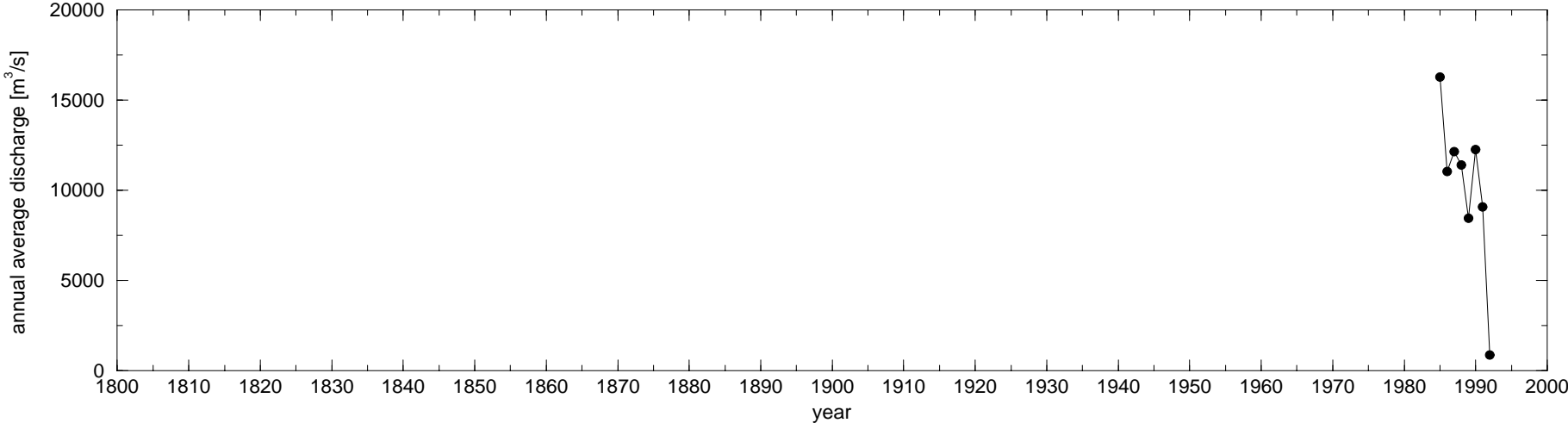
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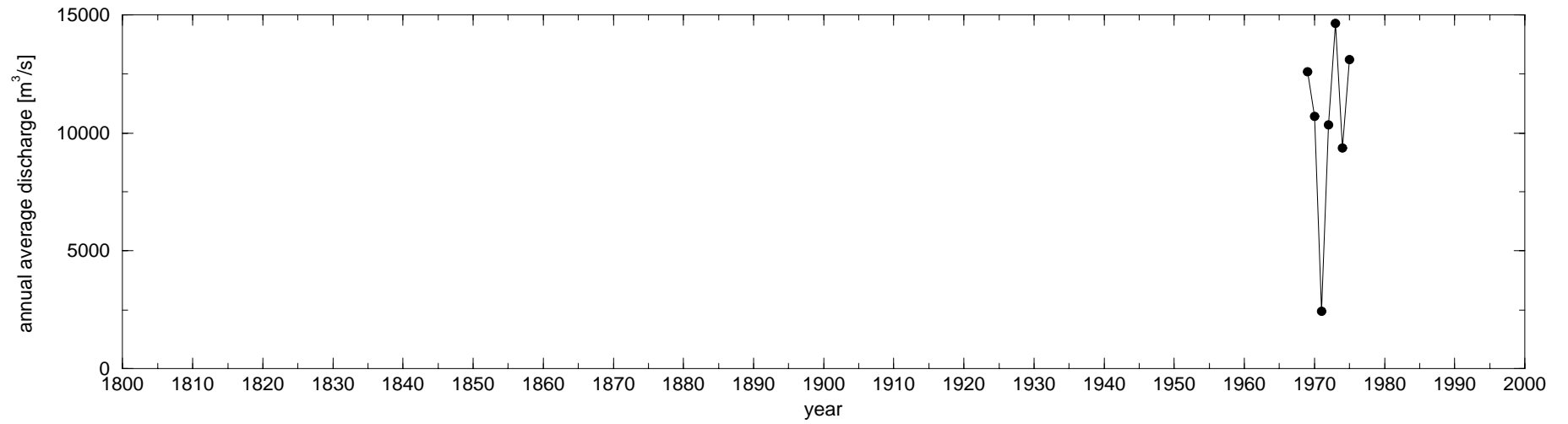
GANGES (FARAKKA)



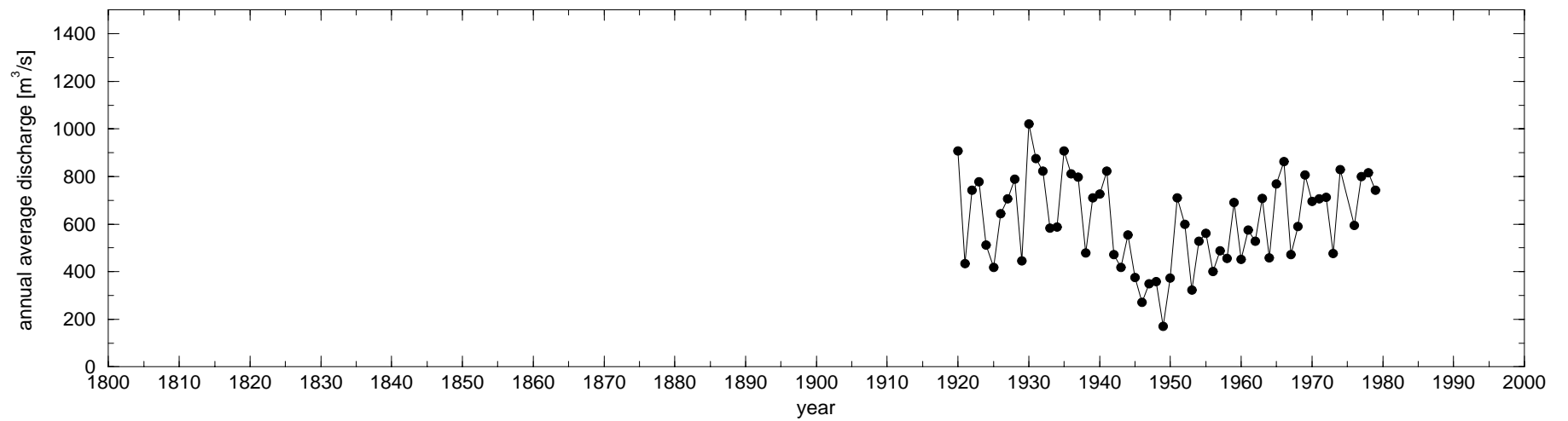
GANGES (HARDINGE BRIDGE)



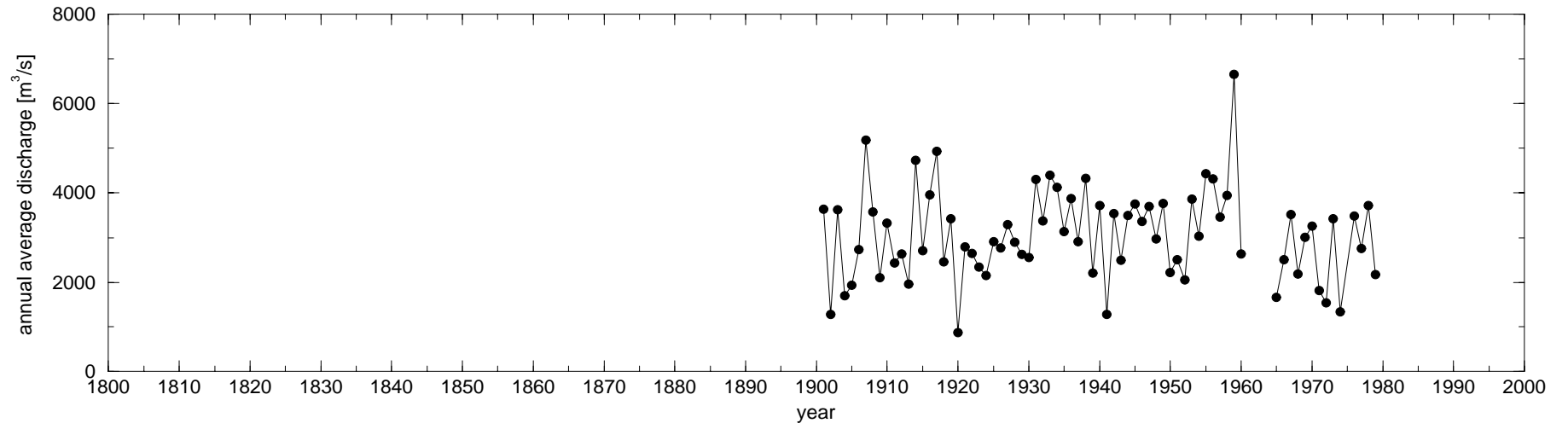
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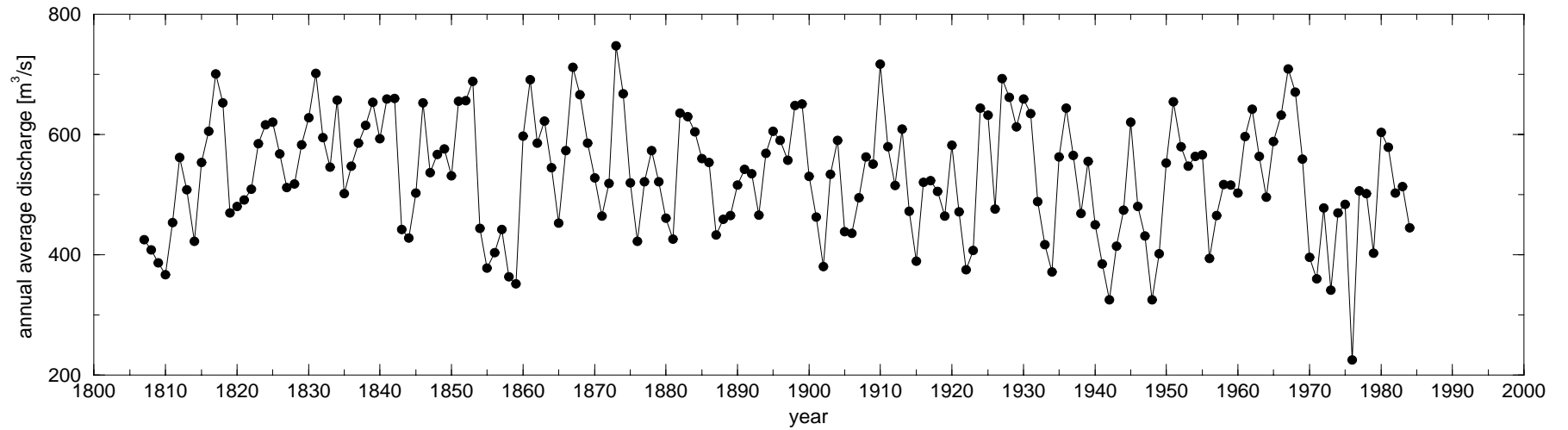
GARONNE (MAS D'AGENAI)



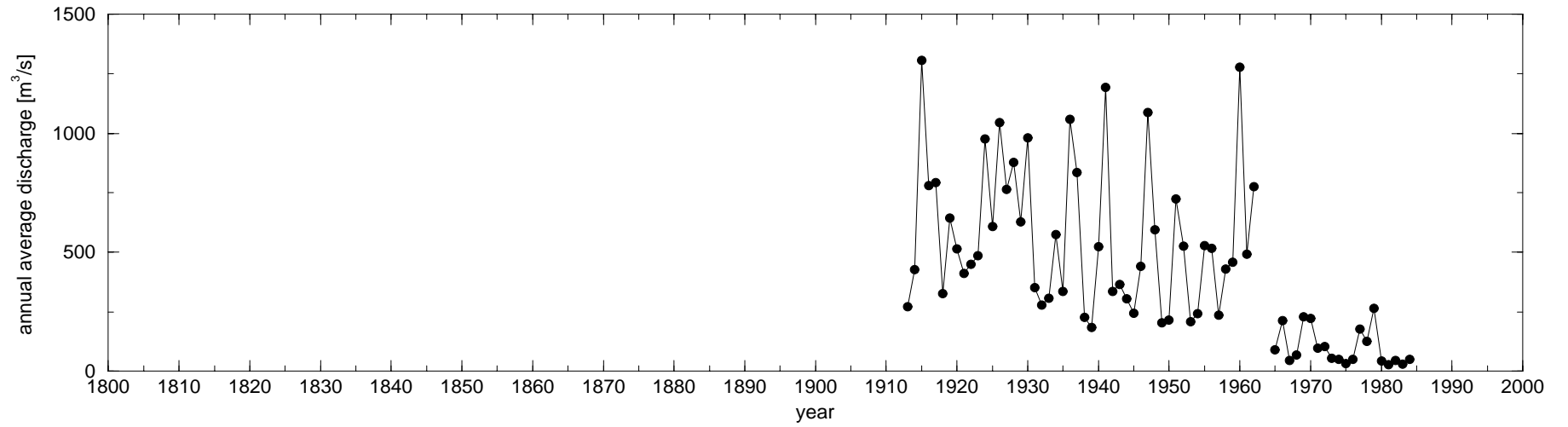
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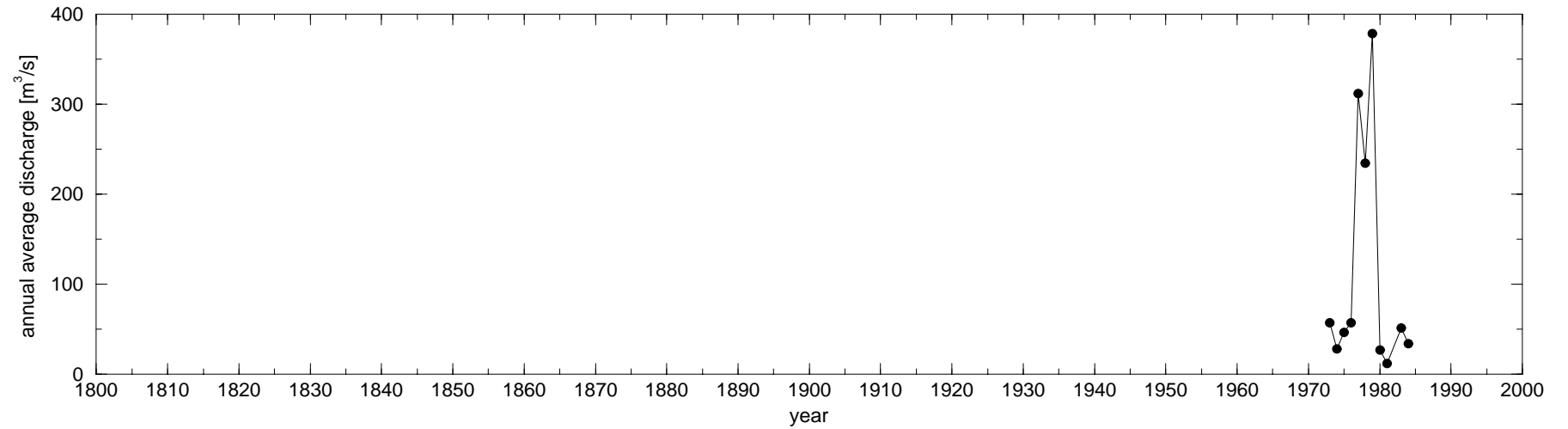
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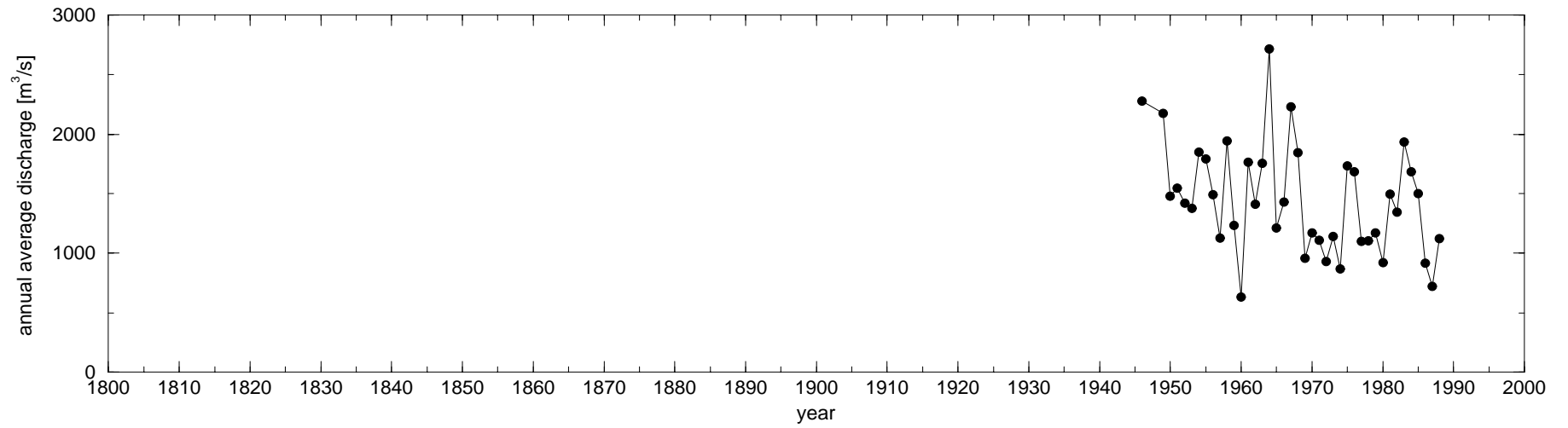
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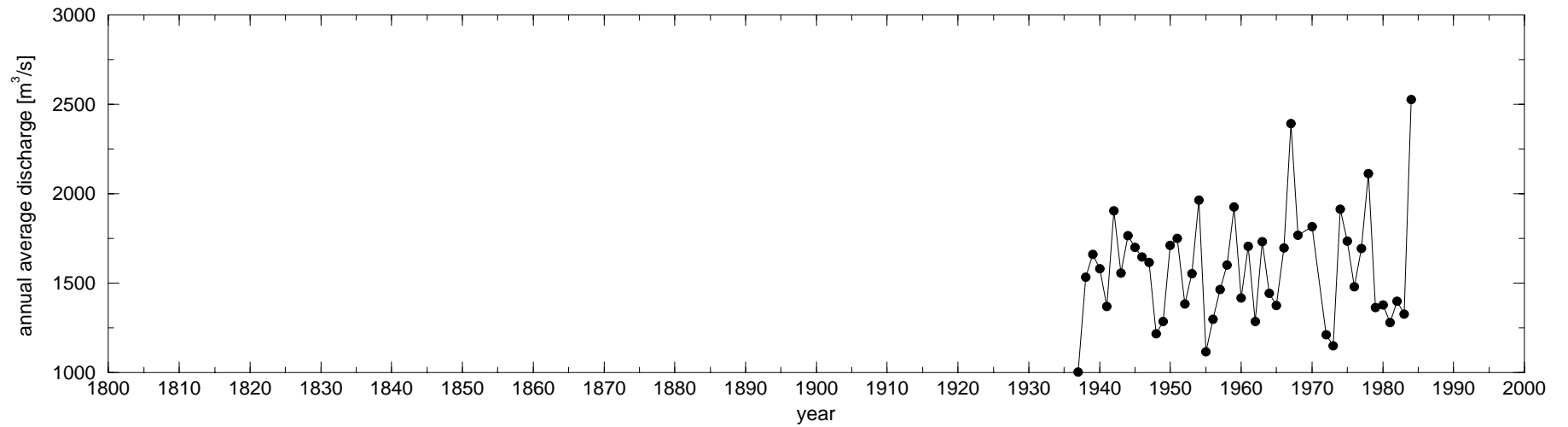
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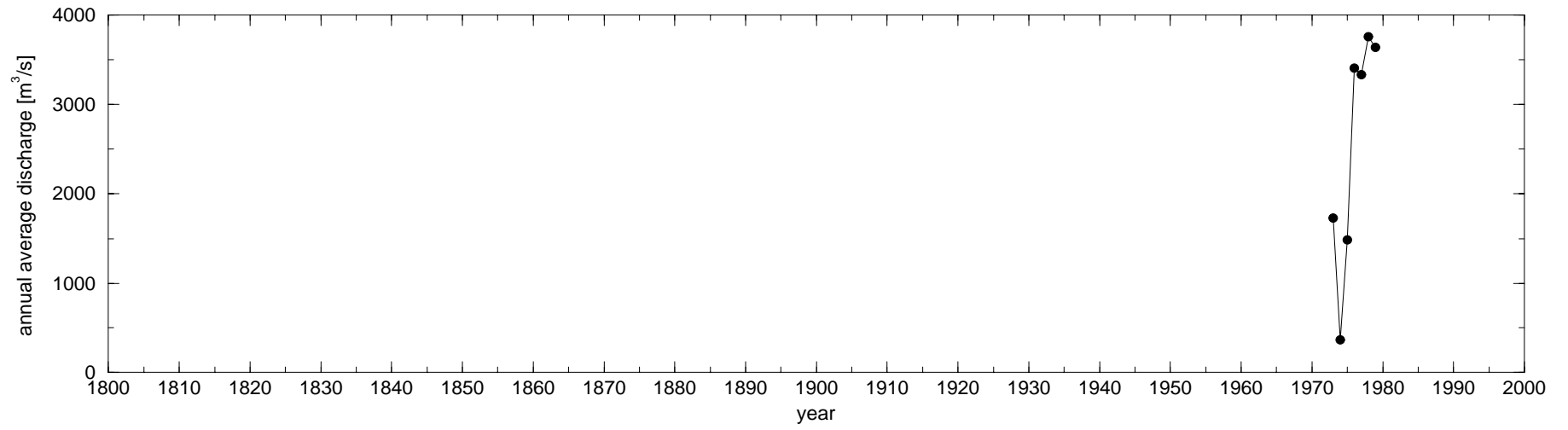
HUANGHE (HUAYUANKOU)



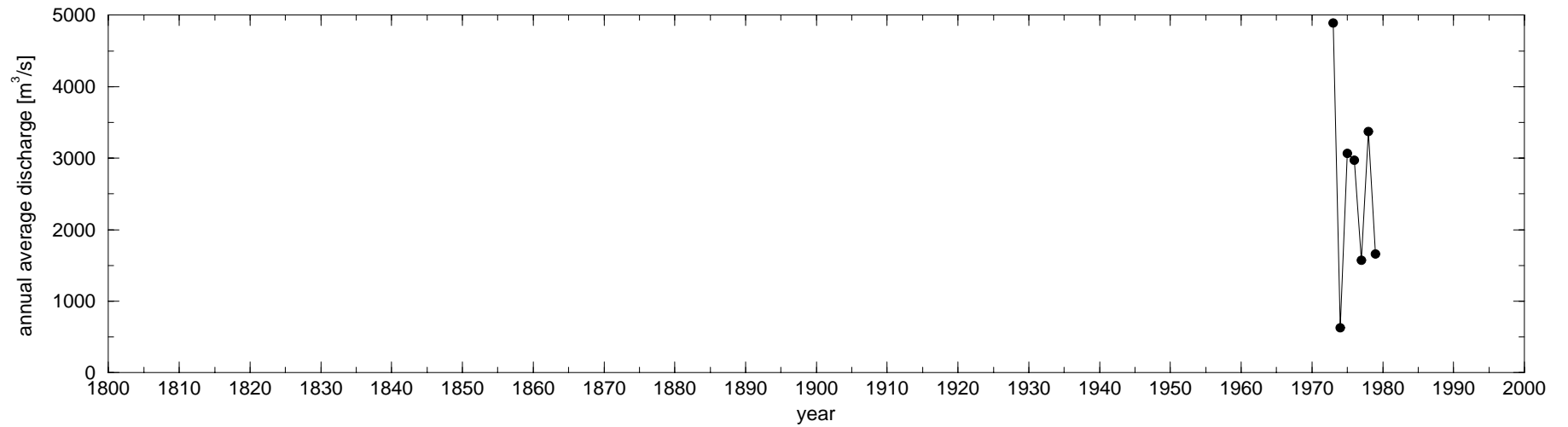
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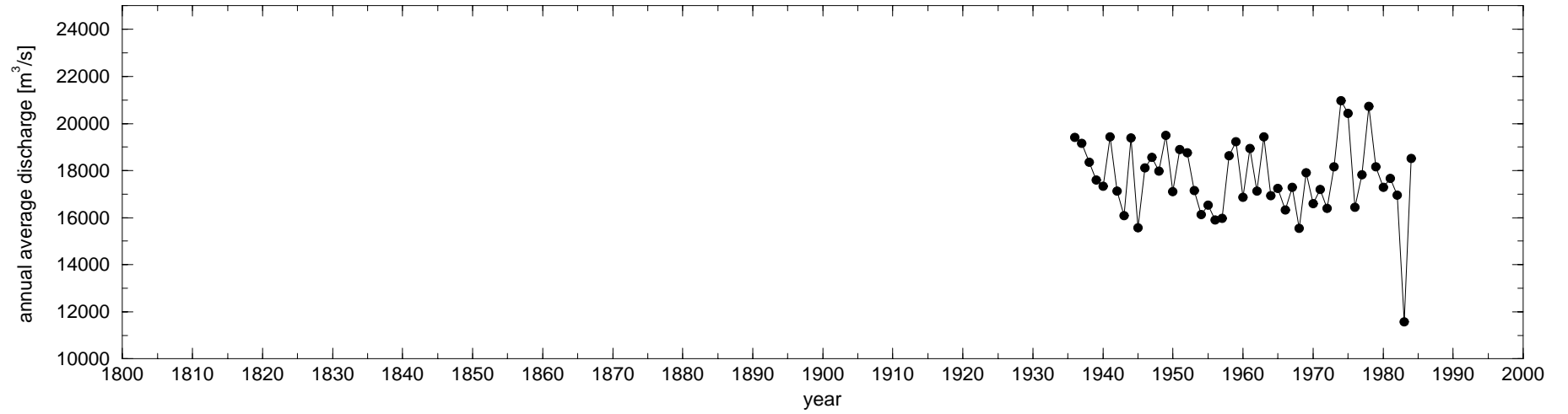
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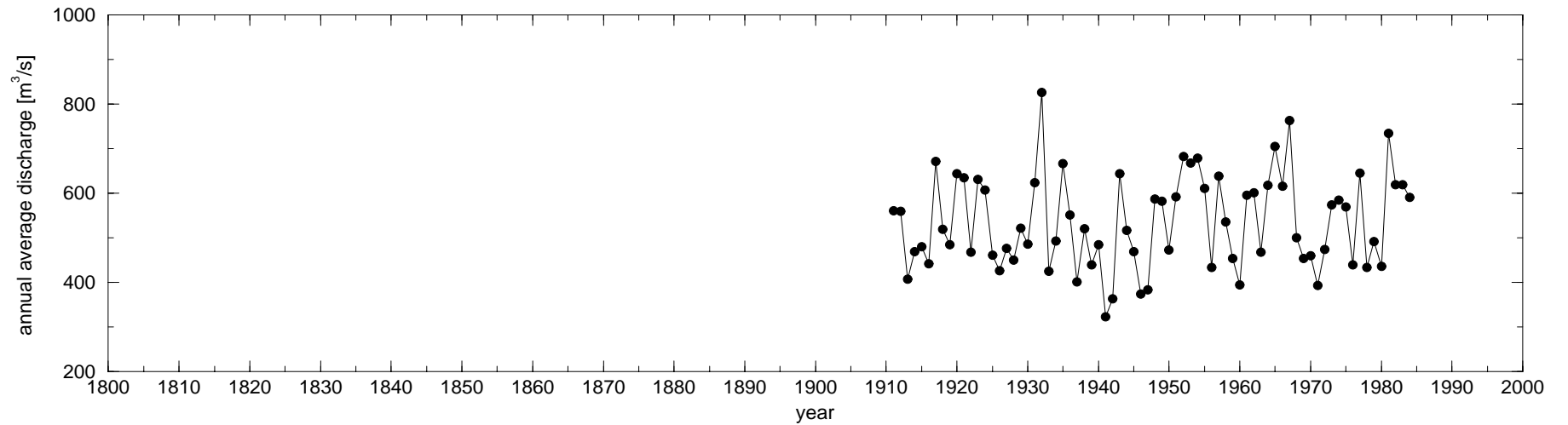
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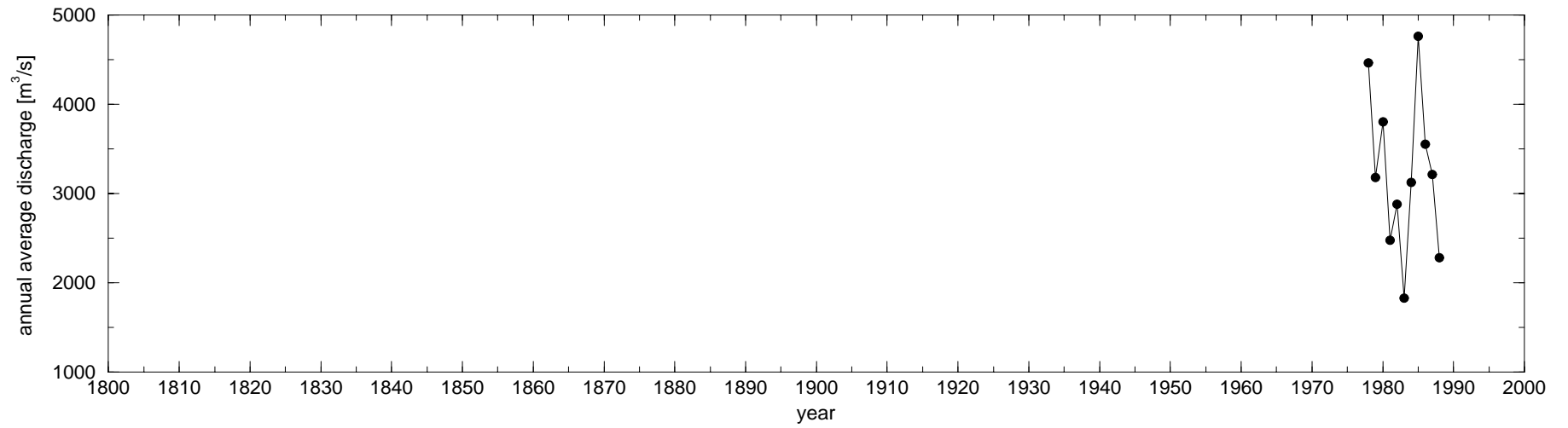
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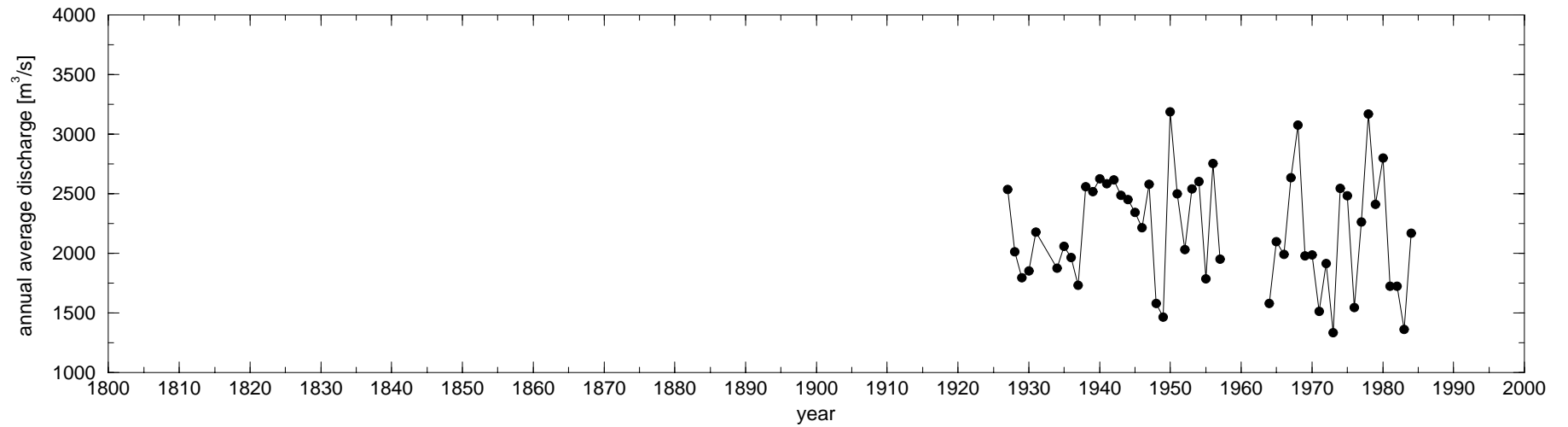
KEMI (TAIVALKOSKI)



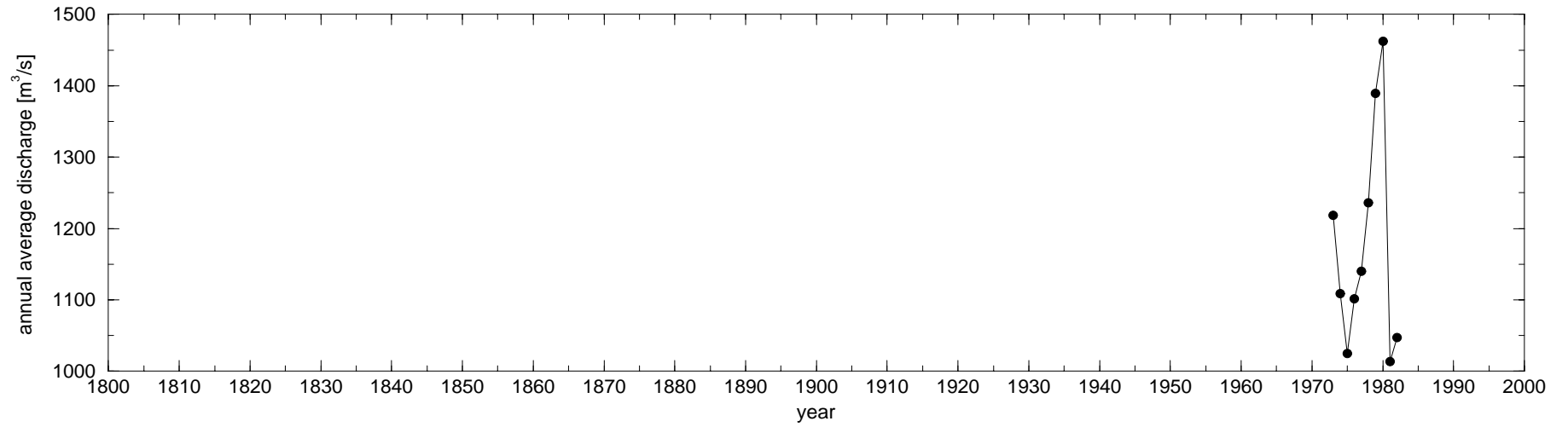
KOLYMA (KOLYMSKAYA)



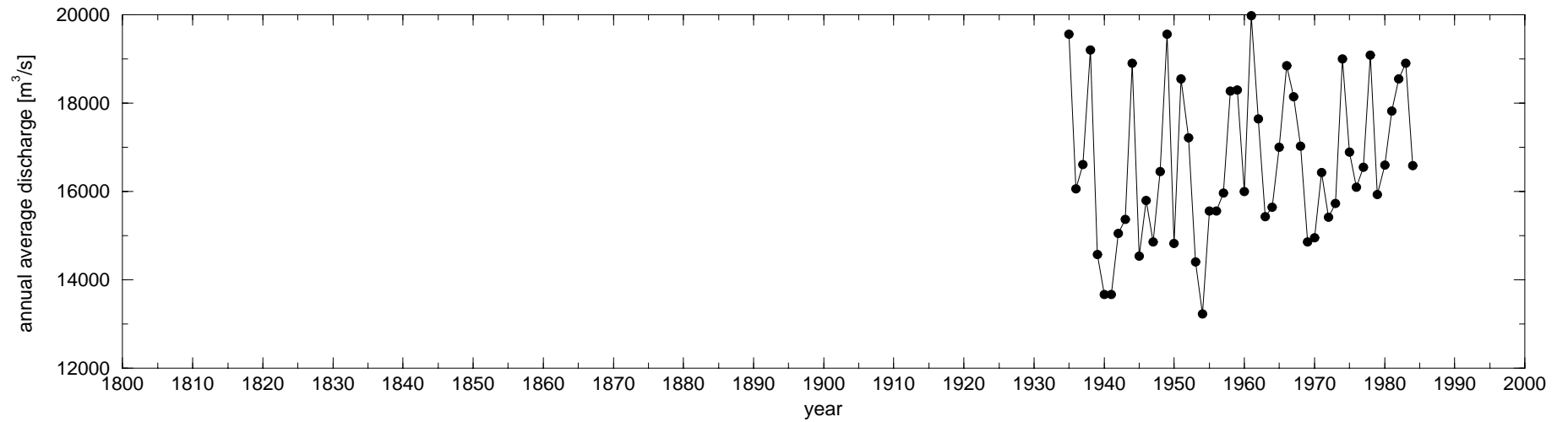
KOLYMA (SREDNE-KOLYMSK)



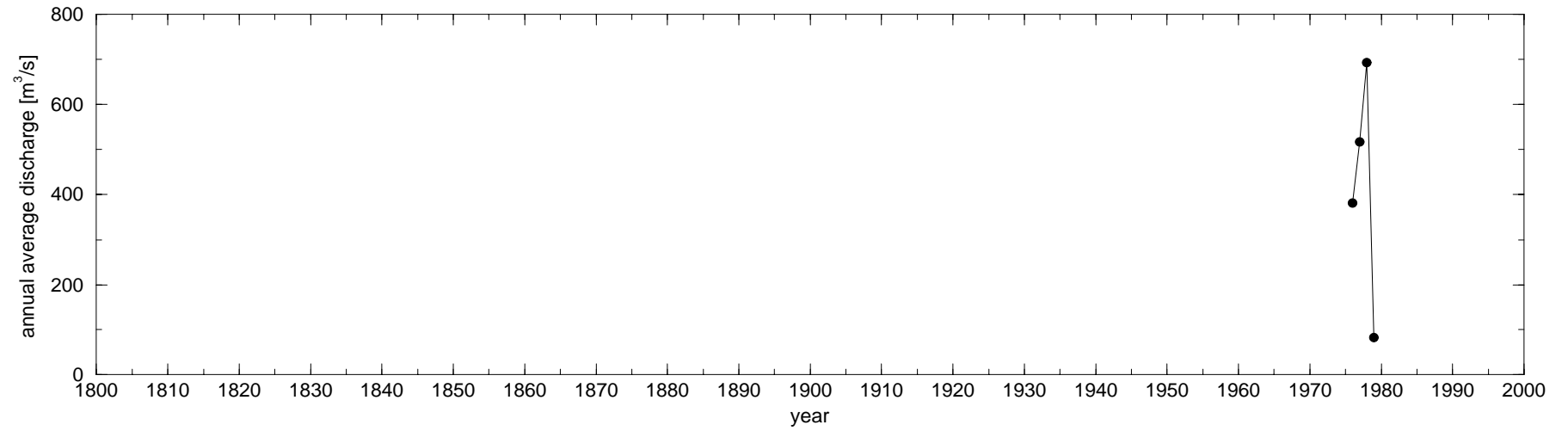
LAKE VICTORIA (OYEAN RES./OWEN FALLS)



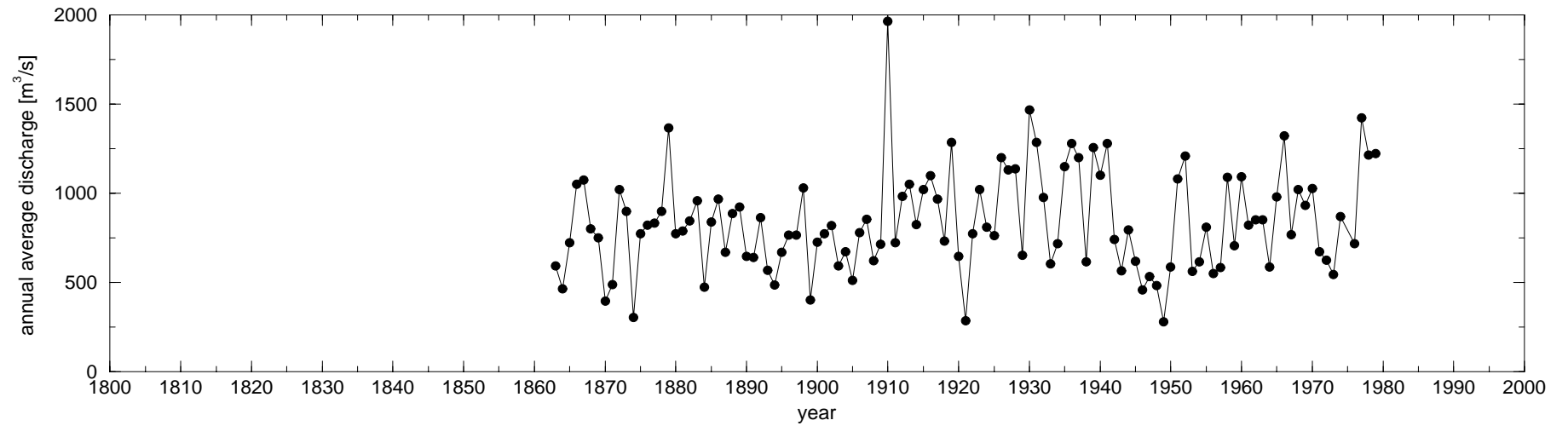
LENA (KUSUR)



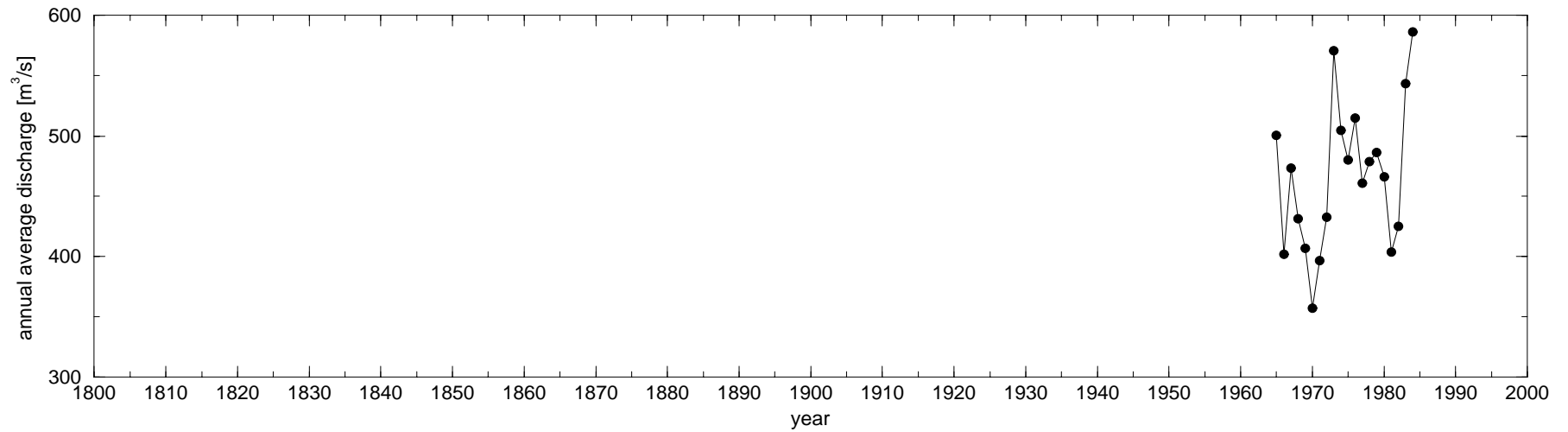
LIMPOPO (CHOKWE)



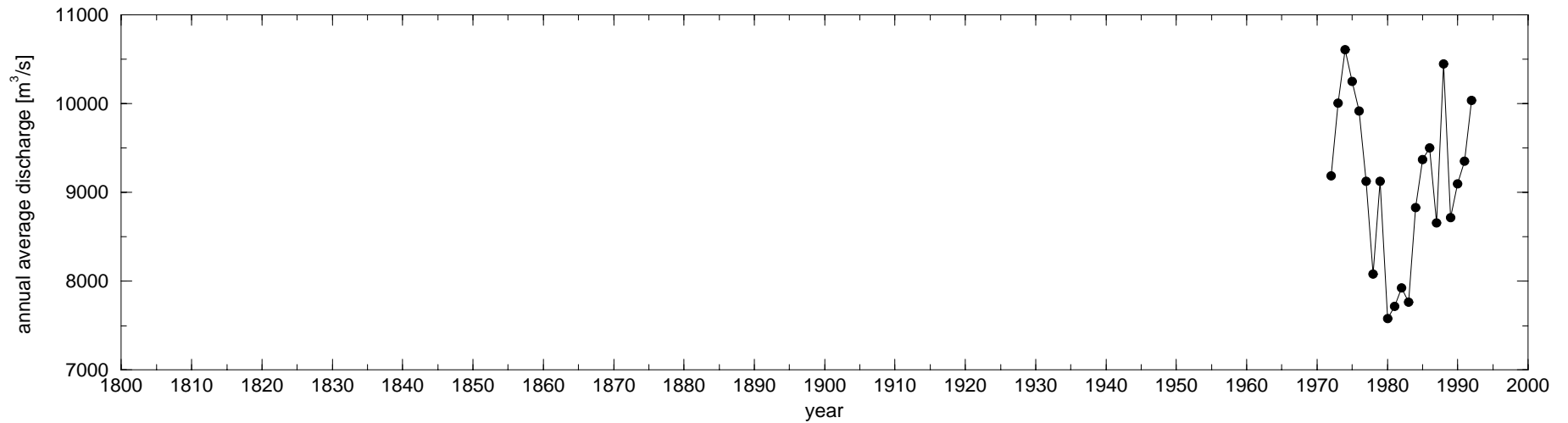
LOIRE (MONTJEAN)



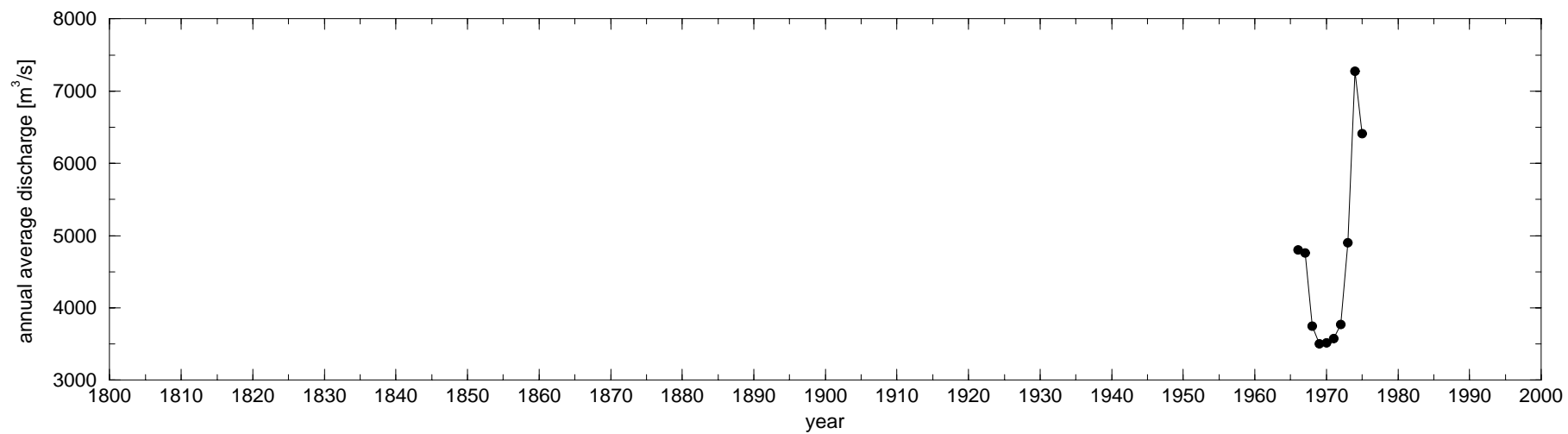
LULEALVEN (BODEN WATERWORKS)



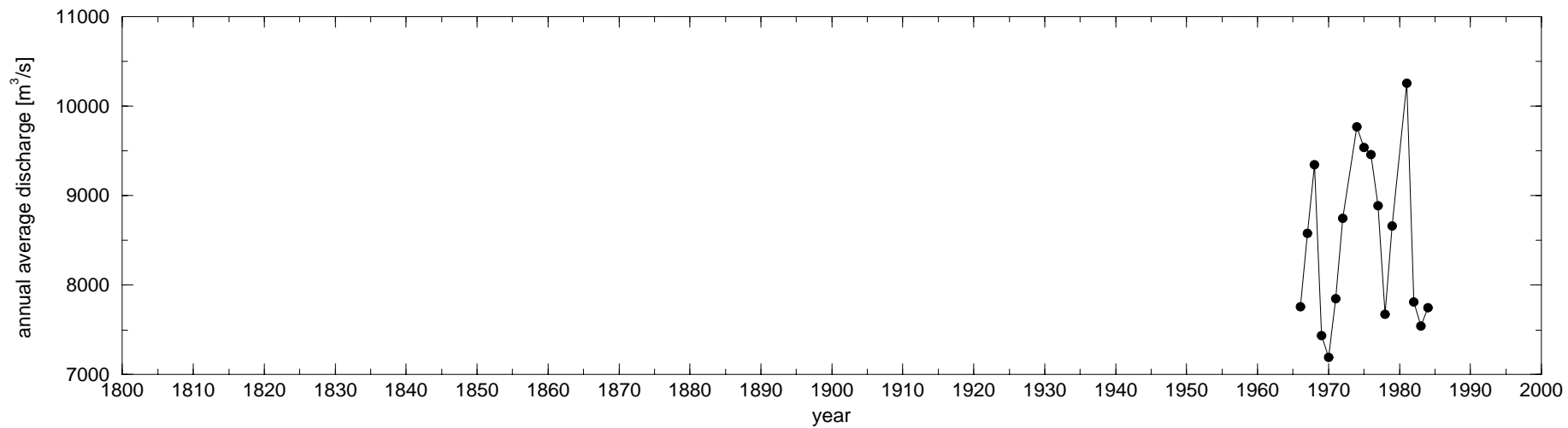
MACKENZIE RIVER (ARCTIC RED RIVER)



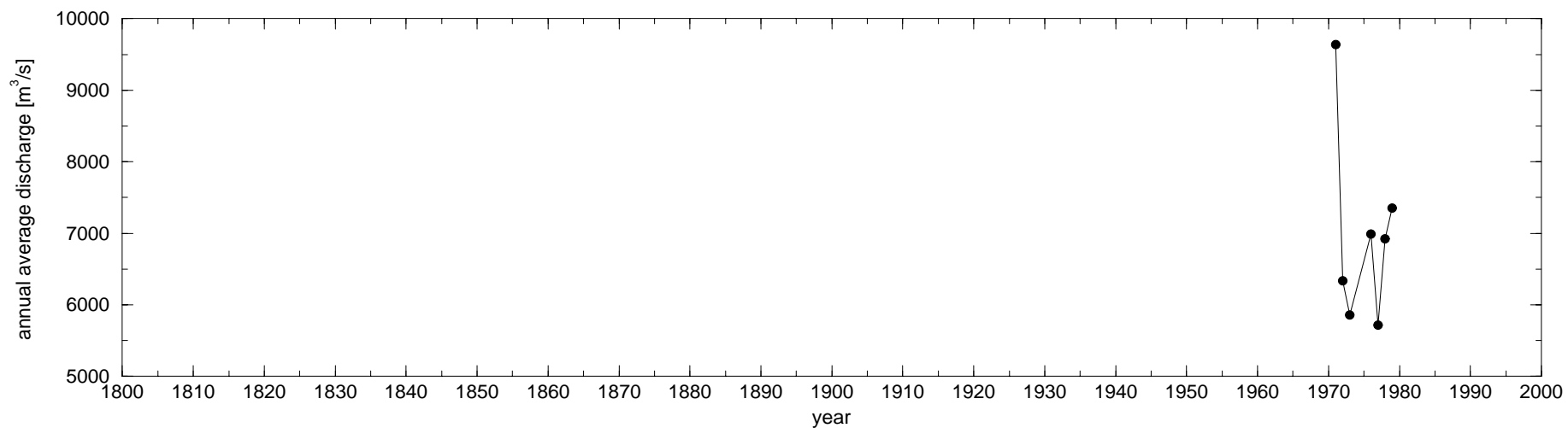
MACKENZIE RIVER (NEAR FORT PROVIDENCE)



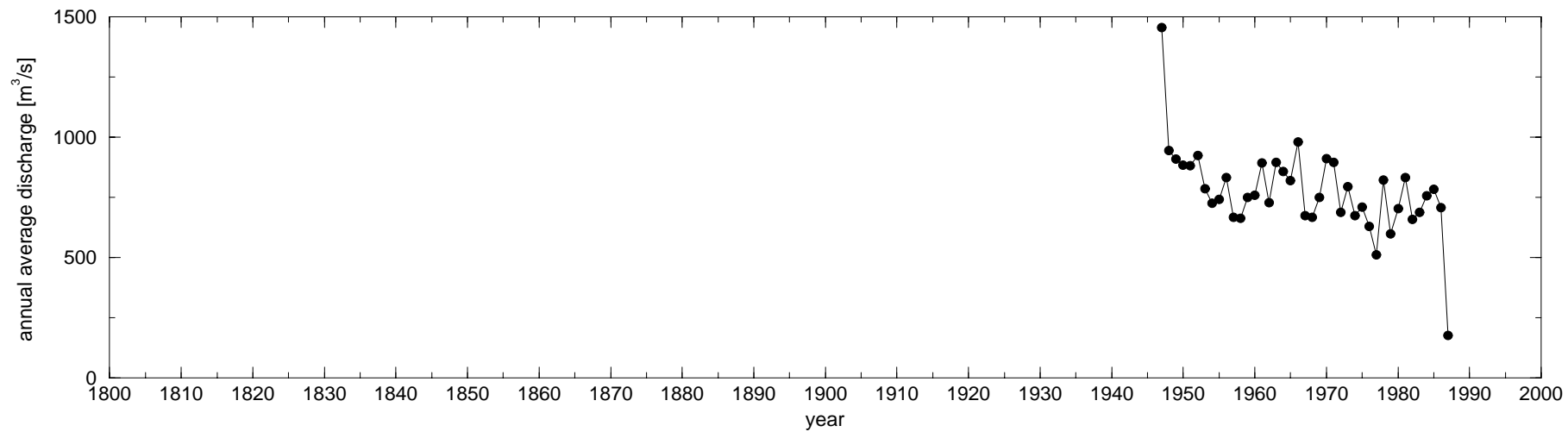
MACKENZIE RIVER (NORMAN WELLS)



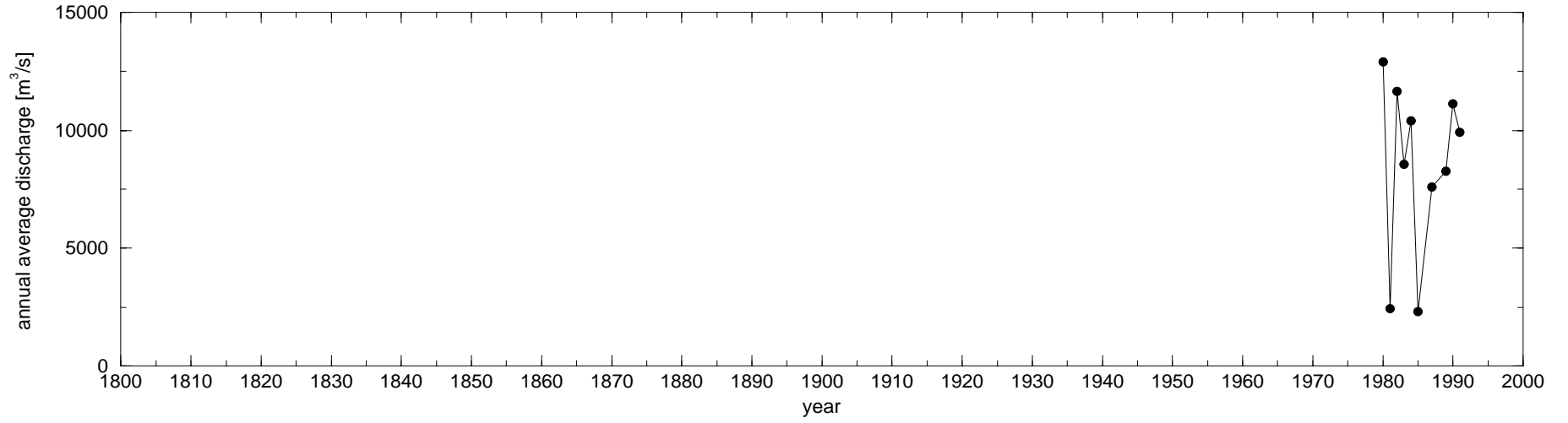
MAGDALENA (CALAMAR)



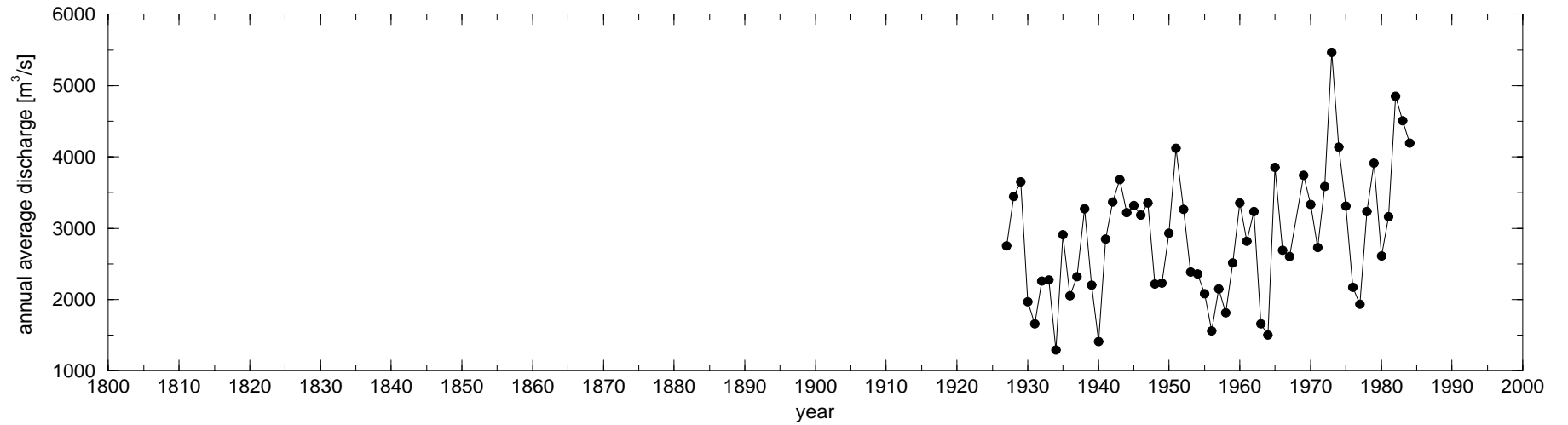
MEKONG (MUKDAHAN)



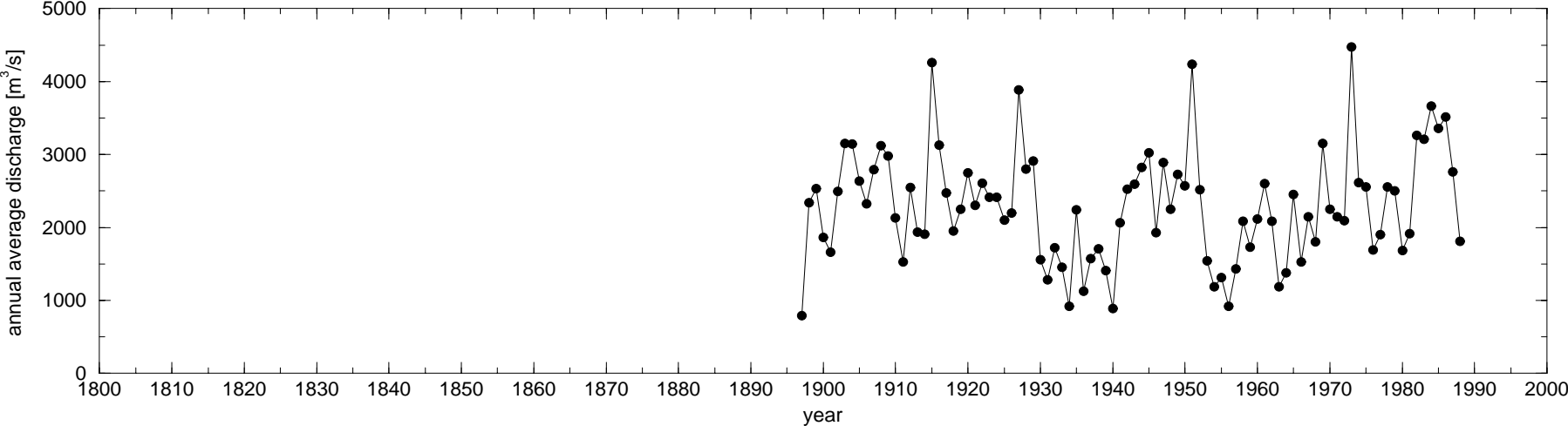
MEKONG (PAKSE)



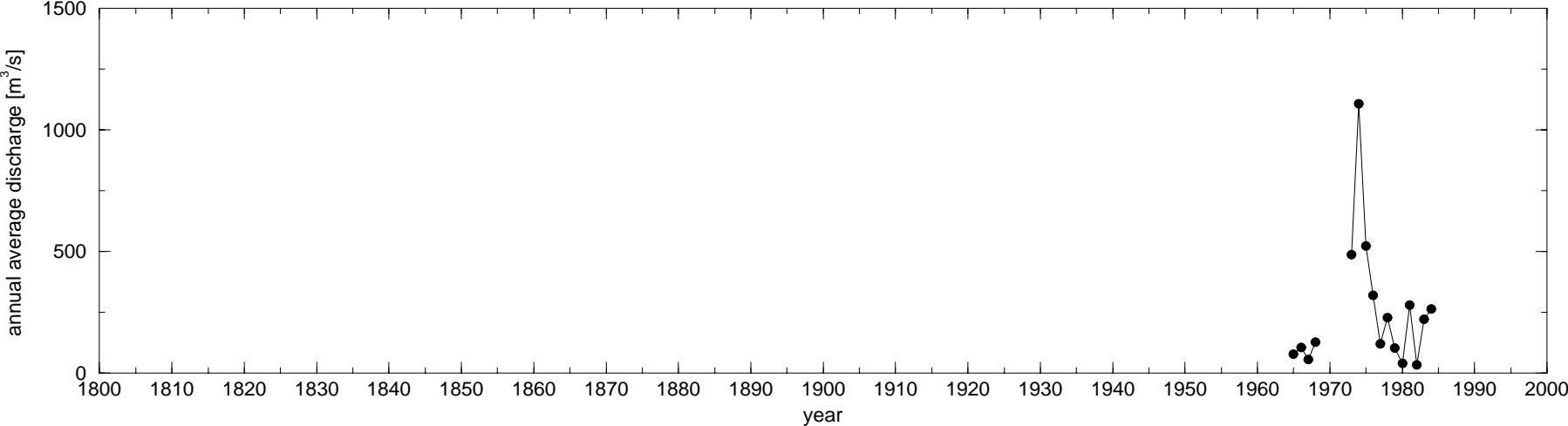
MISSISSIPPI (ALTON, ILL.)



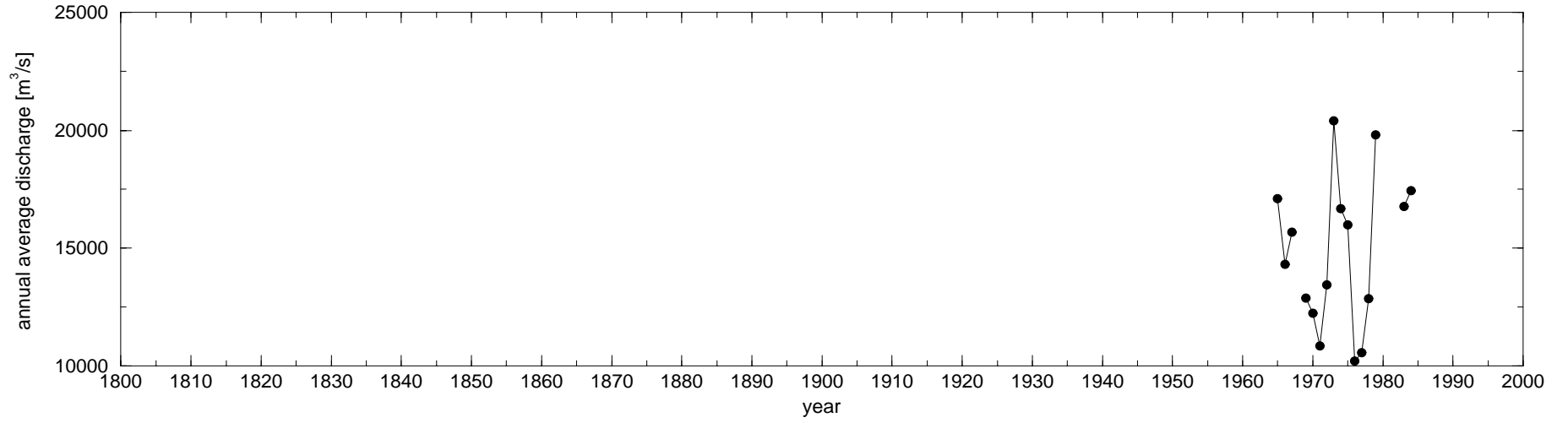
MISSOURI (HERMAN,MONT.)



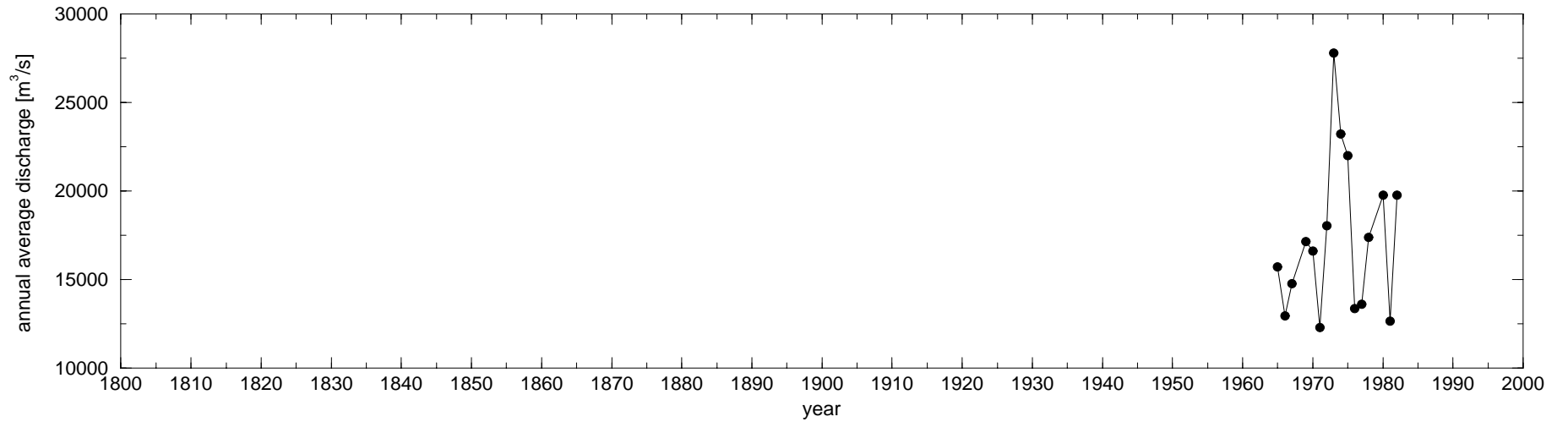
MURRAY (LOCK 9 UPPER)



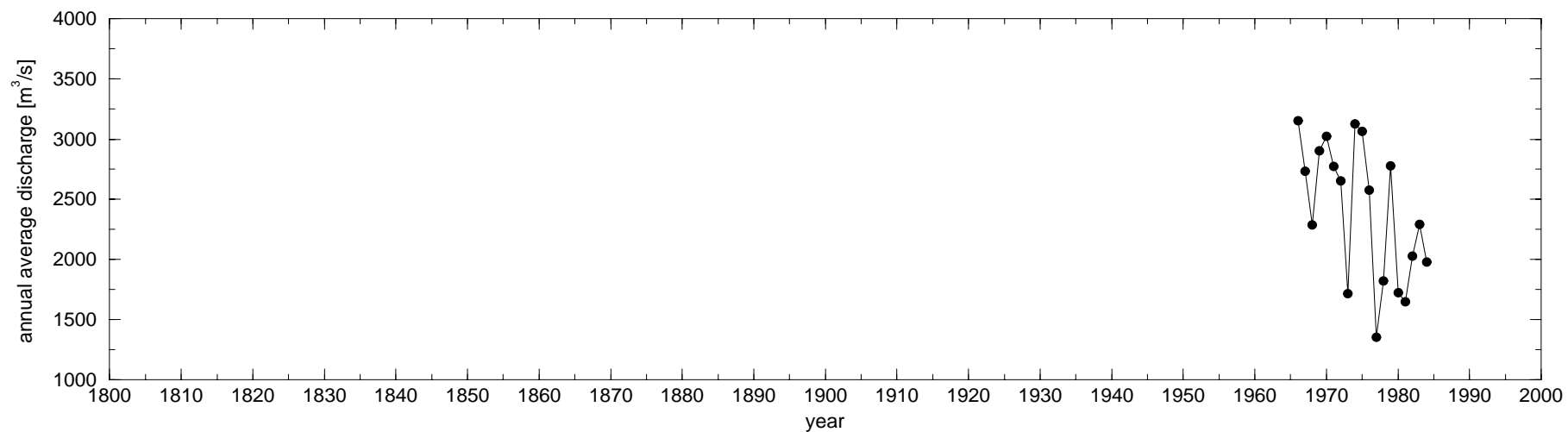
MISSISSIPPI (TARBERT LANDING)



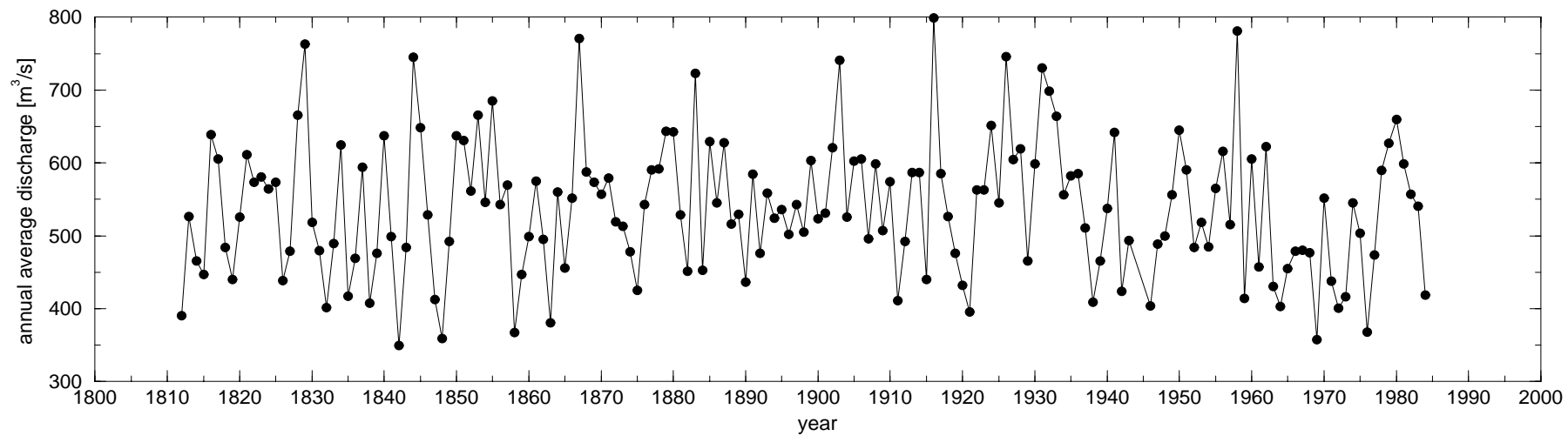
MISSISSIPPI (VICKSBURG, MISSISSIPPI)



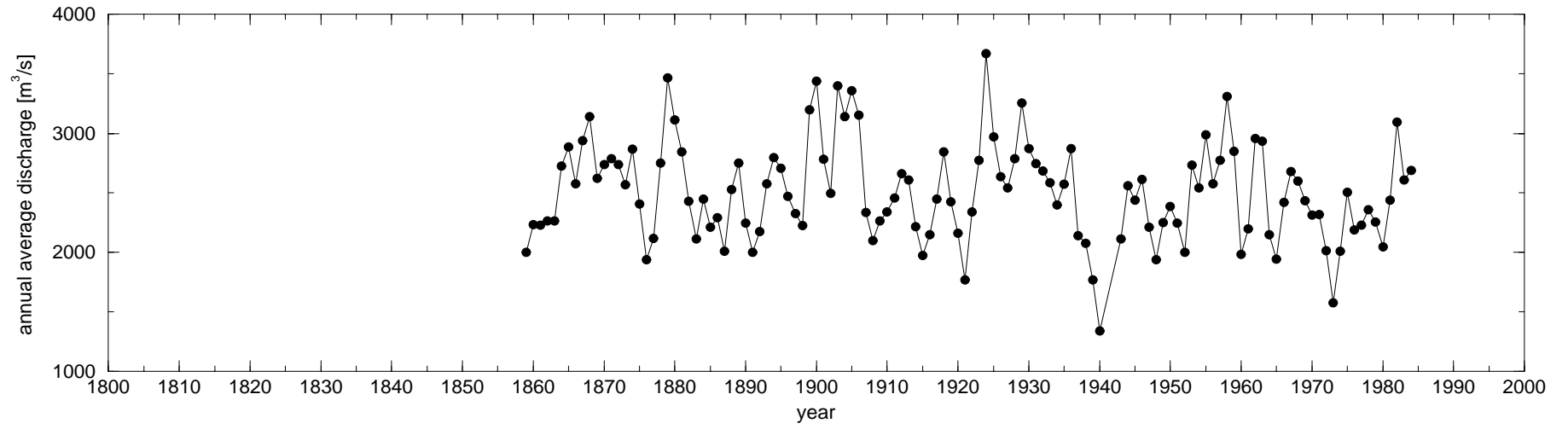
NELSON RIVER (ABOVE BLADDER RAPIDS)



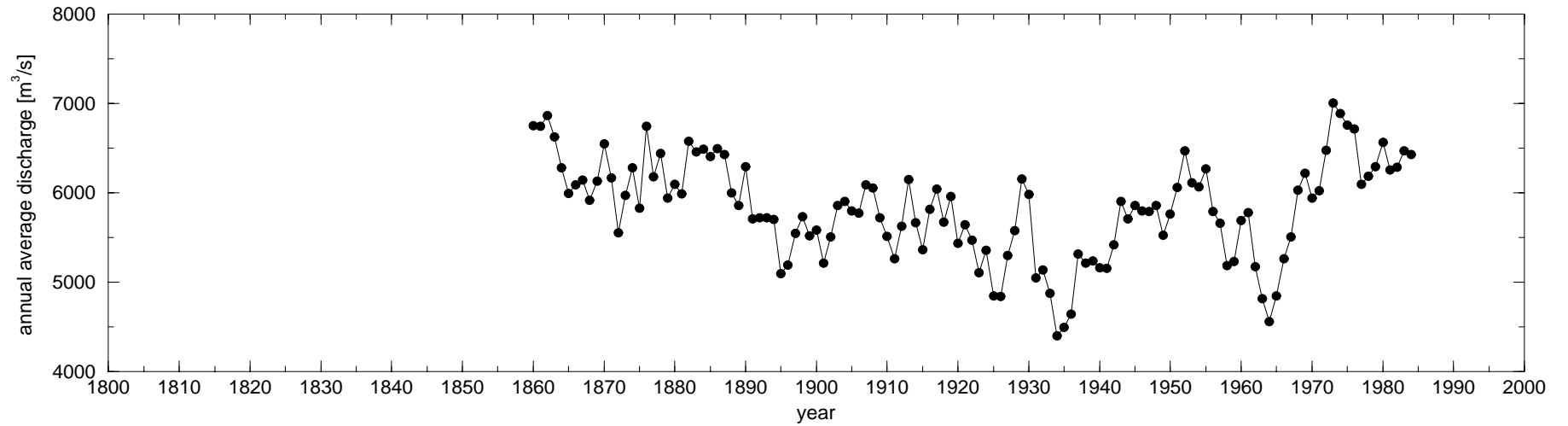
NEMAN (SMALININKAI)



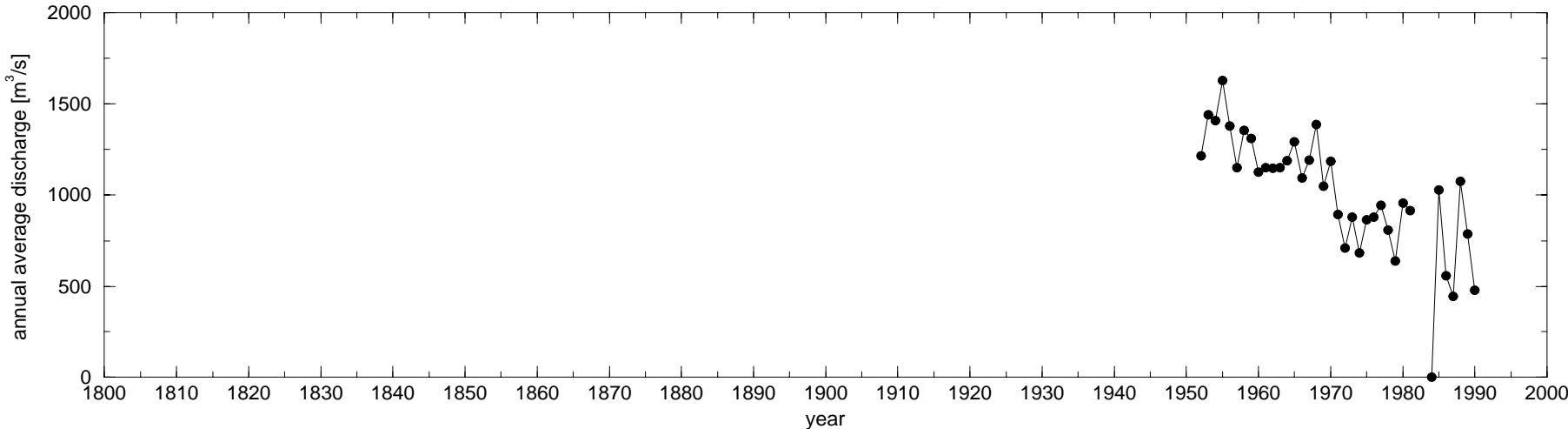
NEVA (NOVOSARATOVKA)



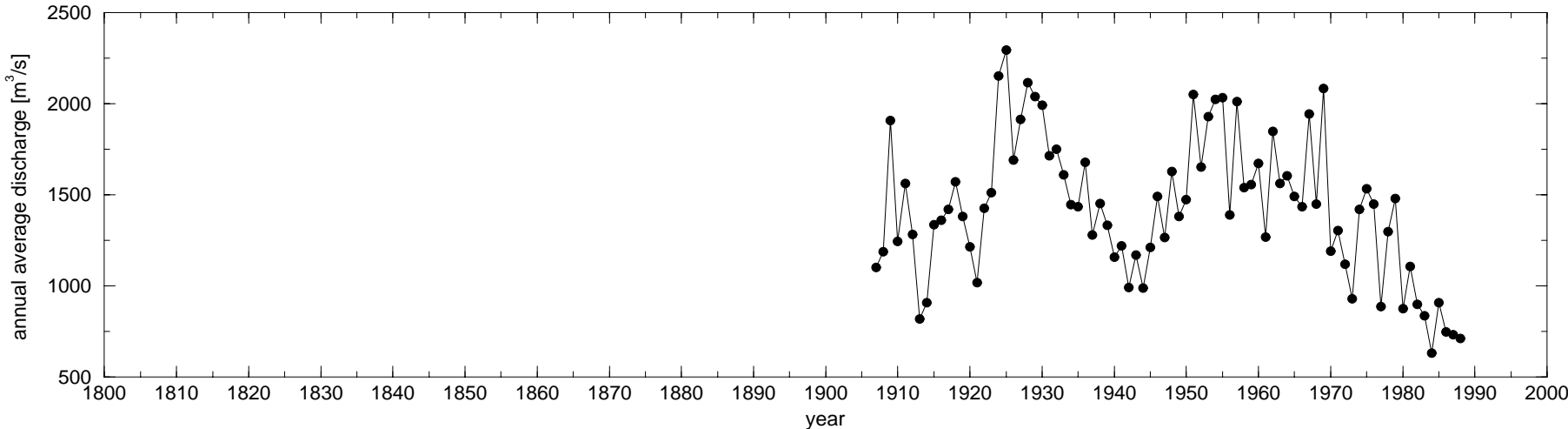
NIAGARA (QUEENSTON)



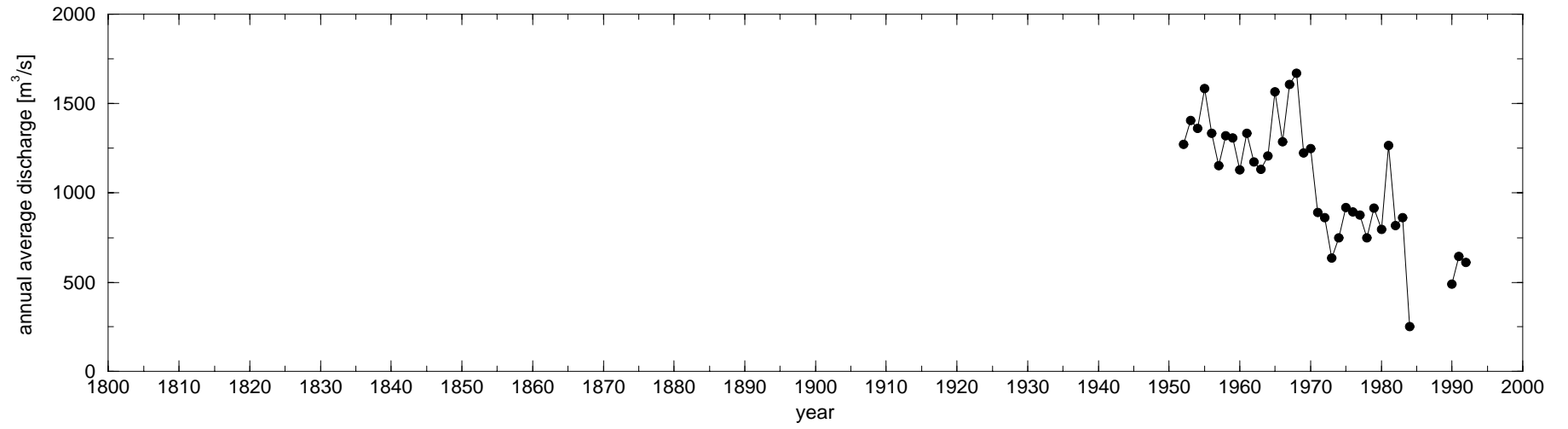
NIGER (GAYA)



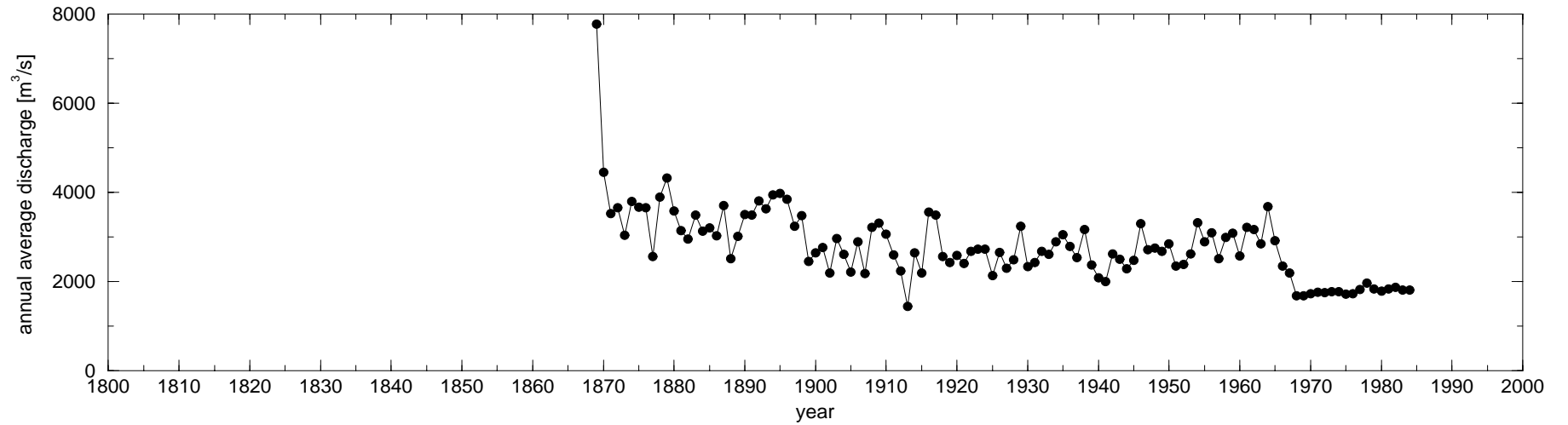
NIGER (KOULIKORO)



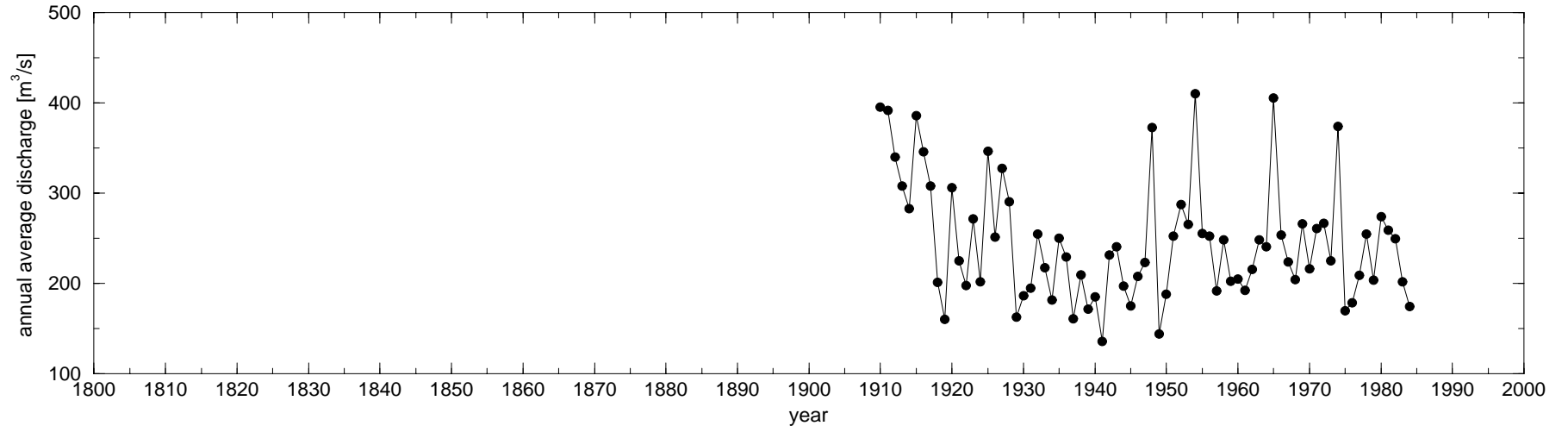
NIGER (MALANVILLE)



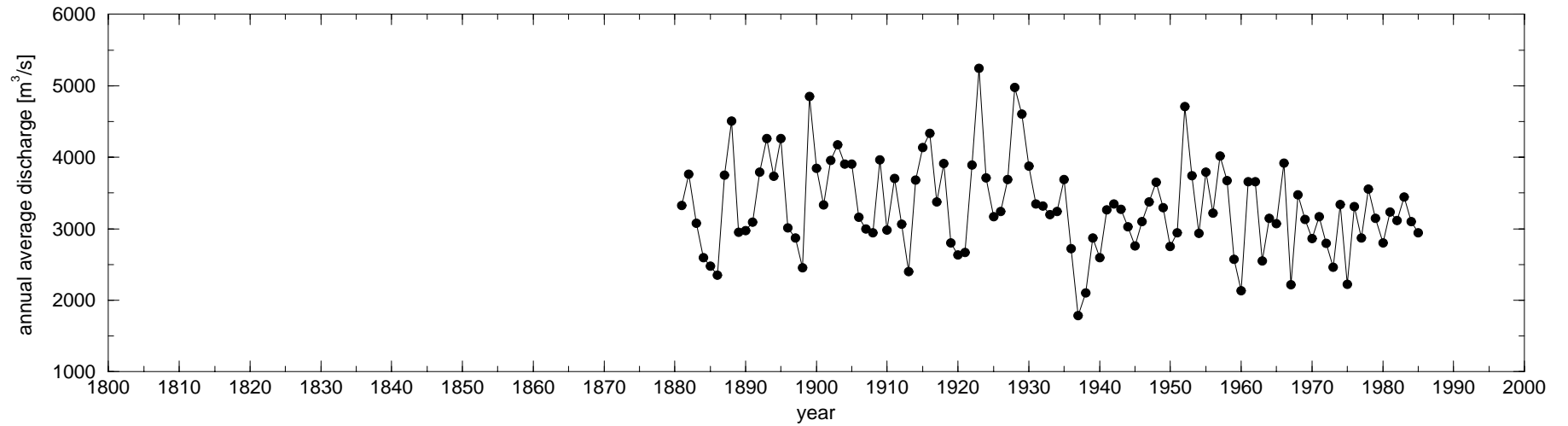
NILE (ASWAN DAM)



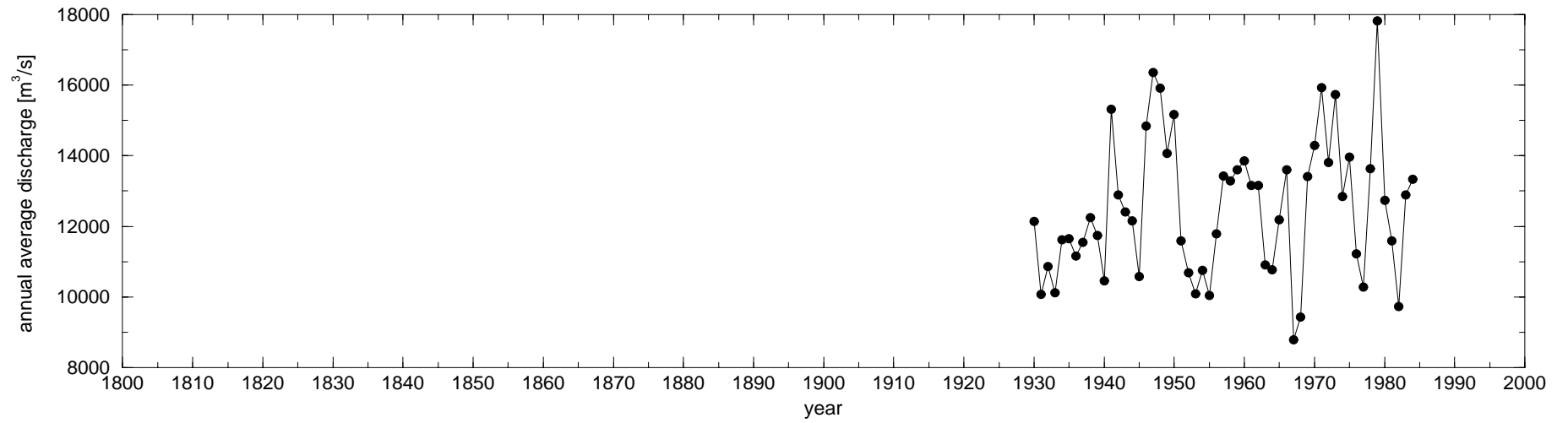
NORTH SASKATCHEWAN (PRINCE ALBERT)



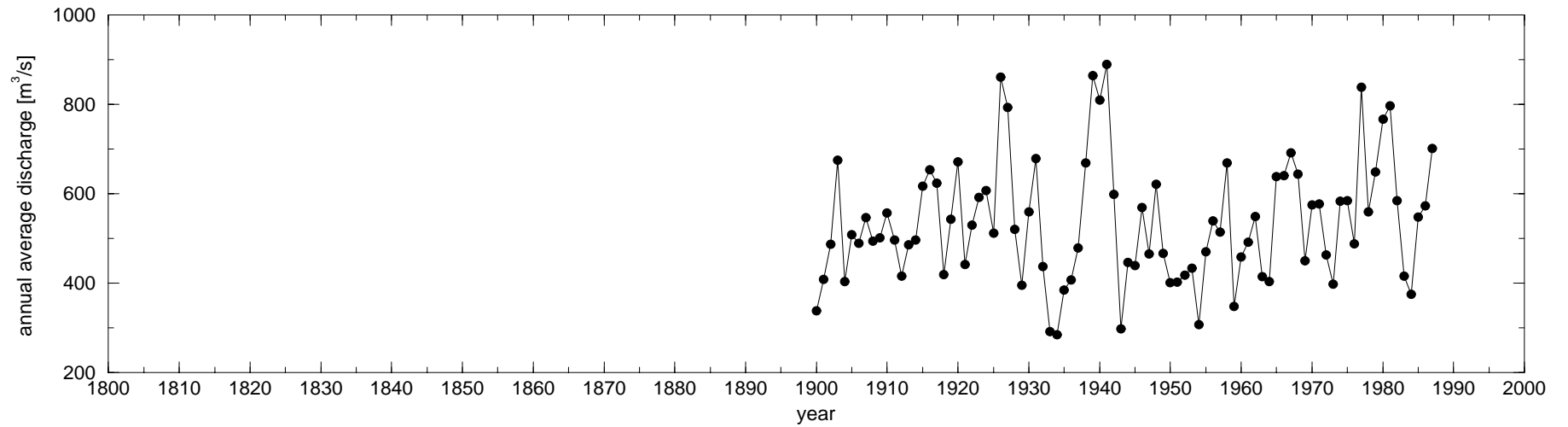
NORTHERN DVINA (UST-PINEGA)



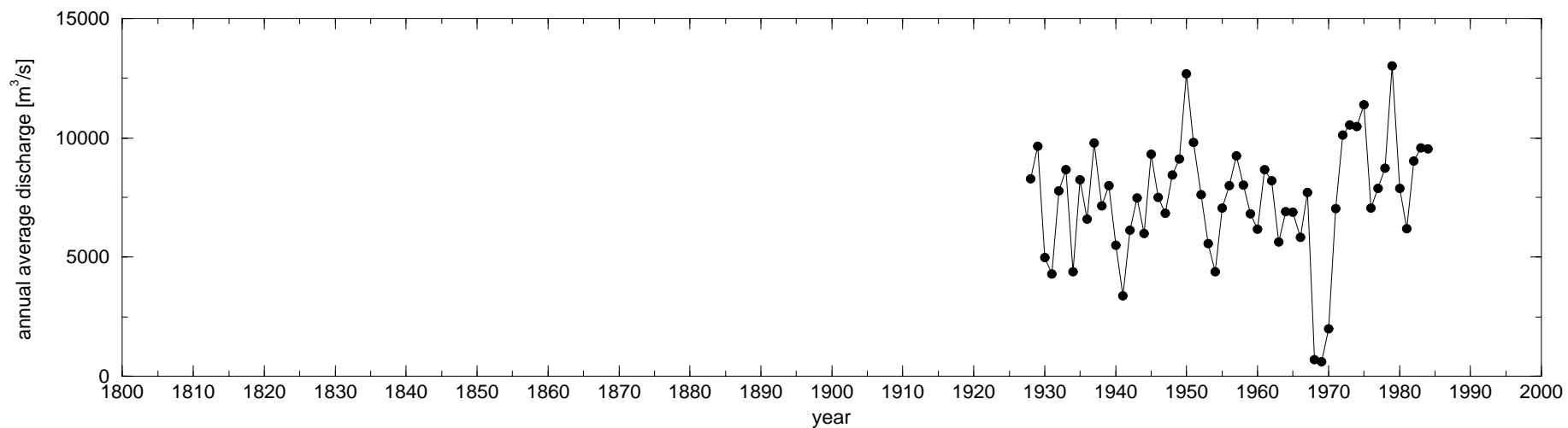
OB (SALEKHARD)



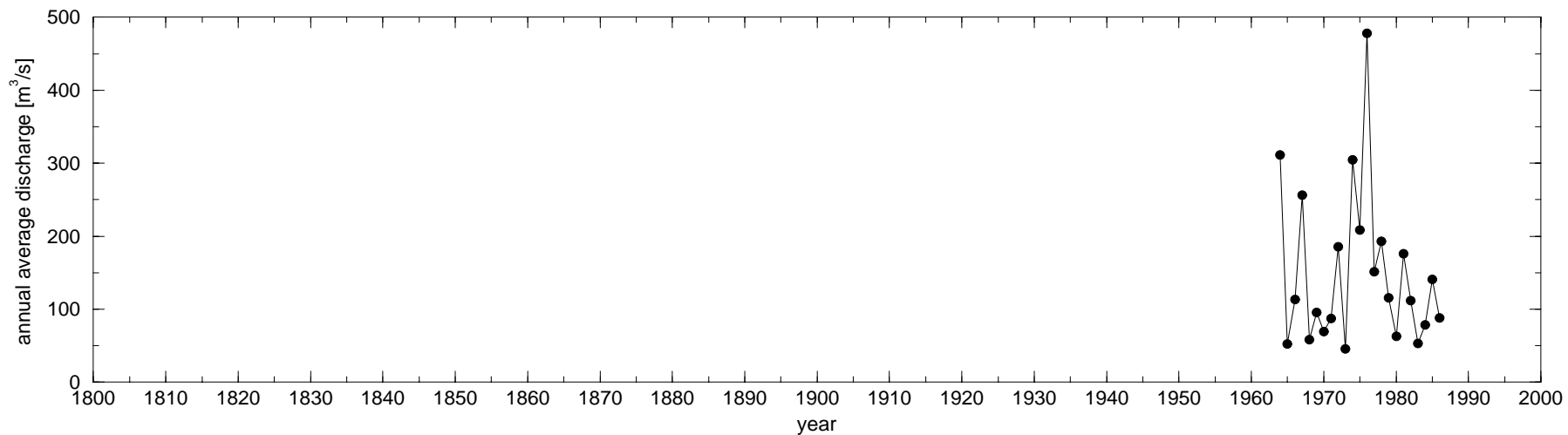
ODRA (GOZDOWICE)



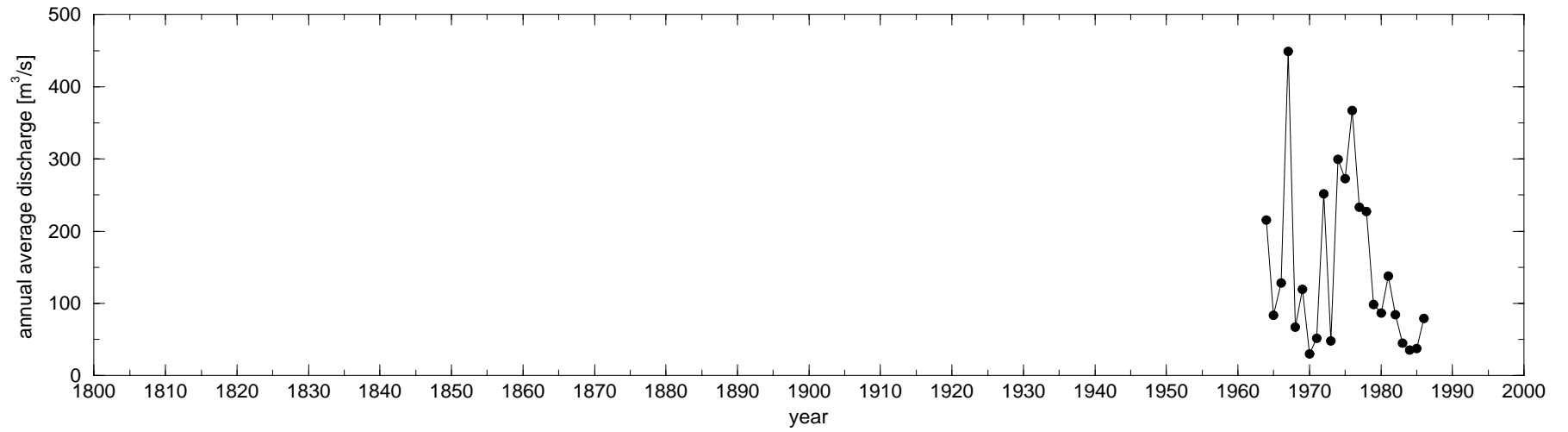
OHIO (METROPOLIS, ILL.)



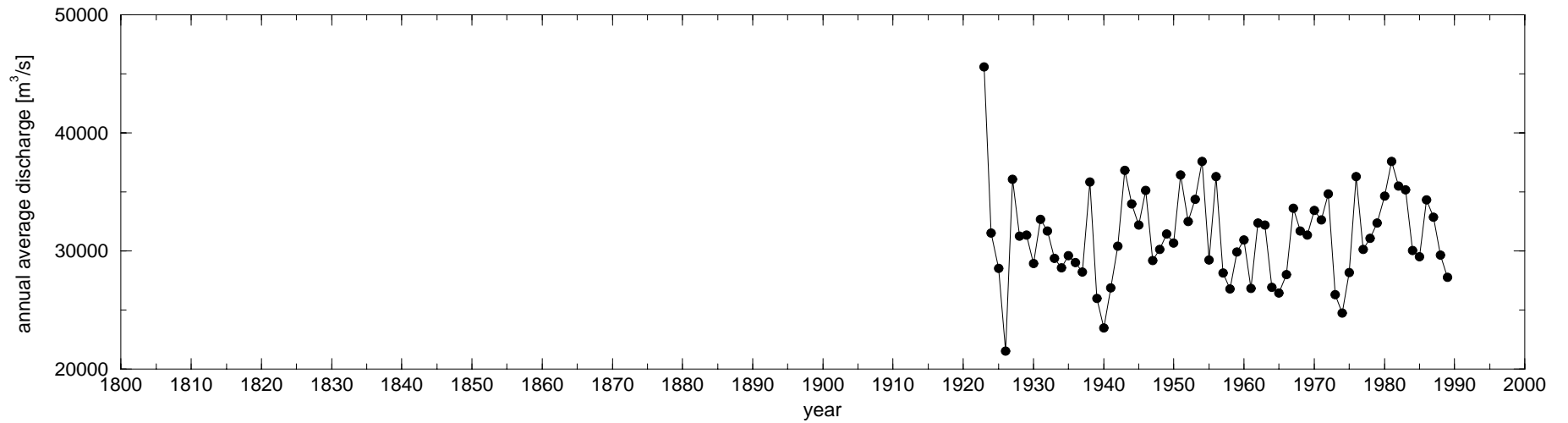
ORANJE (ALIWAL NORTH)



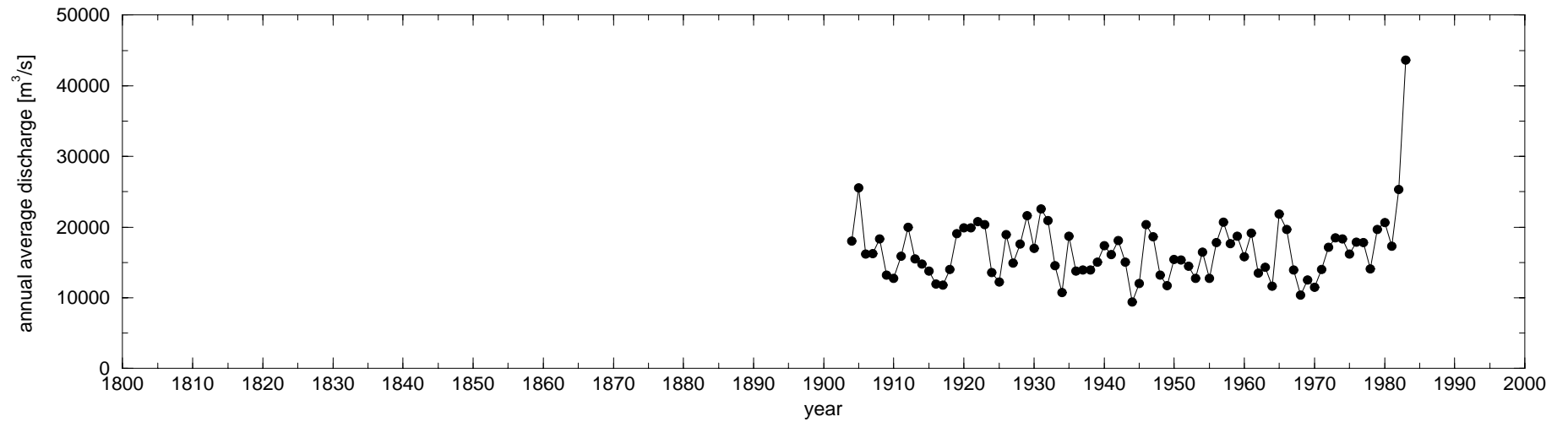
ORANJE (VIOOLSDRIF)



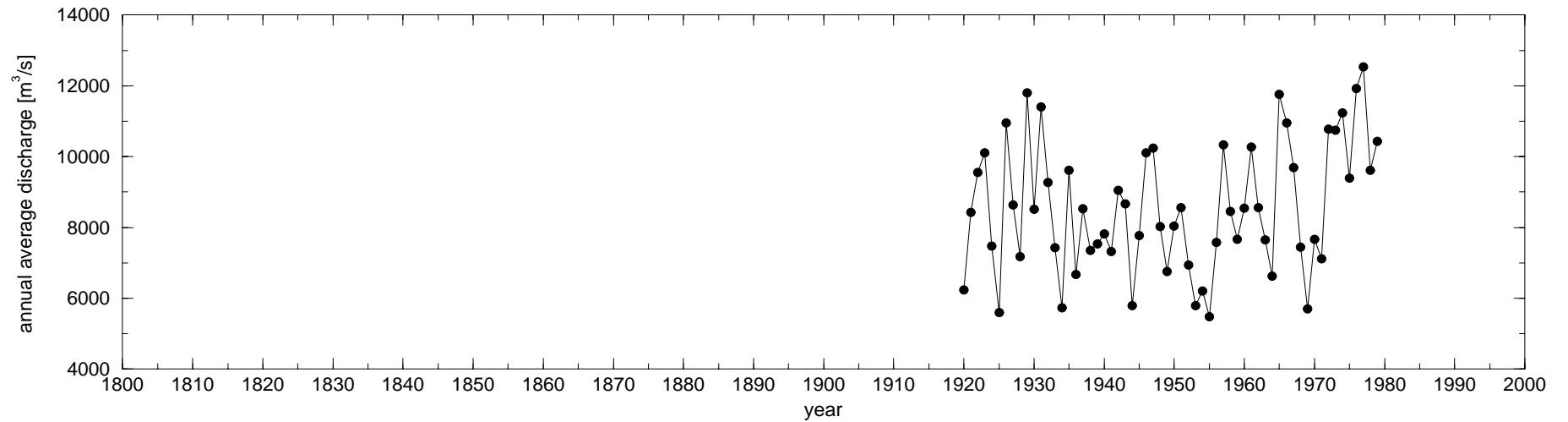
ORINOCO (PUENTE ANGOSTURA)



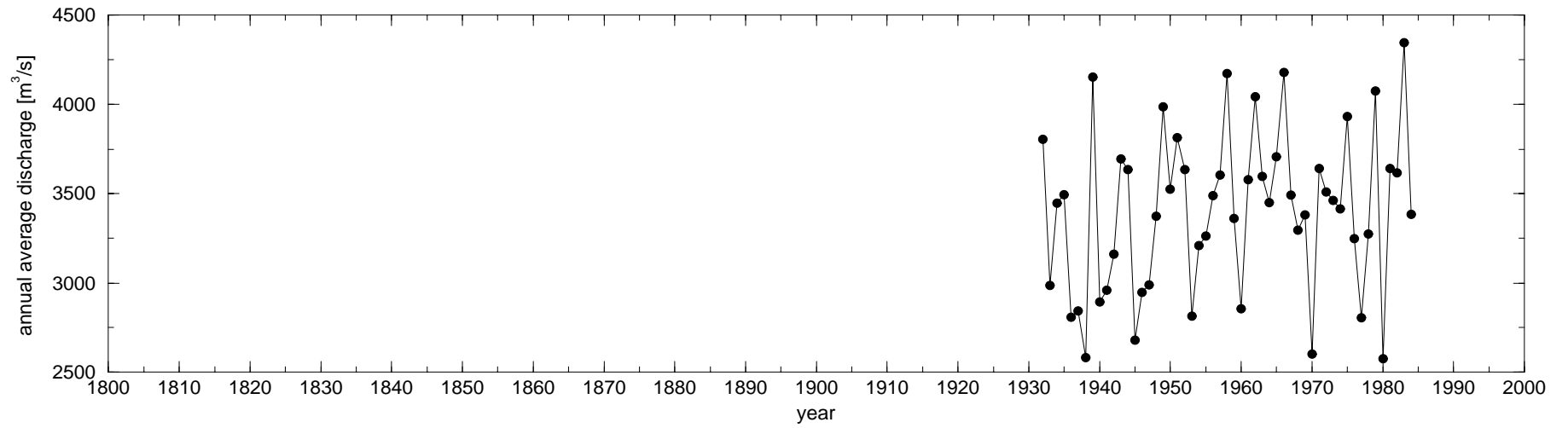
PARANA (CORRIENTES)



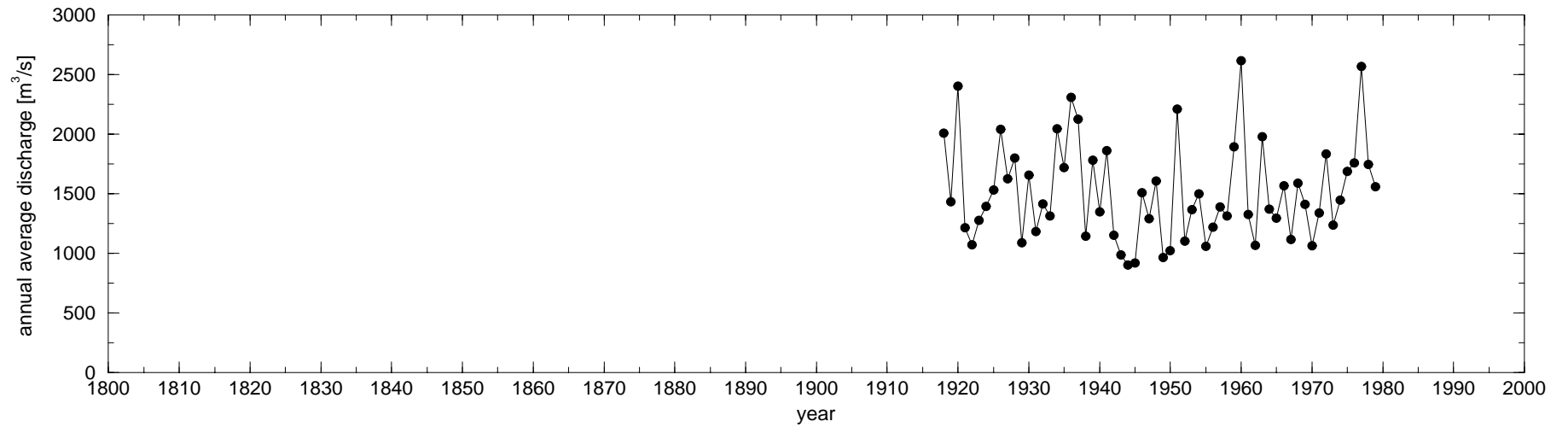
PARANA (GUARIA)



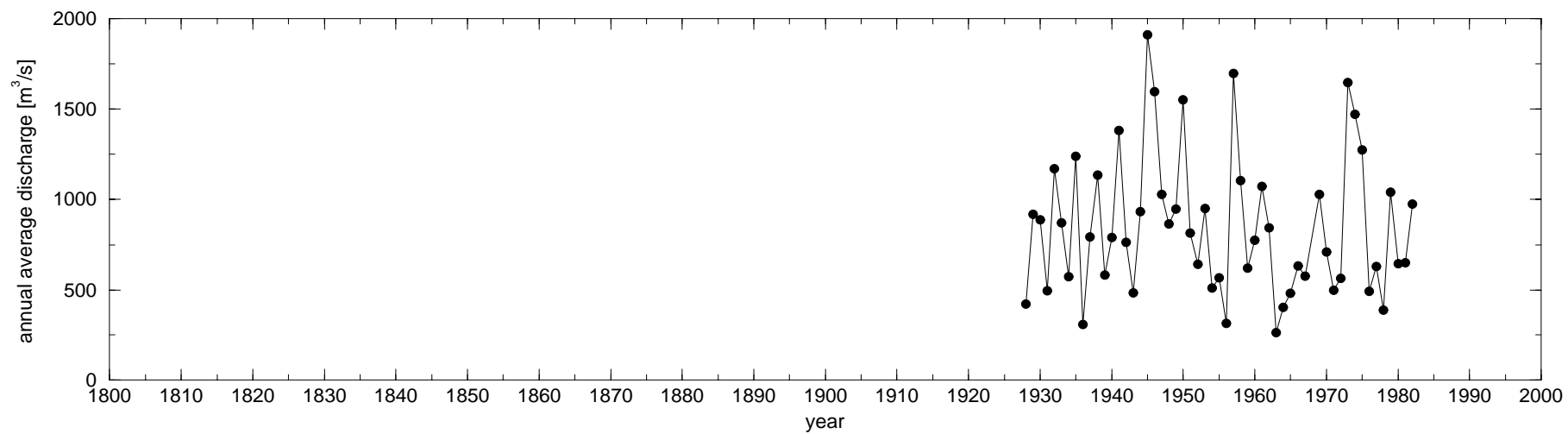
PETCHORA (UST-TSILMA)



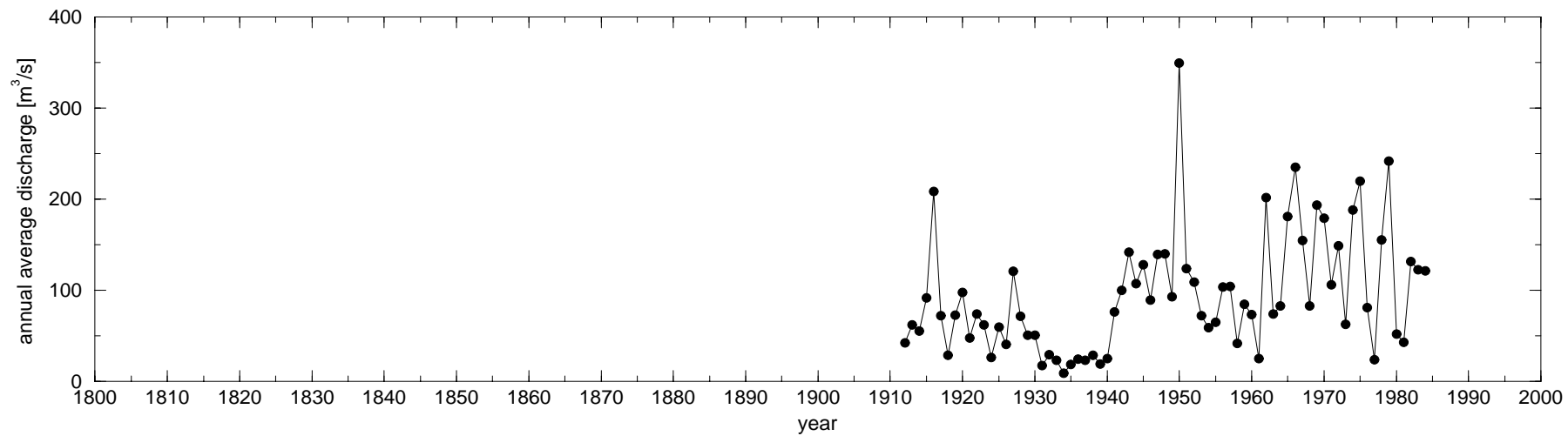
PO (PONTELAGOSCURO)



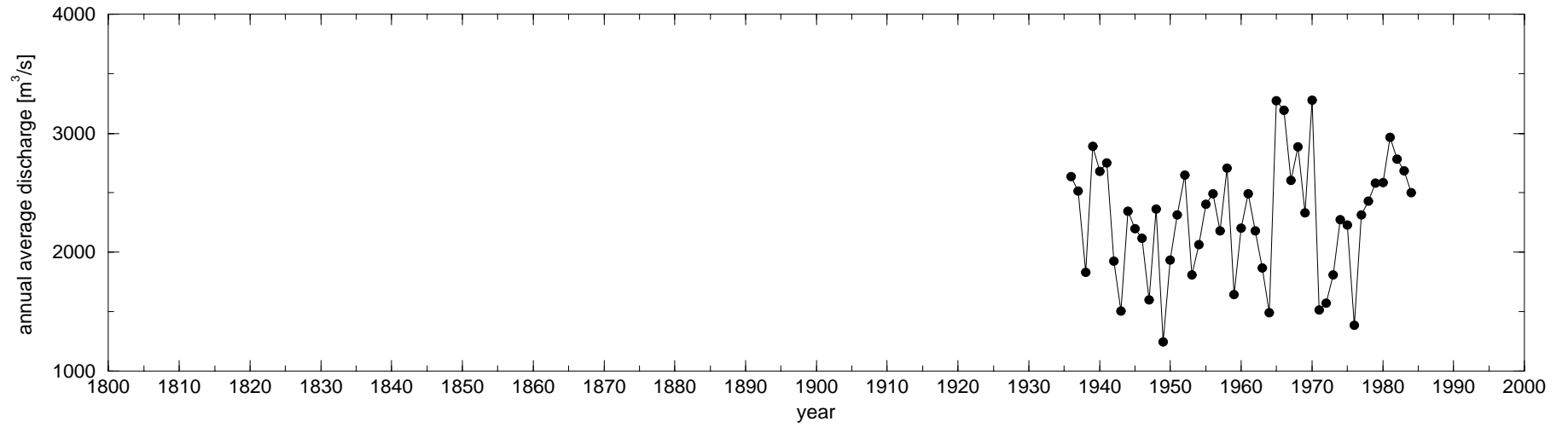
RED RIVER (ALEXANDRIA, LOUSIANA)



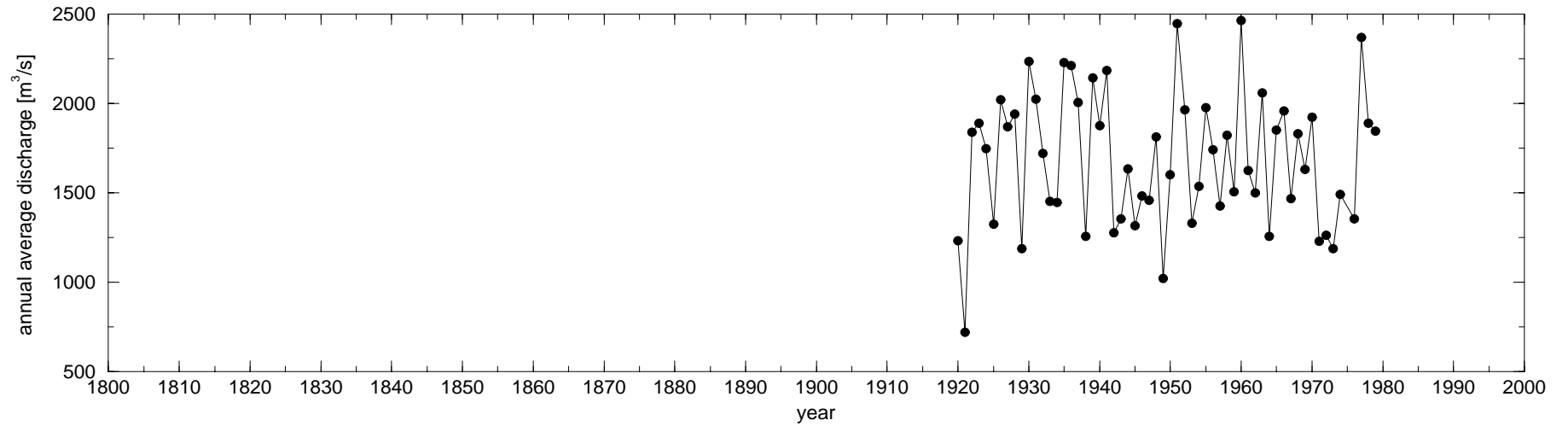
RED RIVER (EMERSON)



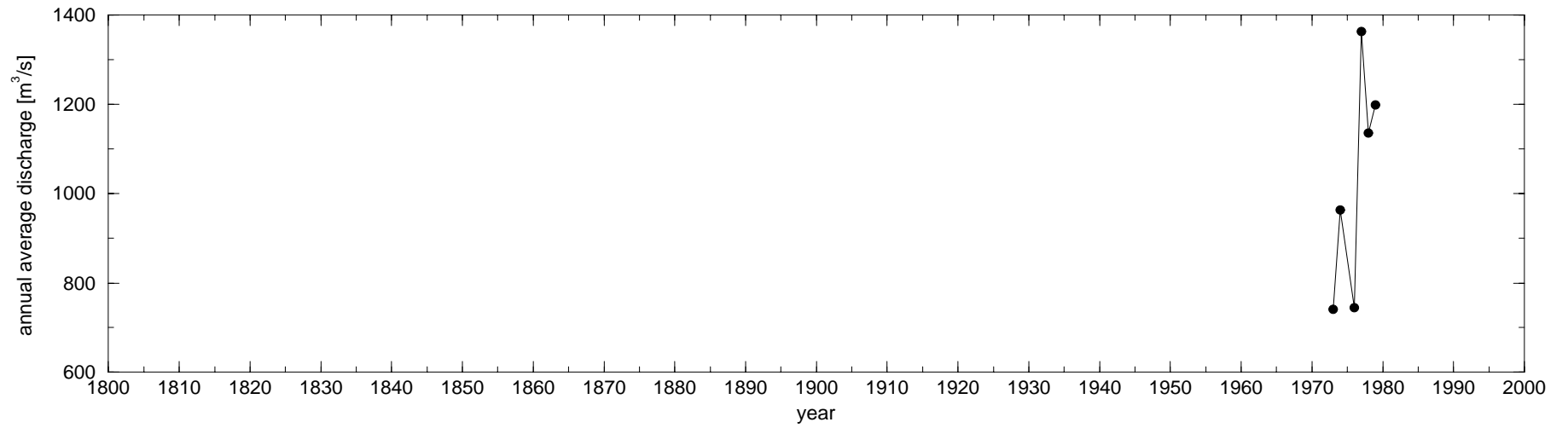
RHEIN (REES)



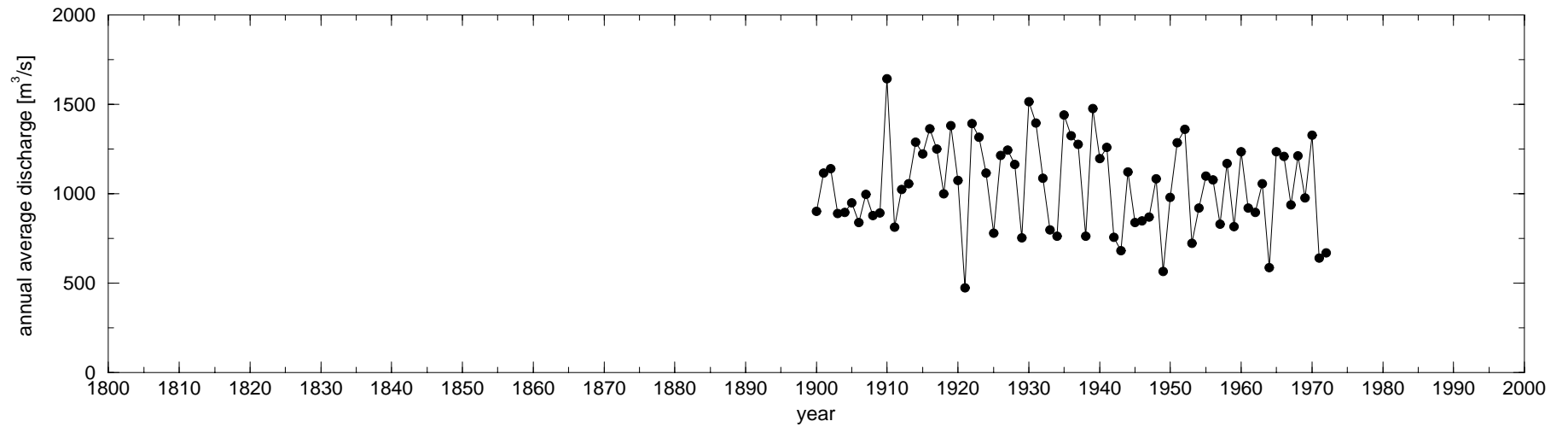
RHONE (BEUCAIRE)



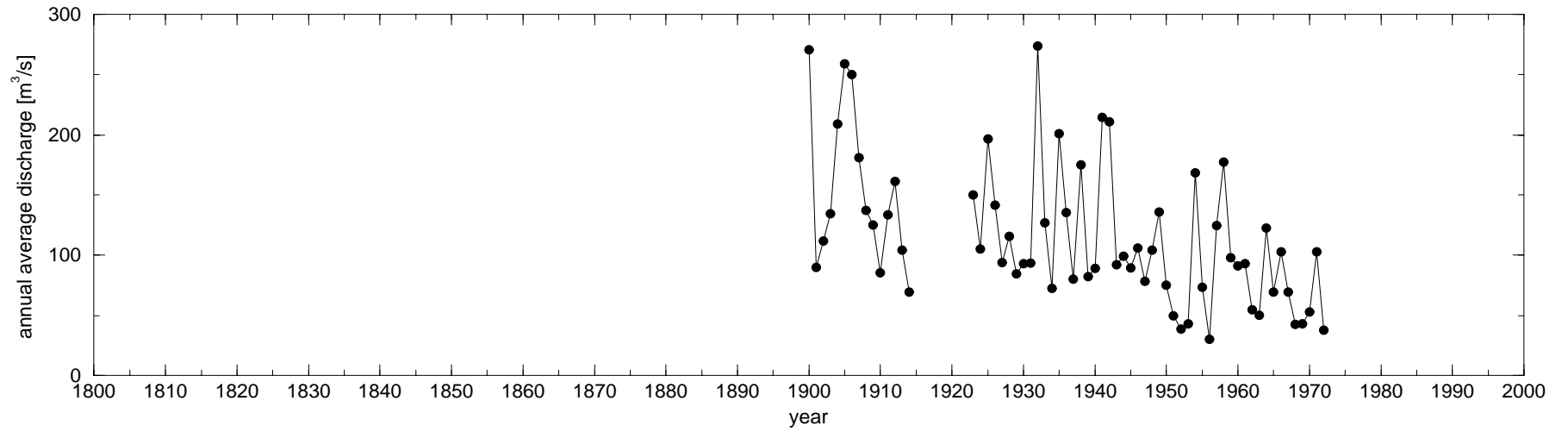
RHONE (GIVORS)



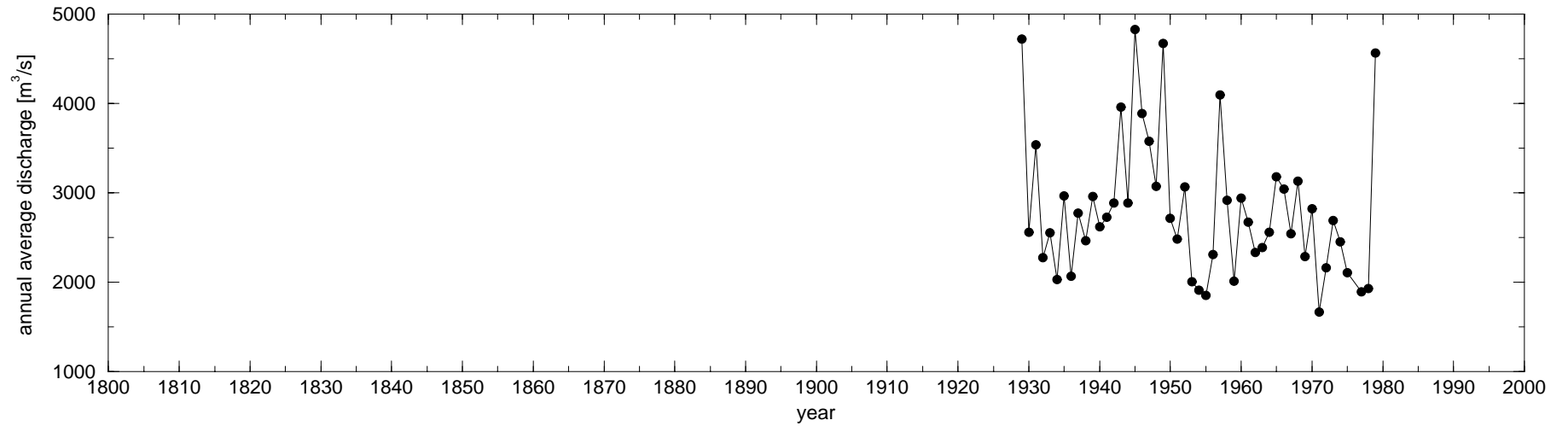
RHONE (LA MULATIERE)



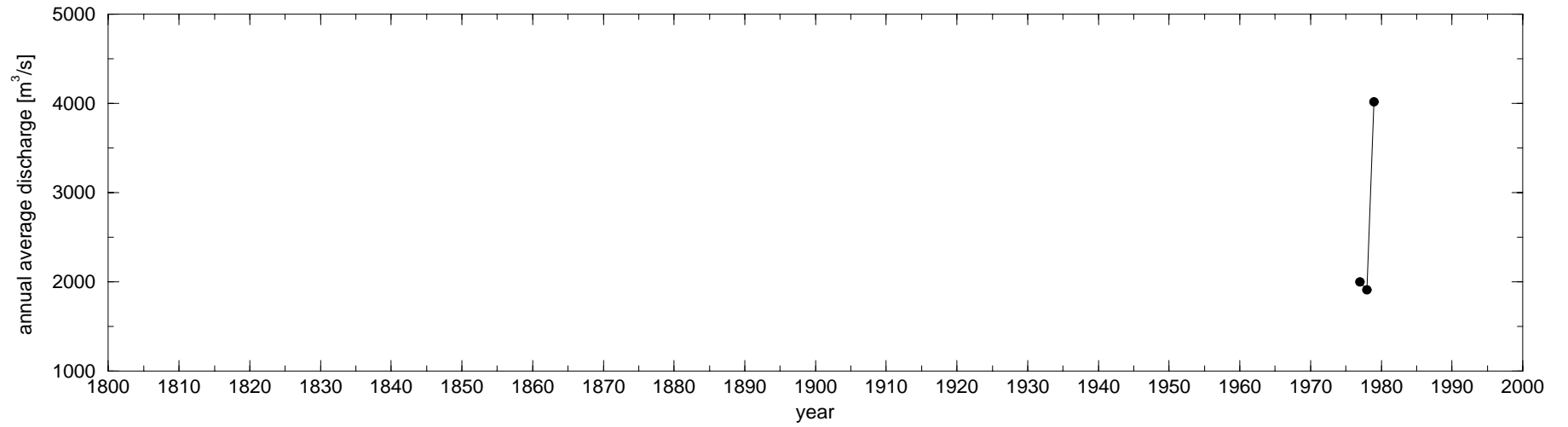
RIO GRANDE (LAREDO, TEXAS)



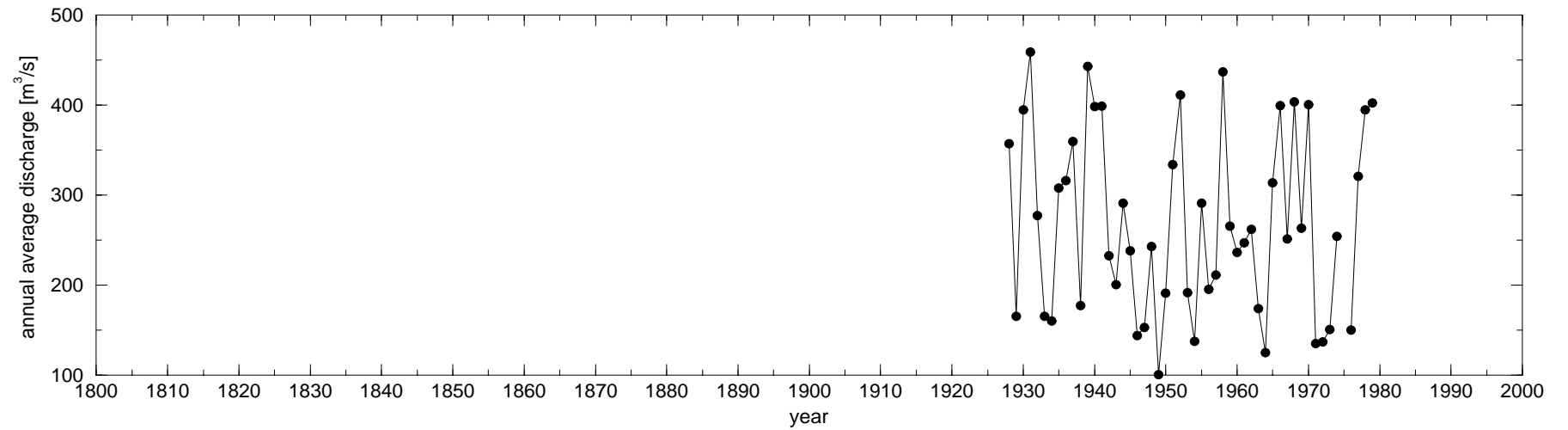
SAO FRANCISCO (JUAZEIRO)



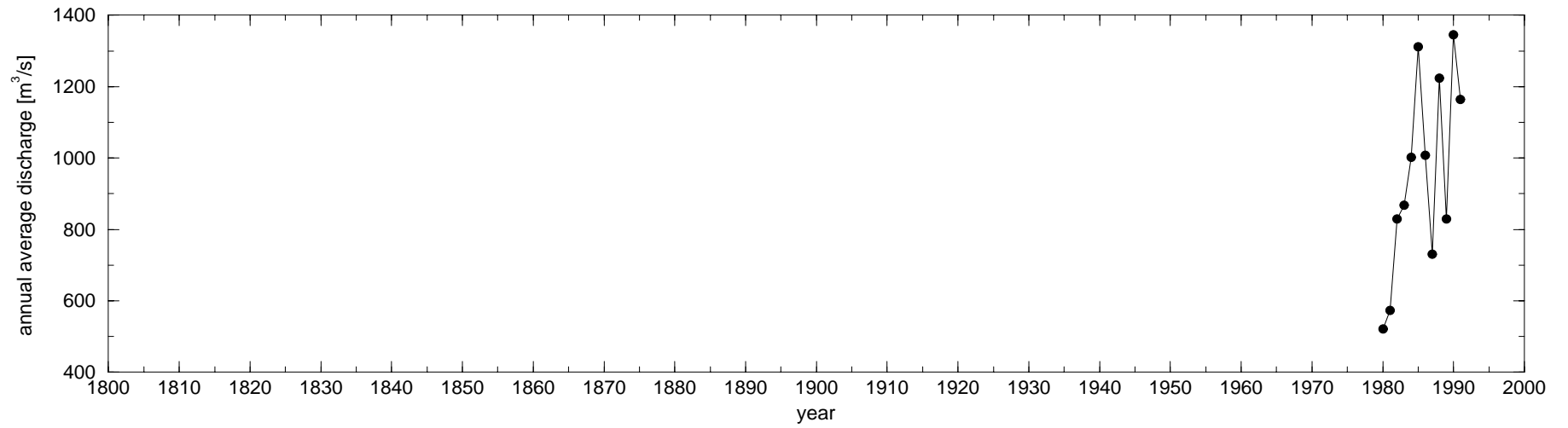
SAO FRANCISCO (TRAIPU)



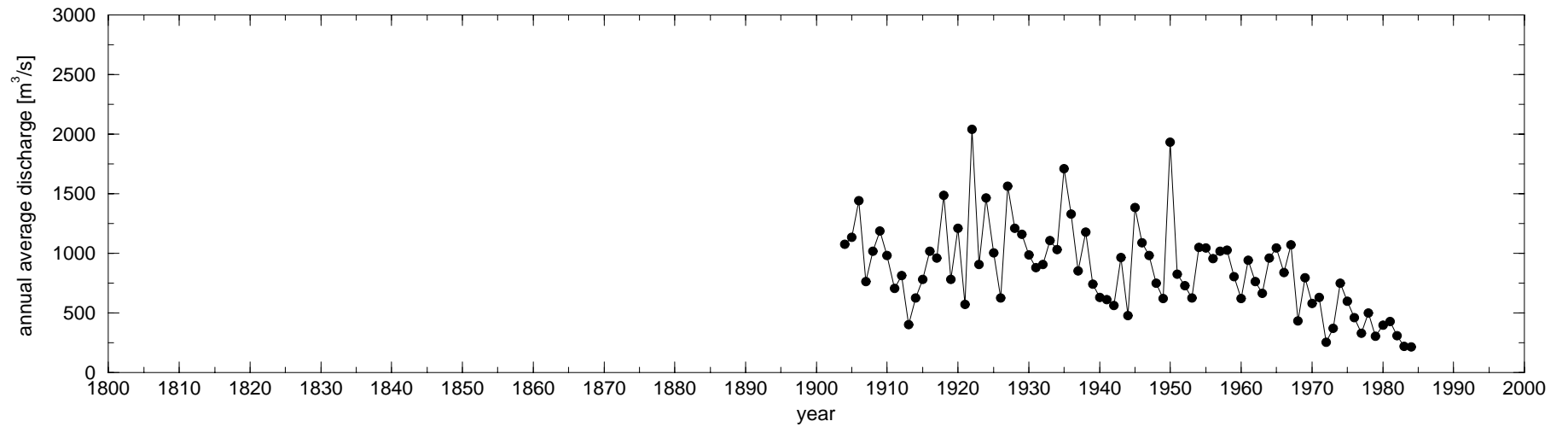
SEINE (PARIS)



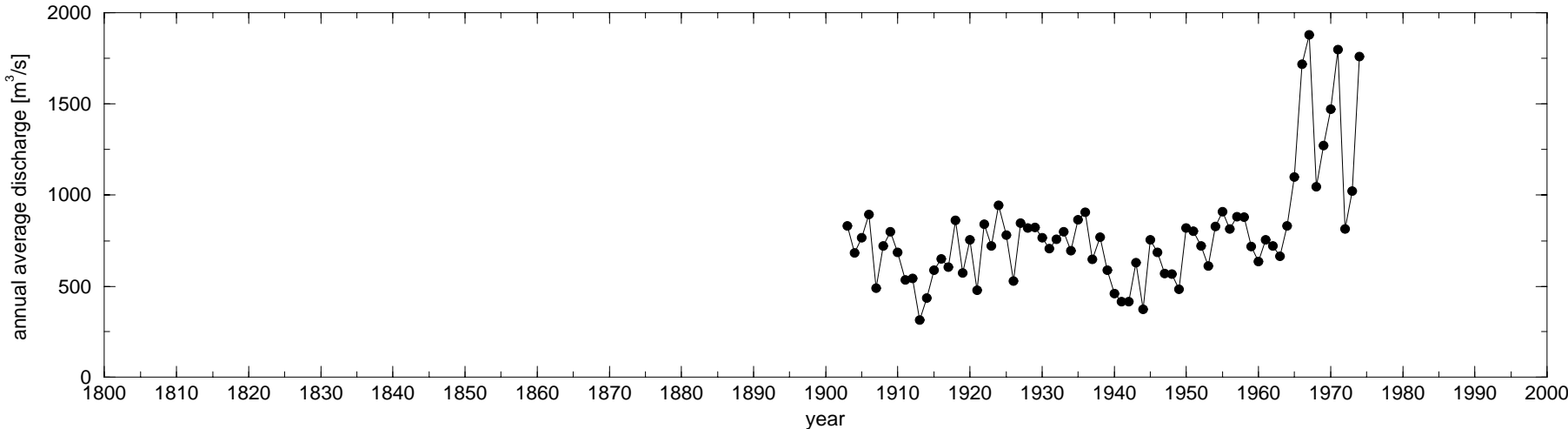
SELENGA (MOSTOVOY)



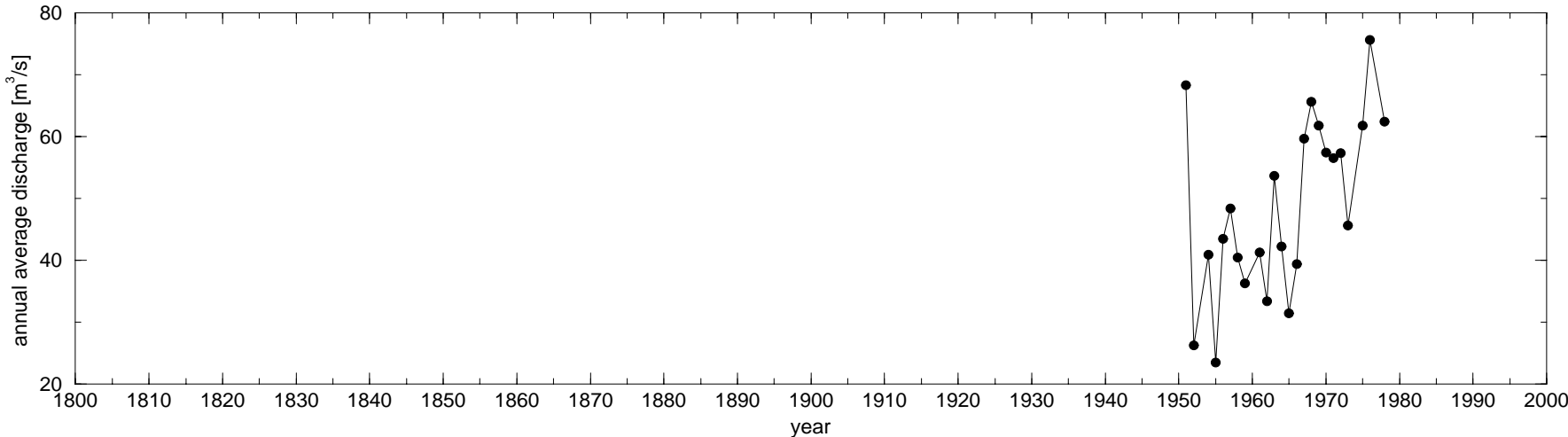
SENEGAL (BAKEL)



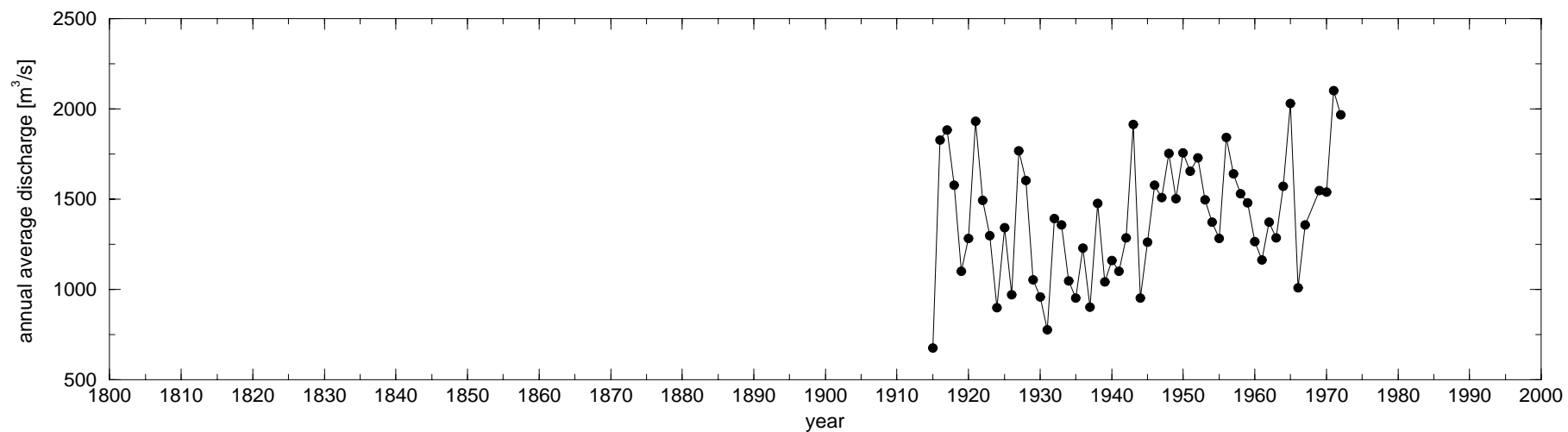
SENEGAL (DAGANA)



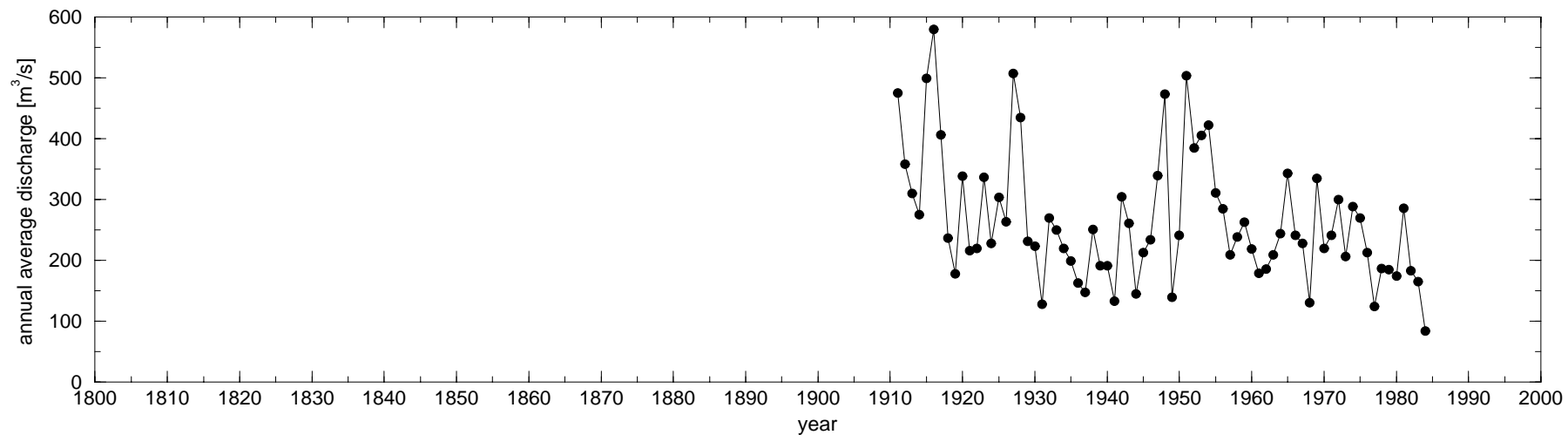
SHEBELE (AFGOI)



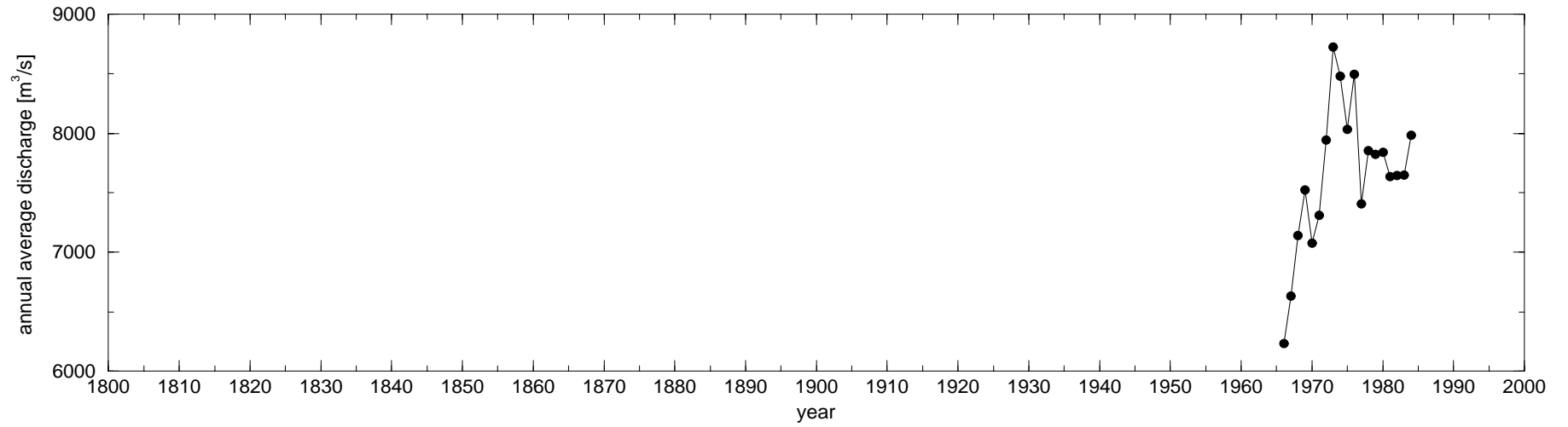
Snake (Clarkston, Wash.)



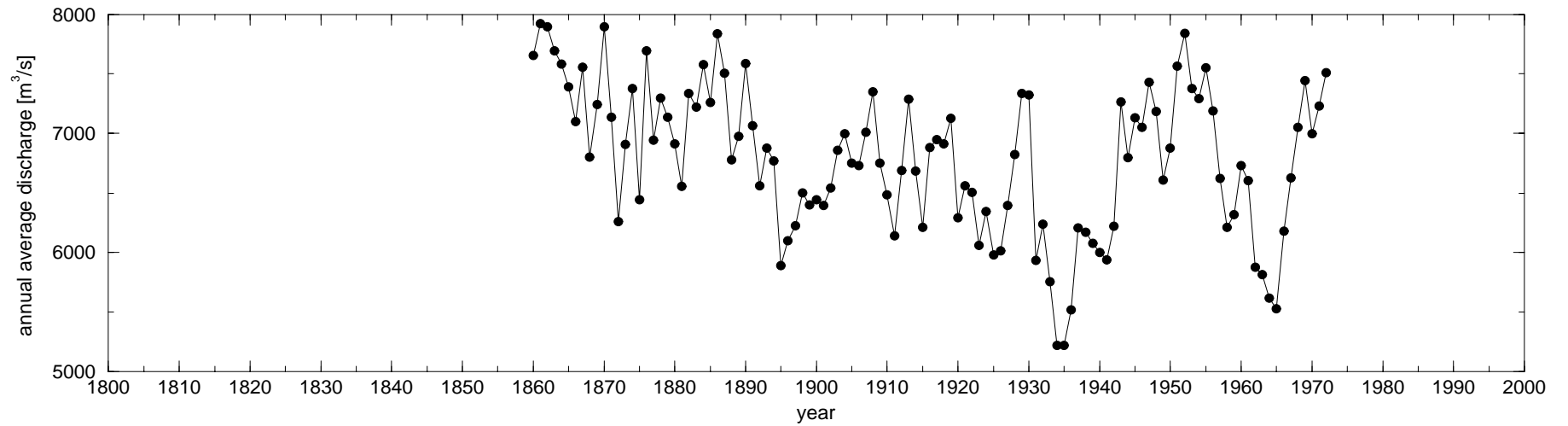
South Saskatchewan (Saskatoon)



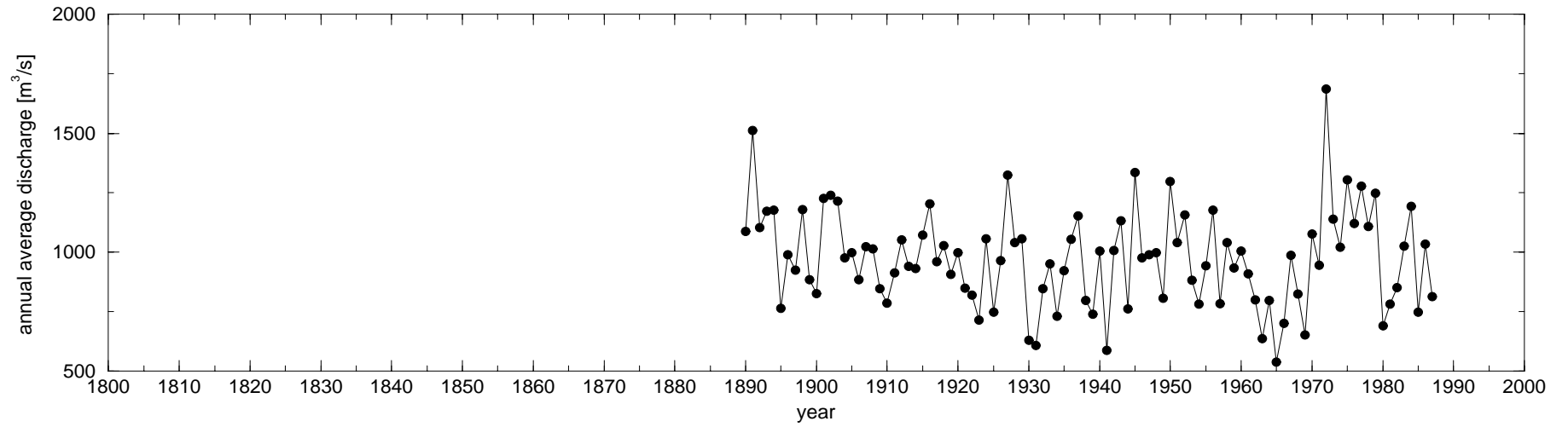
ST. LAWRENCE (CORNWALL, ONT.)



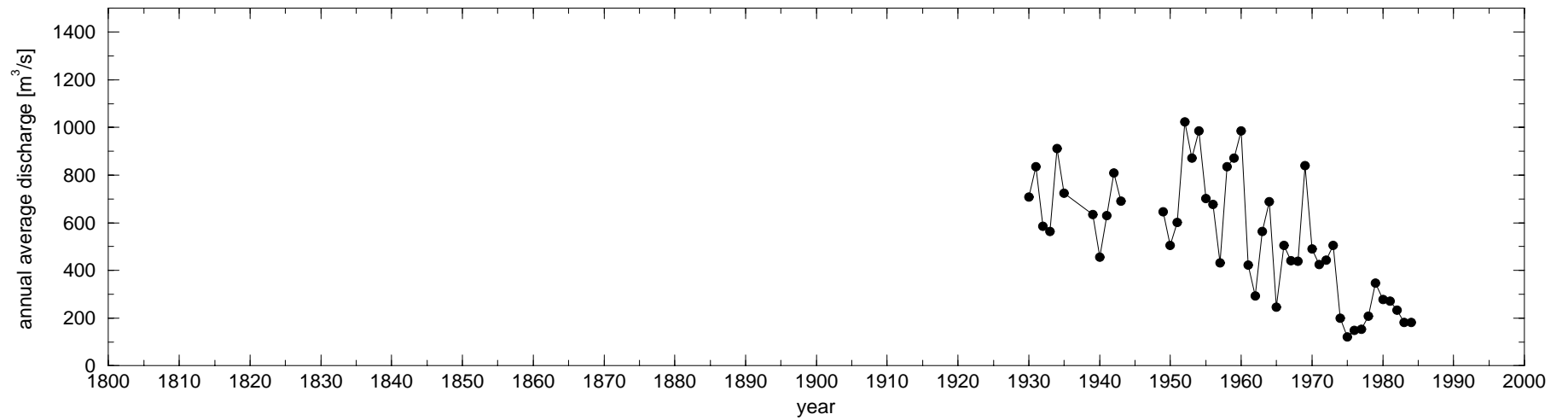
ST. LAWRENCE (OGDENSBURG, N.Y.)



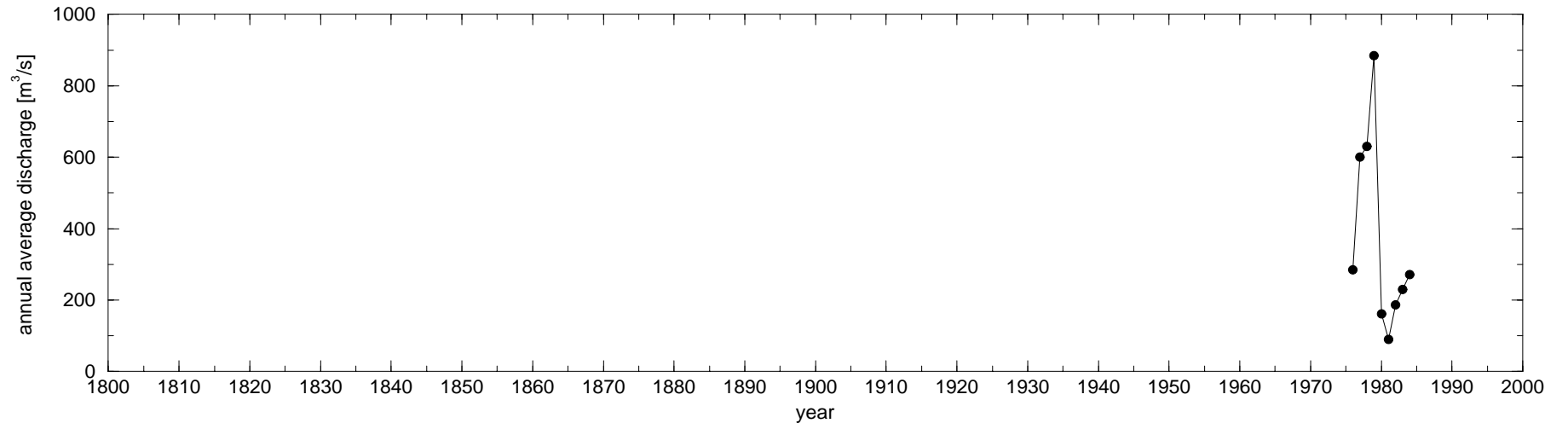
SUSQUEHANNA (HARRISBURG, PA.)



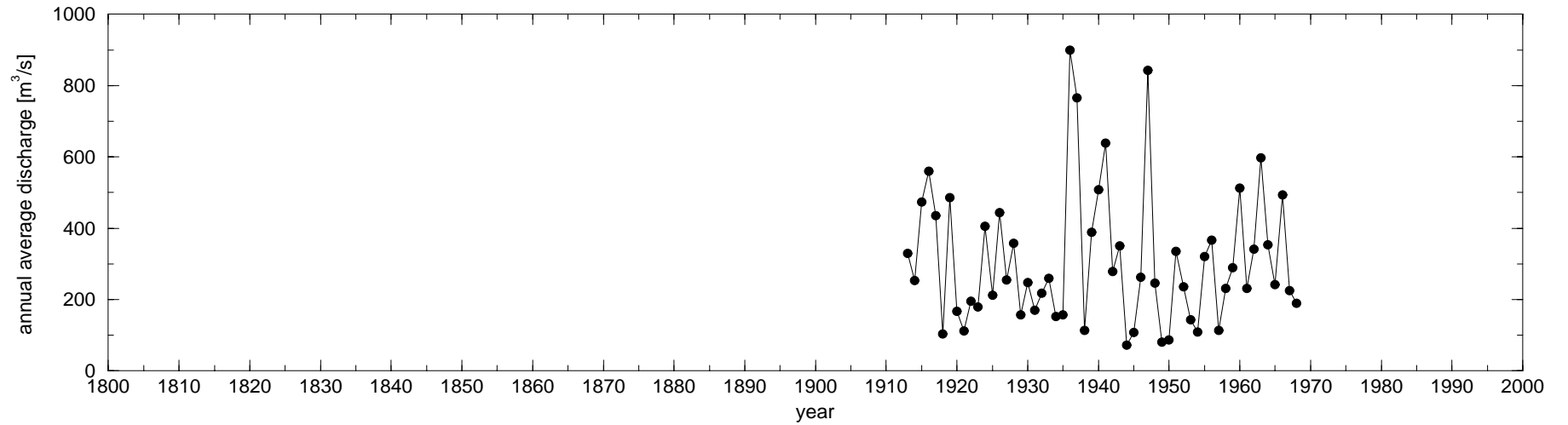
SYR-DARYA (TYUMEN-ARYK)



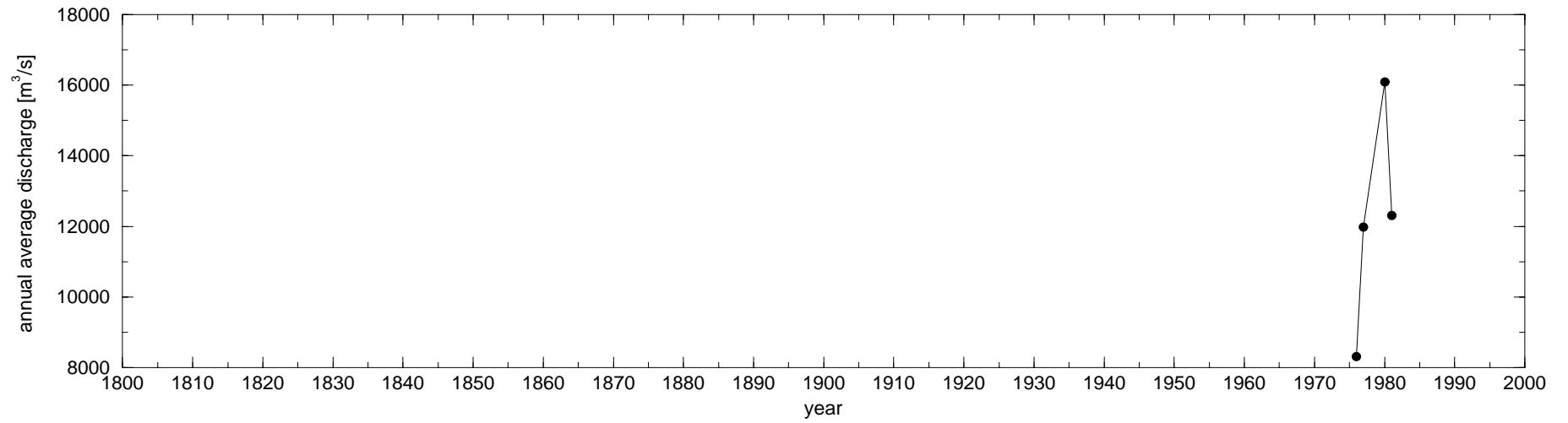
TEJO (ALMOUROL)



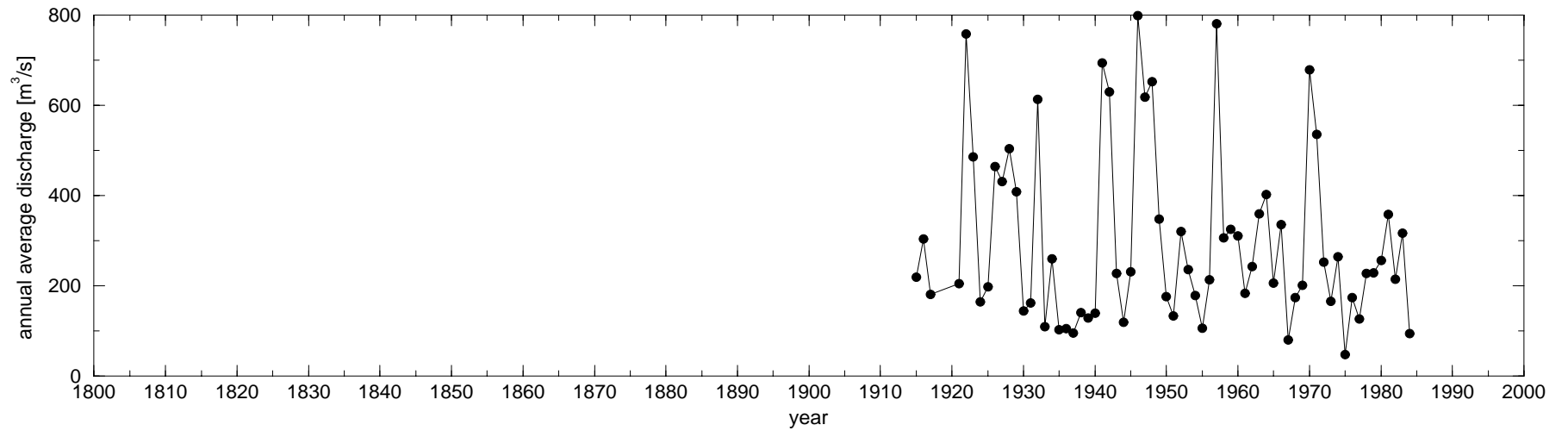
TEJO (V.V. DE RODAO)



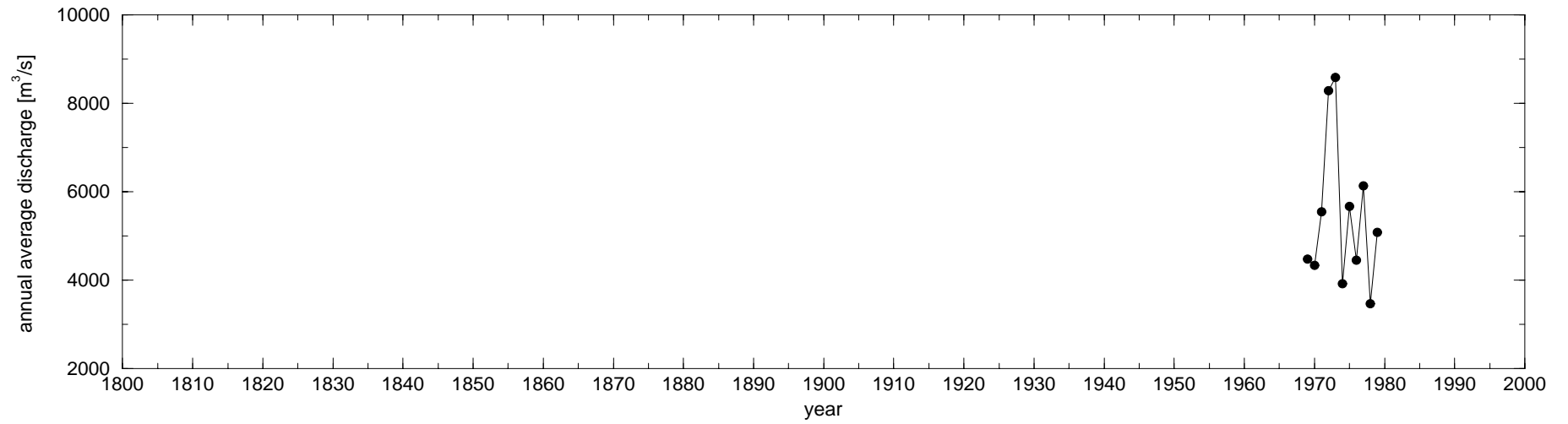
TOCANTINS (ITUPIRANGA)



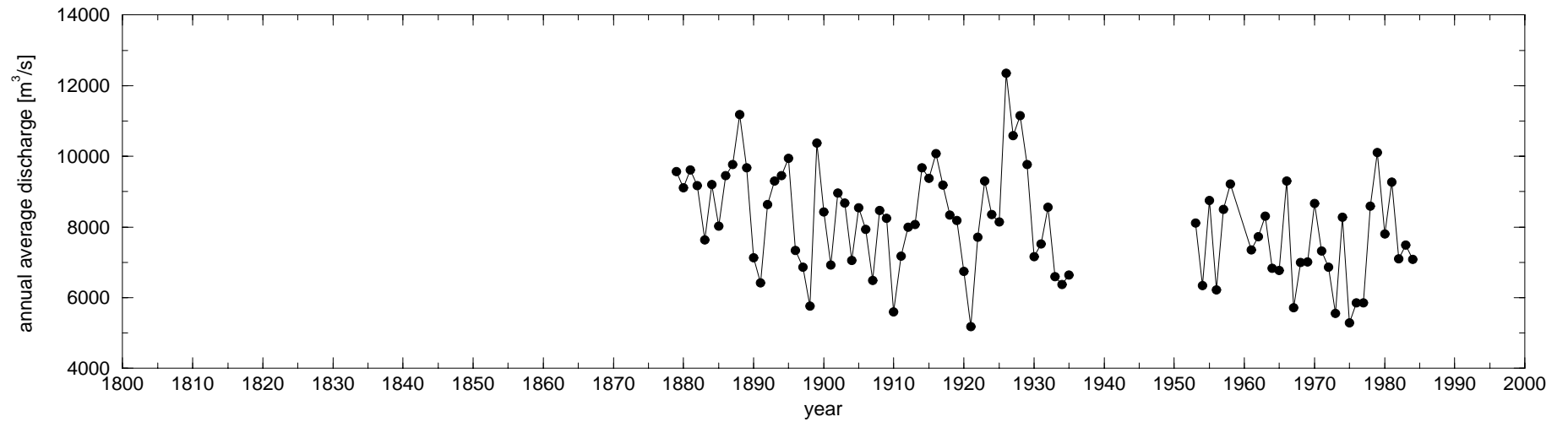
URAL (KUSHUM)



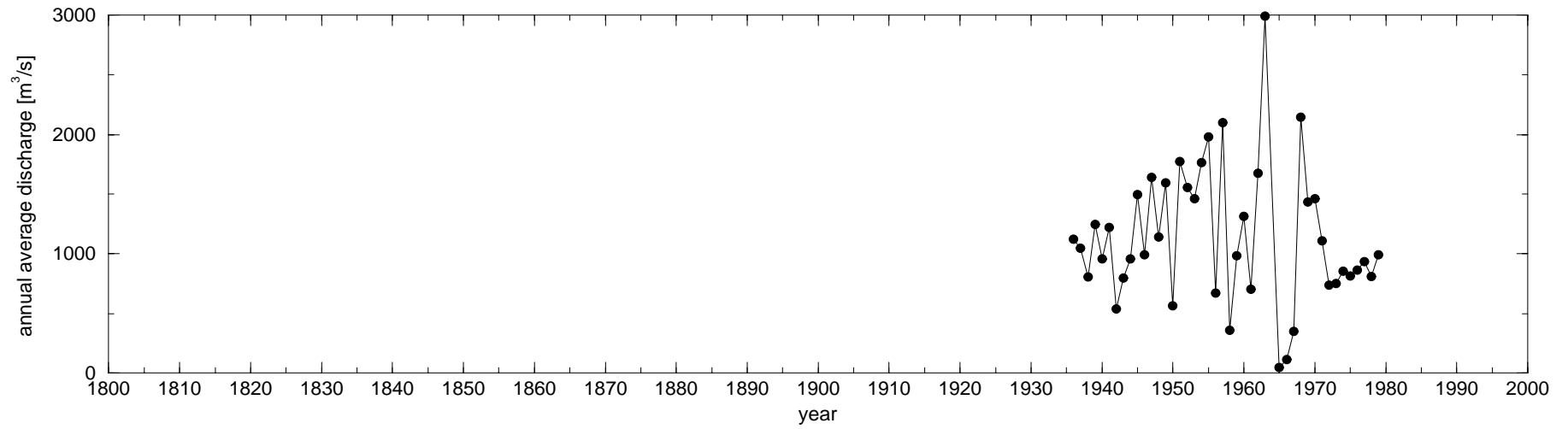
URUGUAY (CONCORDIA)



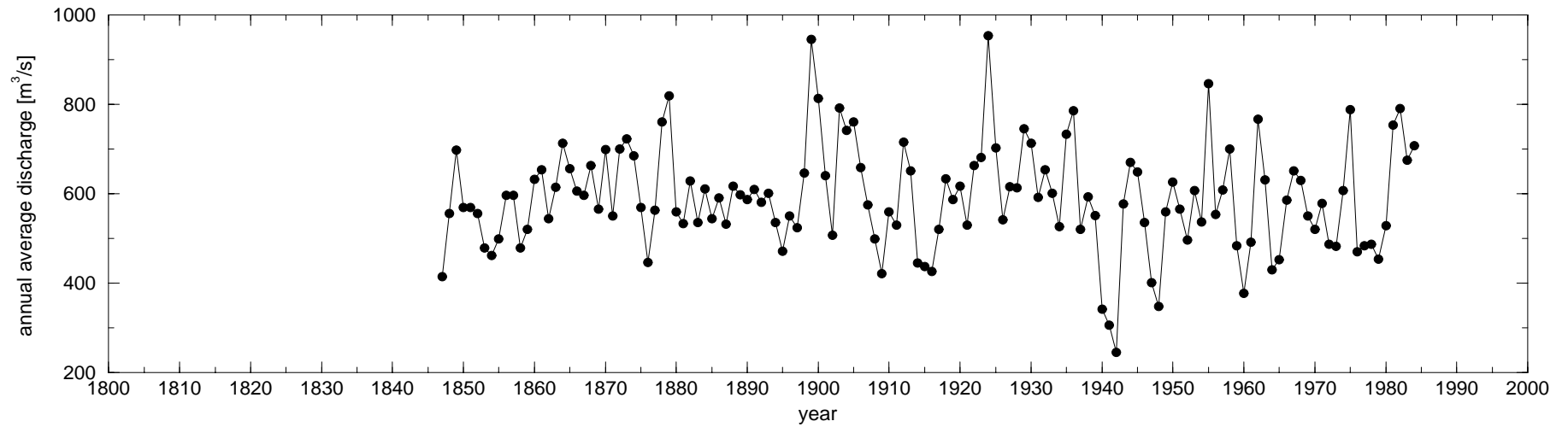
VOLGA (VOLGOGRAD)



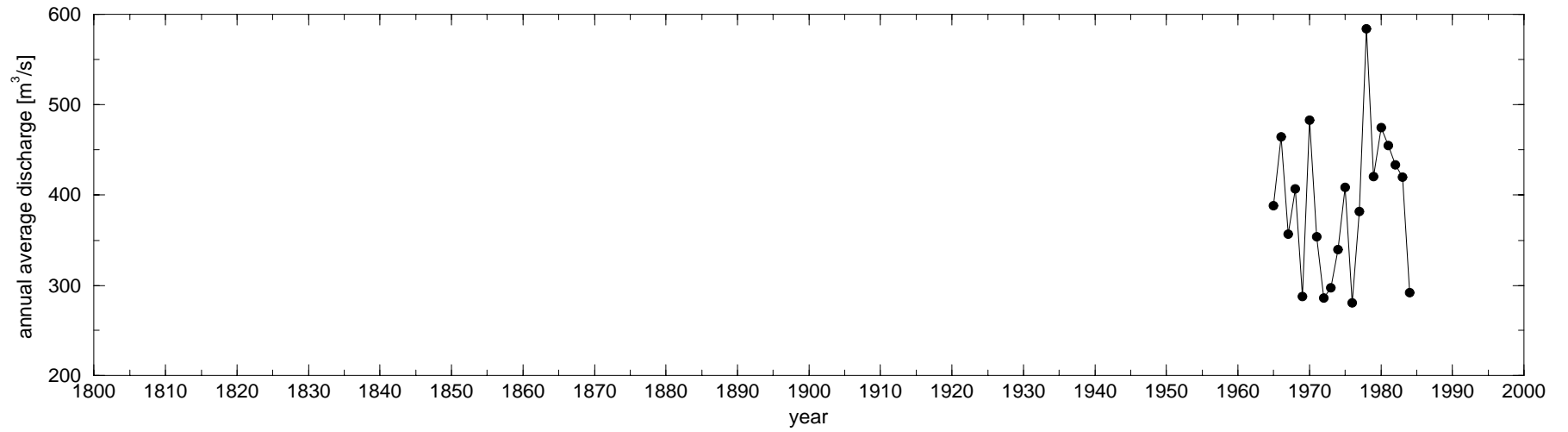
VOLTA (SENCHI)



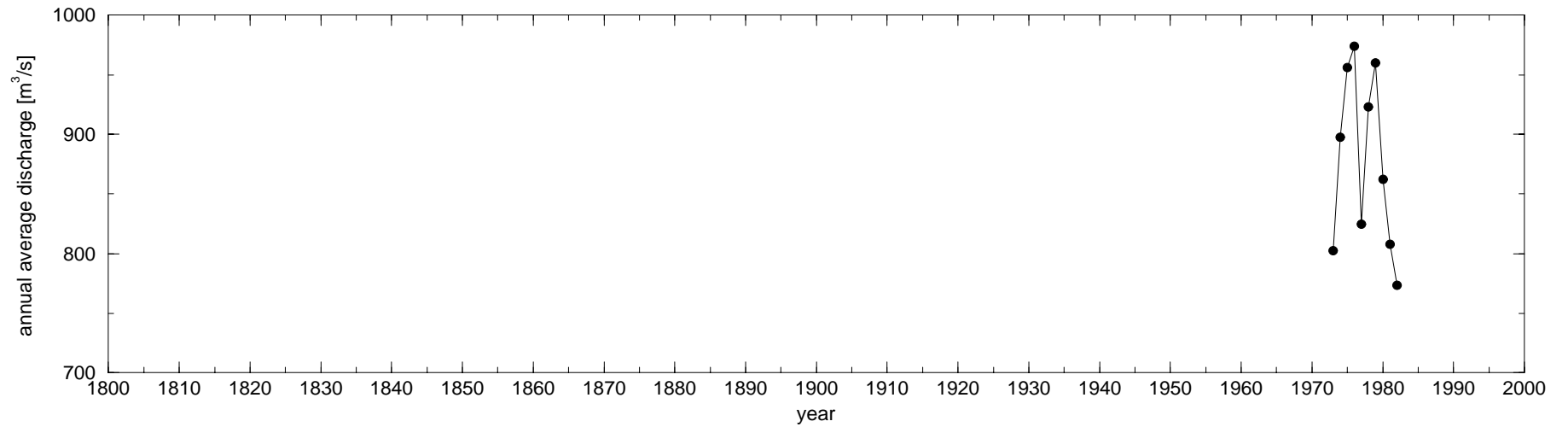
VUOKSI (IMATRA)



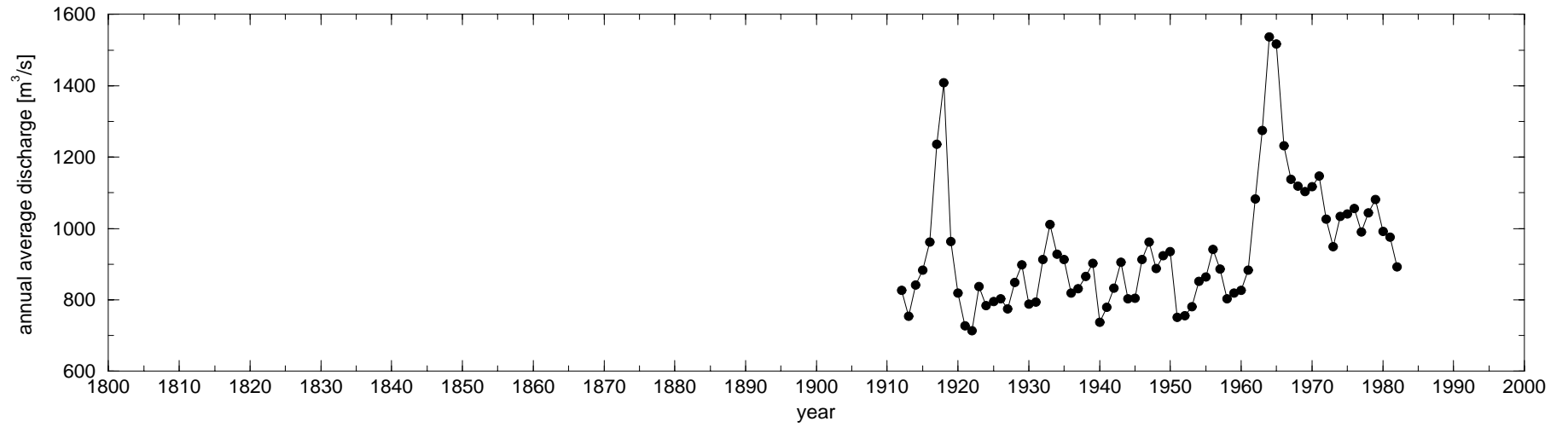
WESTERN DVINA (DAUGAVPILS)



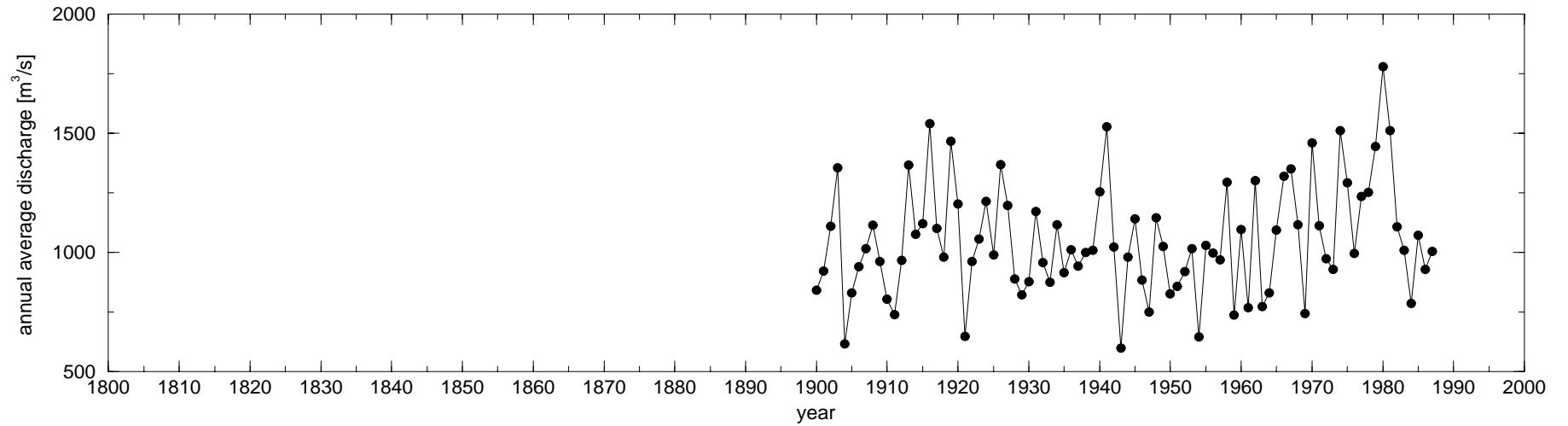
WHITE NILE (JEBEL AULIA DAM)



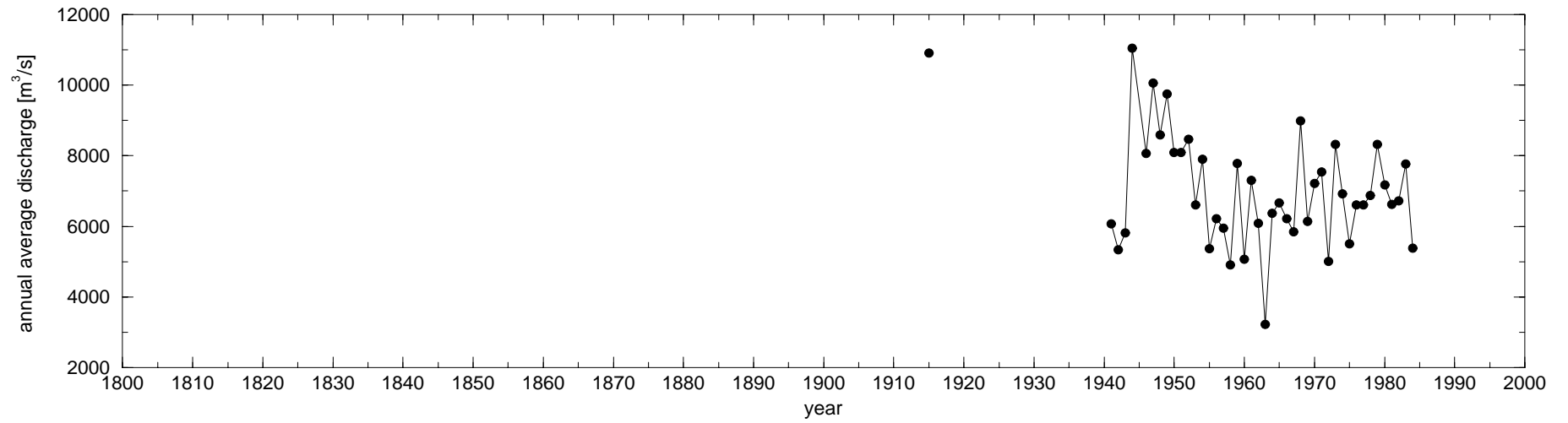
WHITE NILE (MALAKAL)



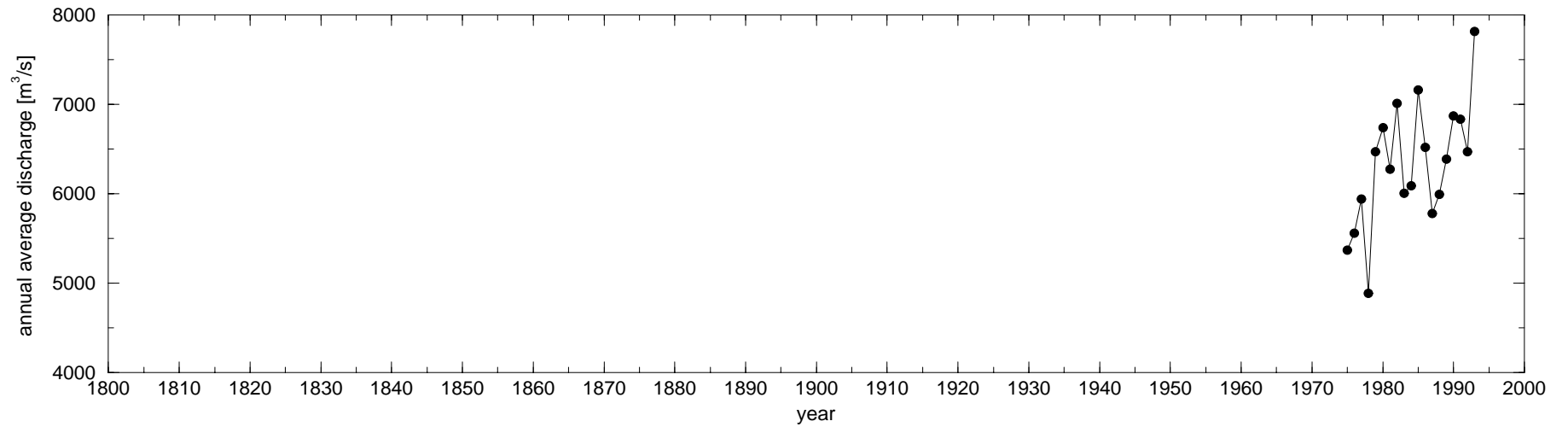
WISLA (TCZEW)



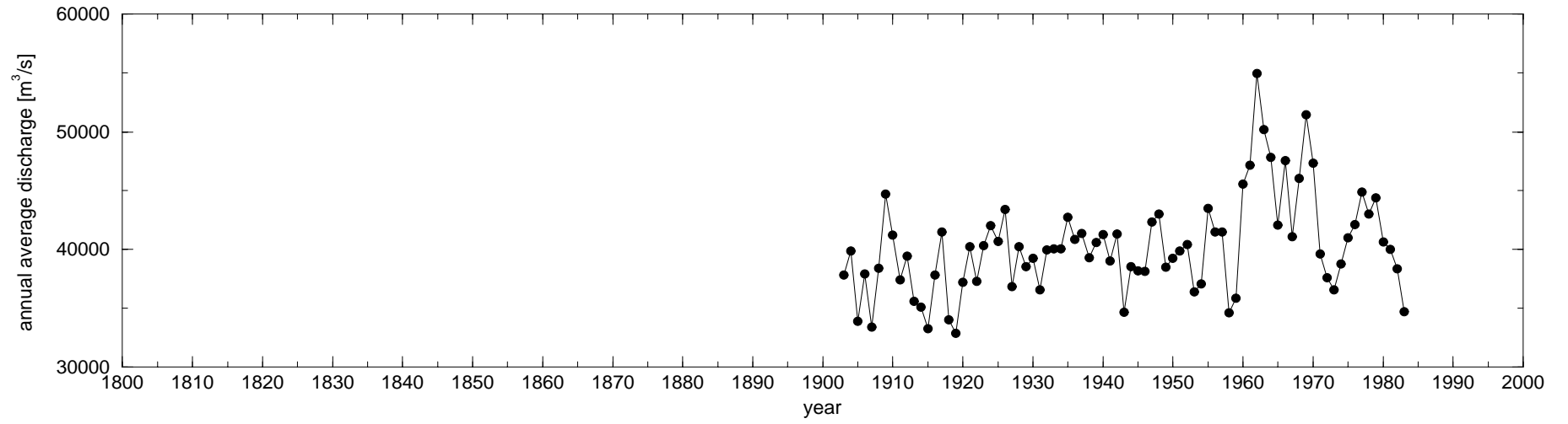
XIJIANG (WUZHOU)



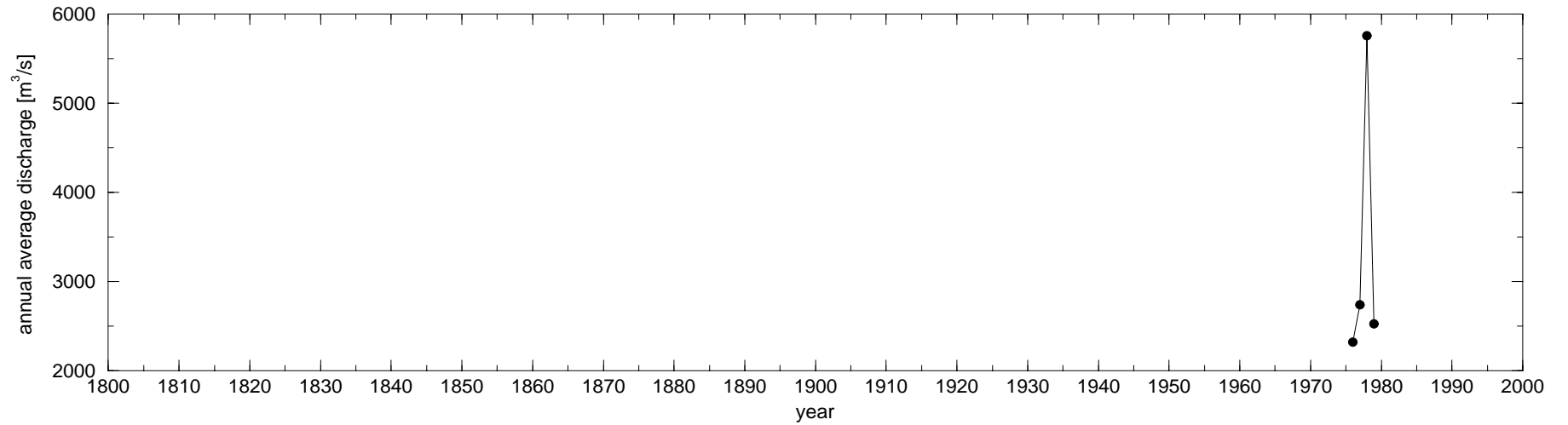
YUKON (PILOT STATION)



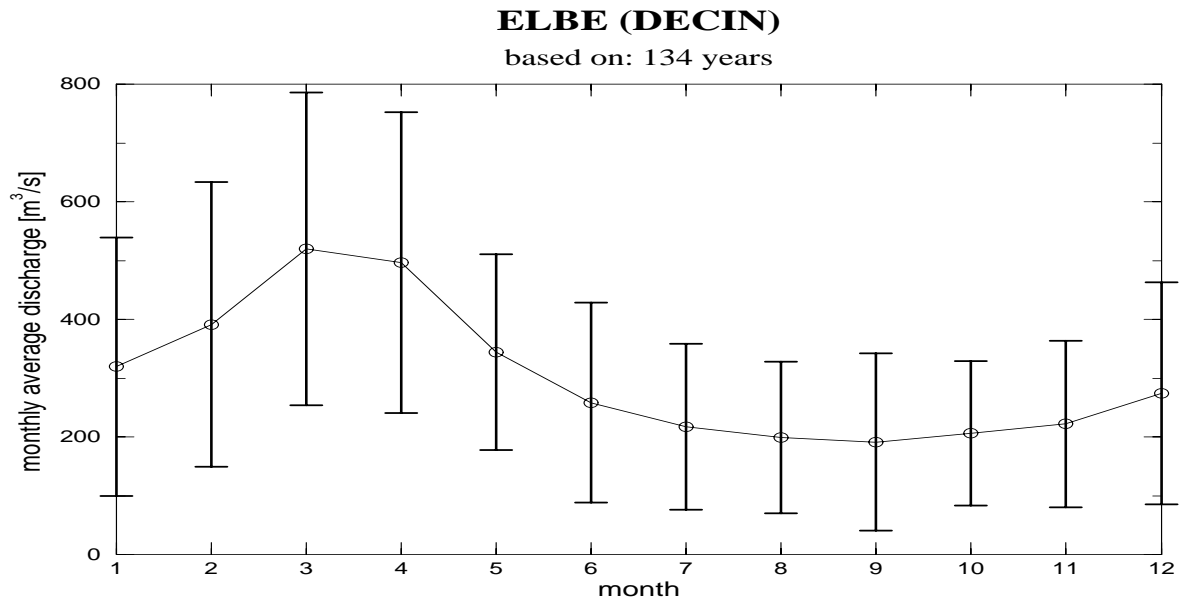
ZAIRE (KINSHASA)



ZAMBEZE (MATUNDO-CAIS)



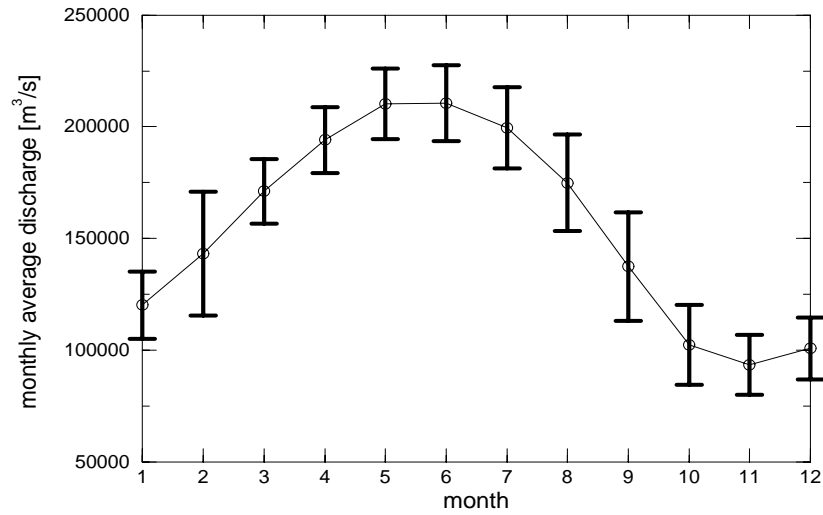
3. Annual cycles: monthly averages and standard deviations



This section presents the annual cycles of monthly mean discharge averaged over all the years that are available for an individual river. For each river, the standard deviations of the annual cycles are shown by error bars.

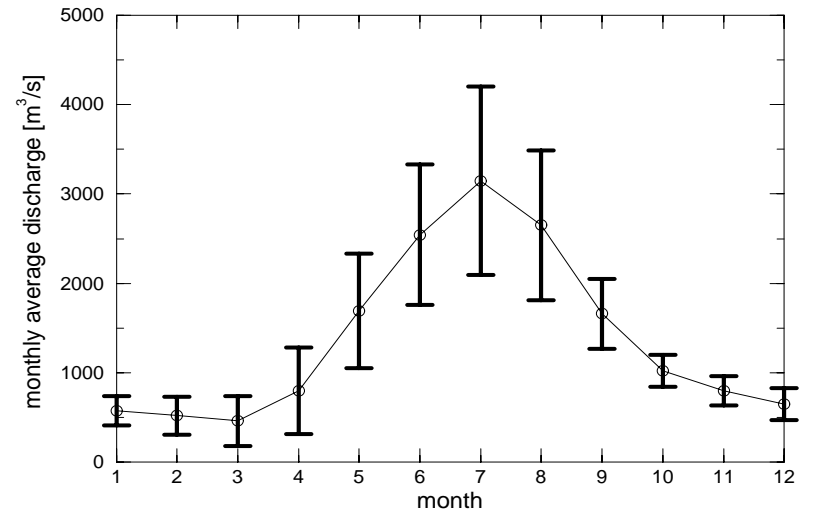
AMAZONAS (OBIDOS)

based on: 56 years



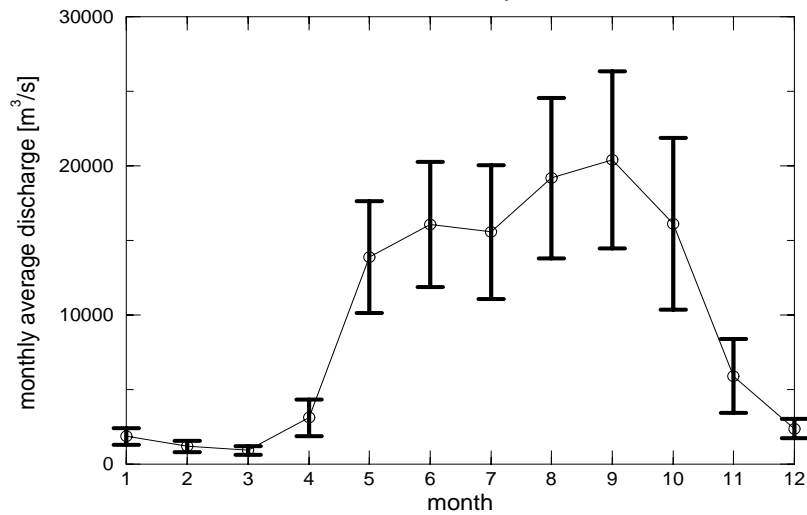
AMU-DARYA (CHATLY)

based on: 43 years



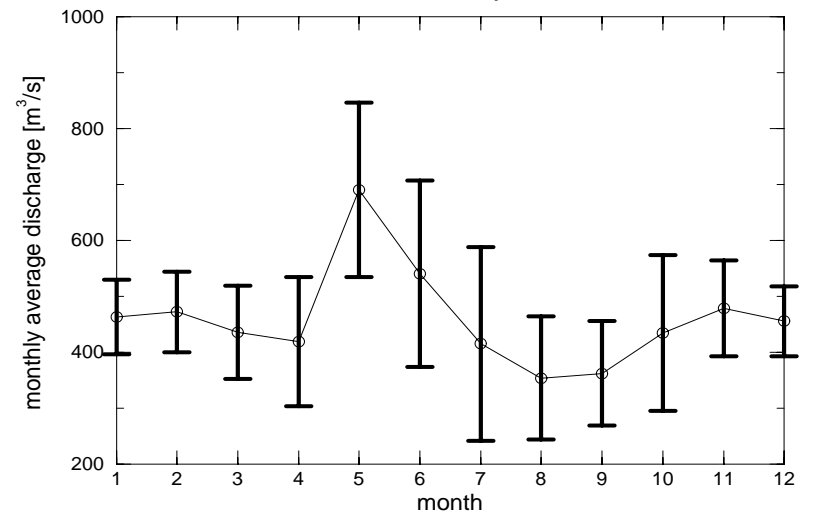
AMUR (KOMSOMOLSK)

based on: 52 years



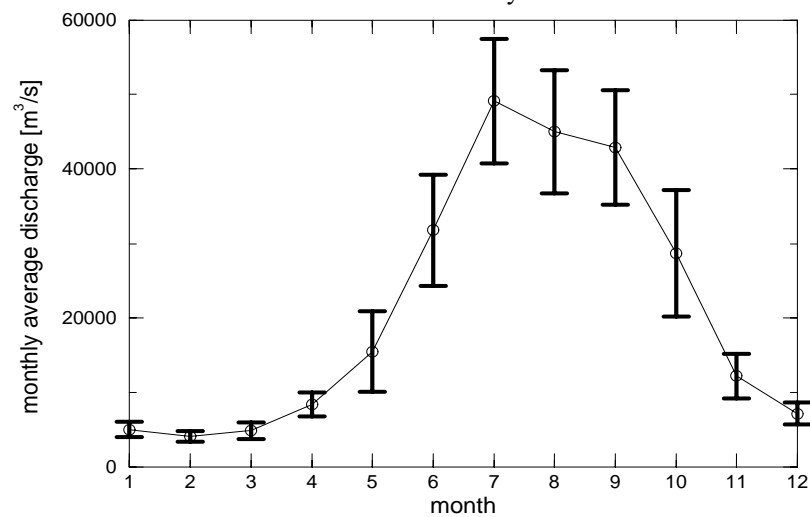
ANGERMANALVEN (SOLLEFTEN)

based on: 20 years



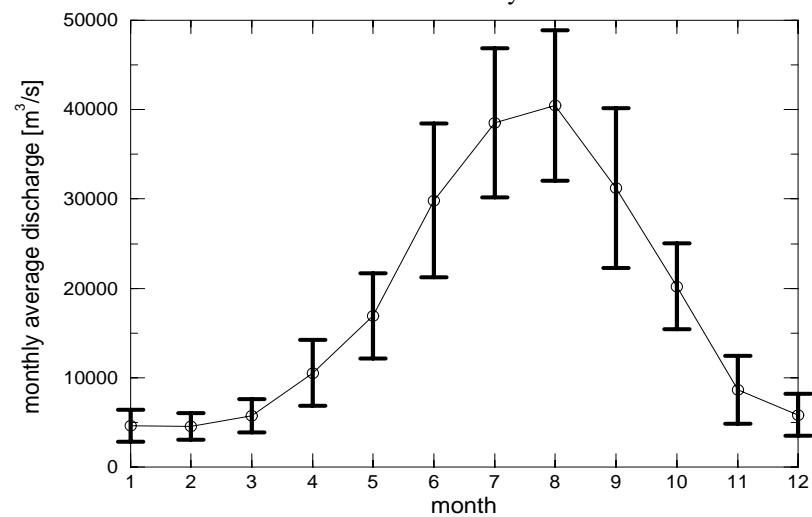
BRAHMAPUTRA (BAHADURABAD)

based on: 24 years



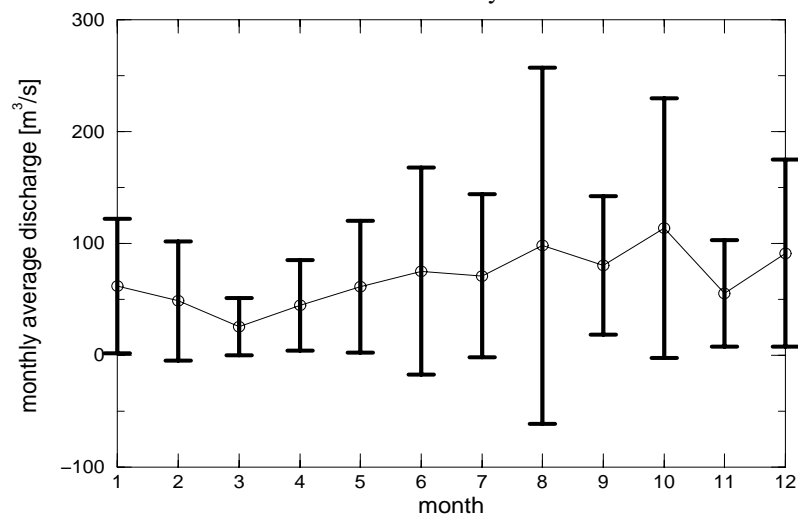
BRAHMAPUTRA (PANDU)

based on: 24 years



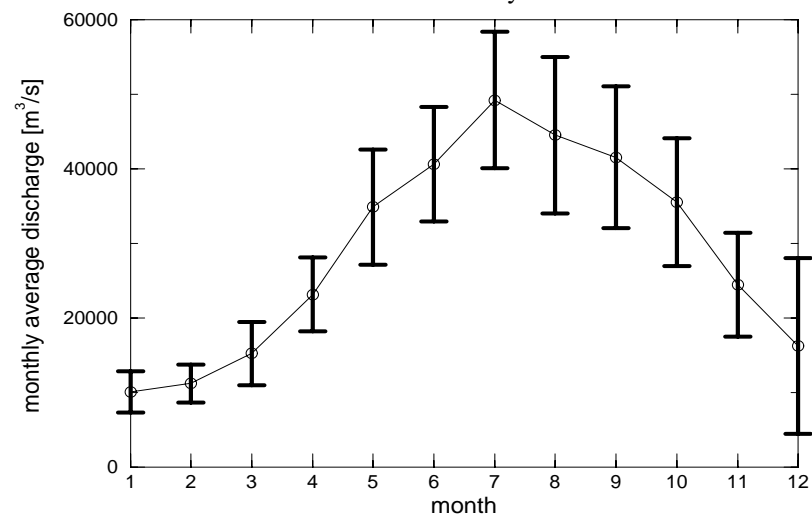
BRAVO (MATAMOROS)

based on: 4 years



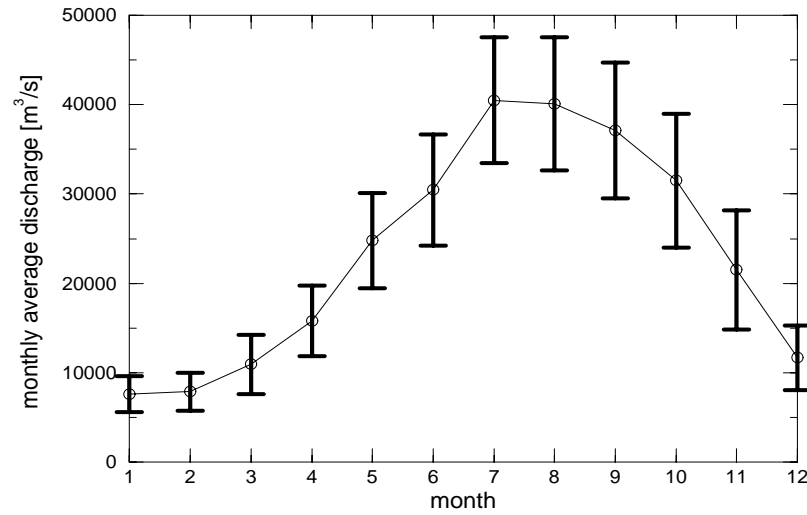
CHANGJIANG (DATONG)

based on: 64 years

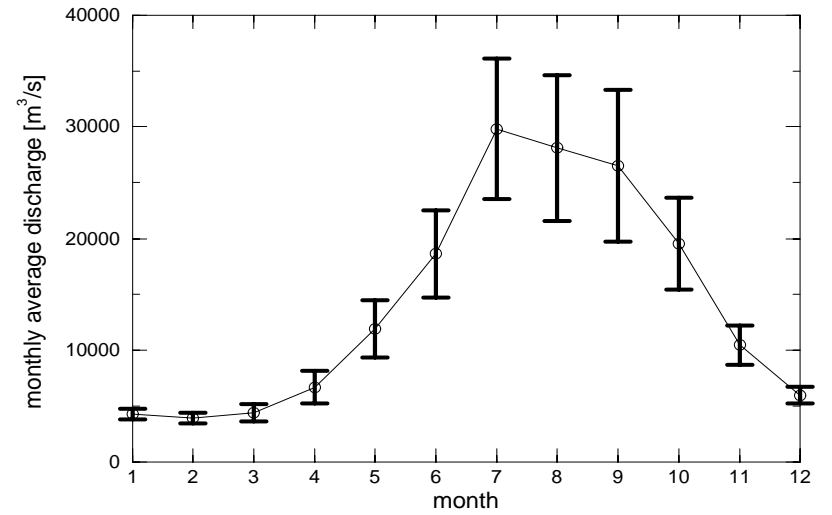


CHANGJIANG (HANKOU)

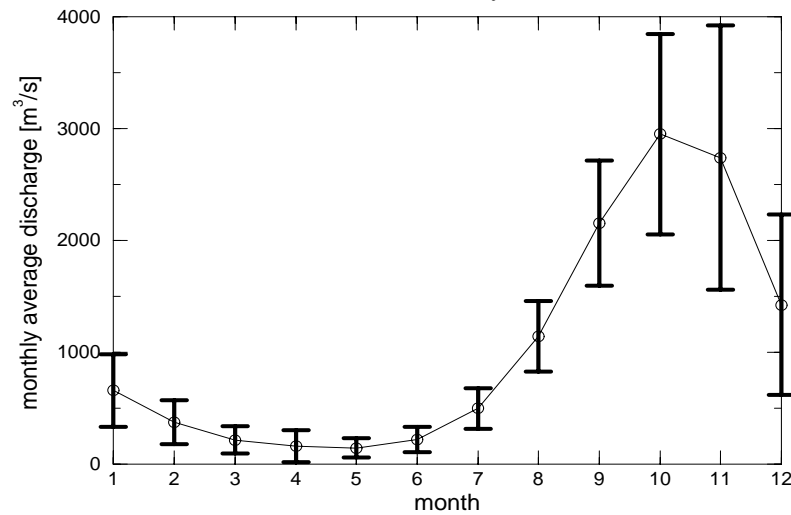
based on: 115 years

**CHANGJIANG (YICHANG)**

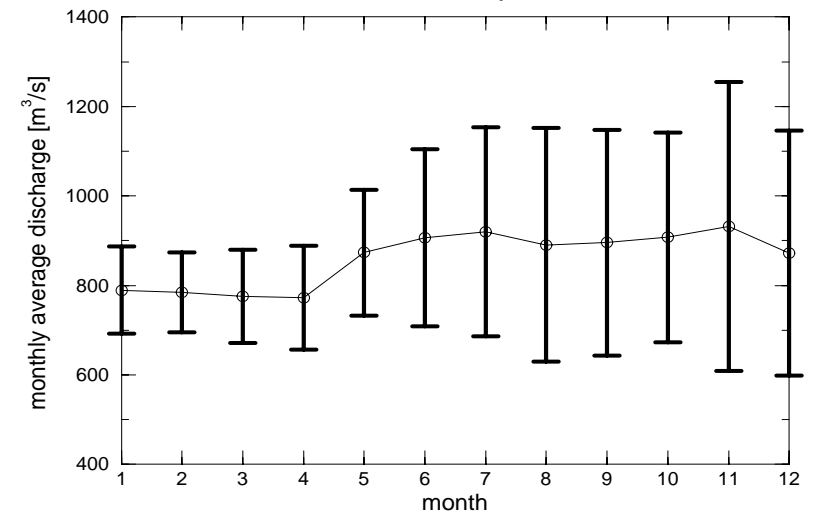
based on: 107 years

**CHARI (N'DJAMENA)**

based on: 59 years

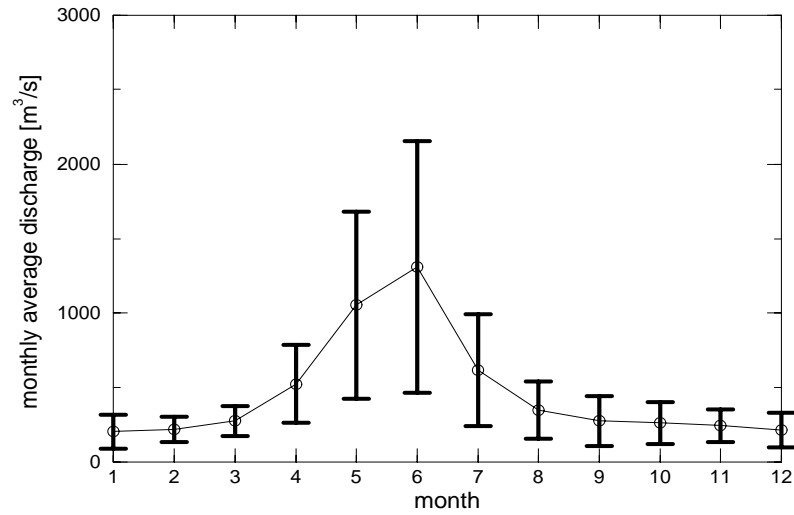
**CHURCHILL (GRANVILLE FALLS)**

based on: 19 years

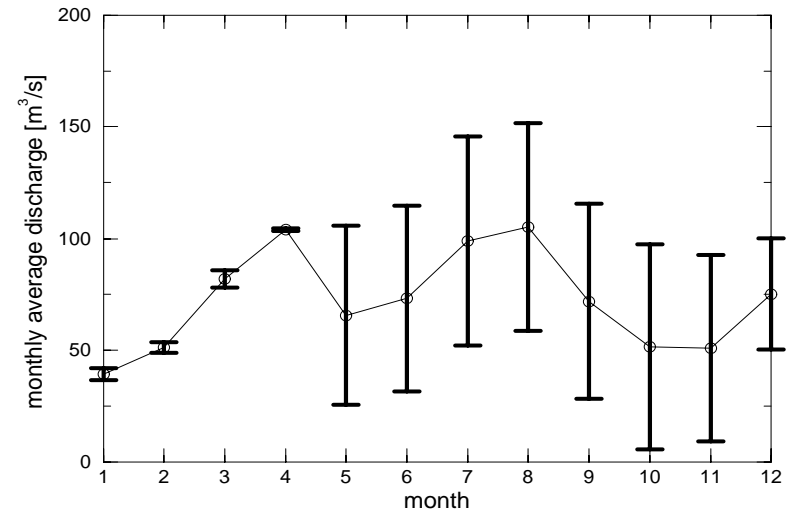


COLORADO (LEES FERRY, ARIZ.)

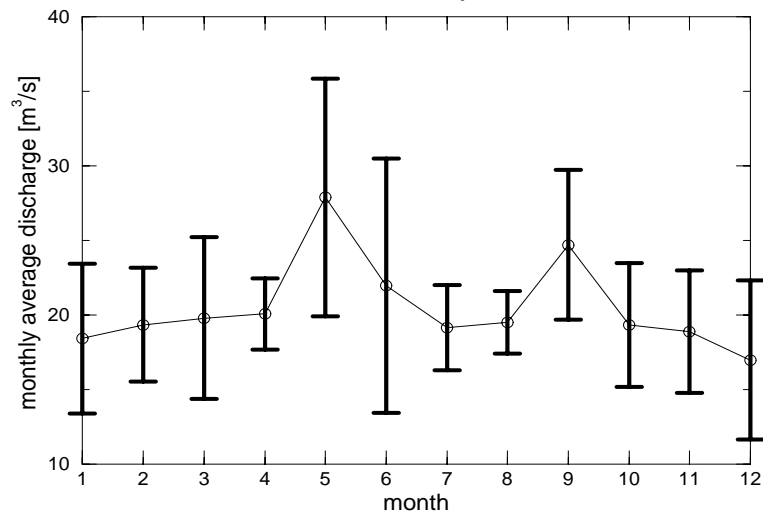
based on: 74 years

**COLORADO (LIMITE INTERNATIONAL NORTE)**

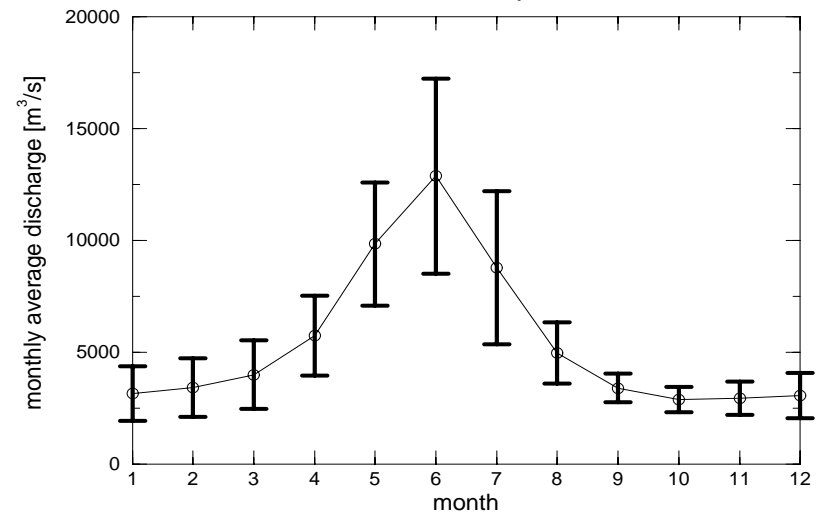
based on: 4 years

**COLORADO (YUMA, ARIZ.)**

based on: 11 years

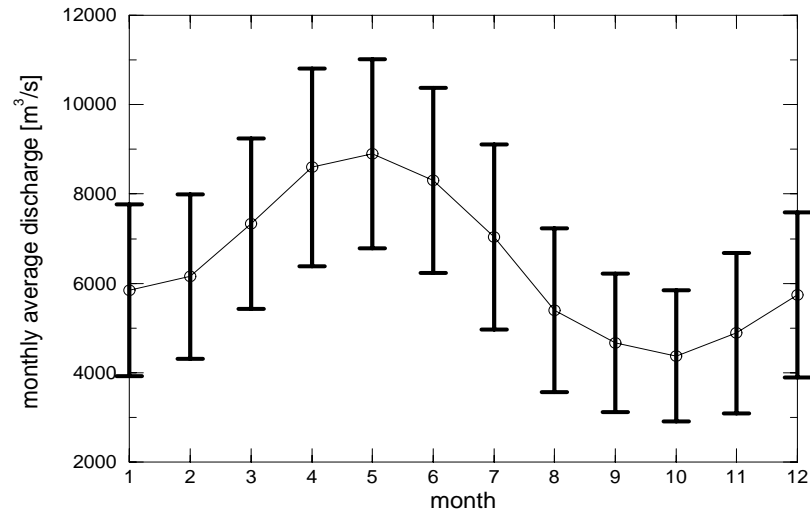
**COLUMBIA (THE DALLAS, OREG.)**

based on: 111 years

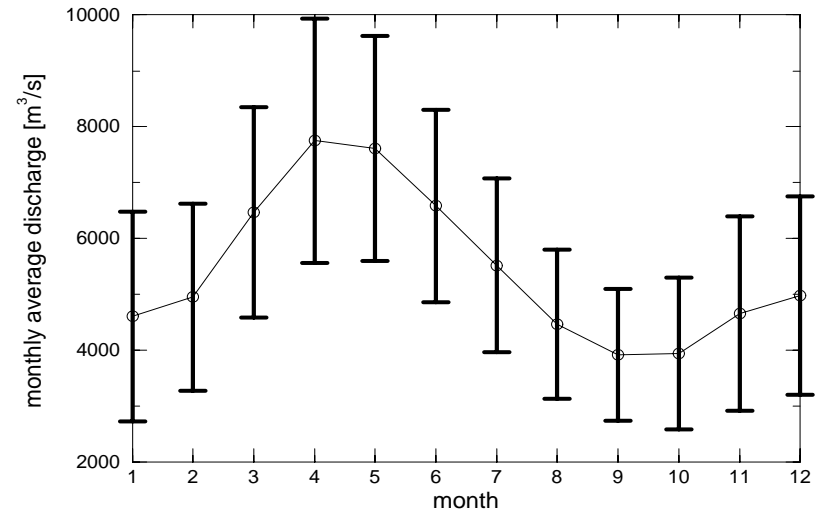


DANUBE (CEANTAL IZMAIL)

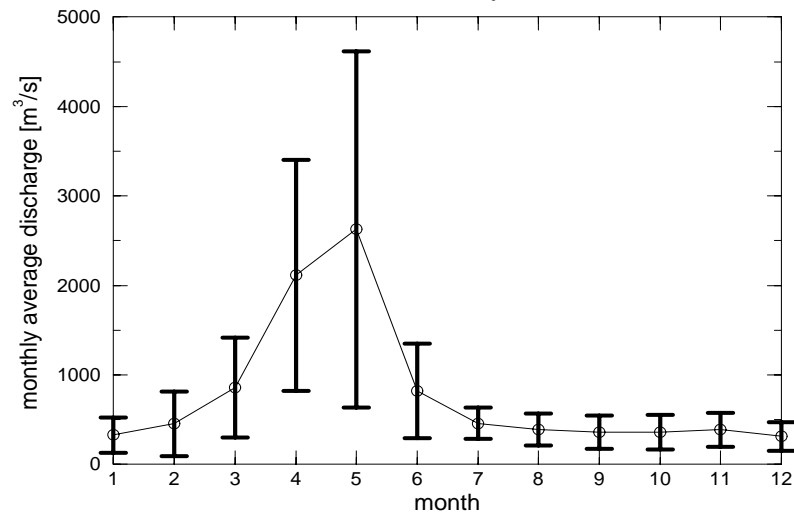
based on: 70 years

**DANUBE (ORSOVA)**

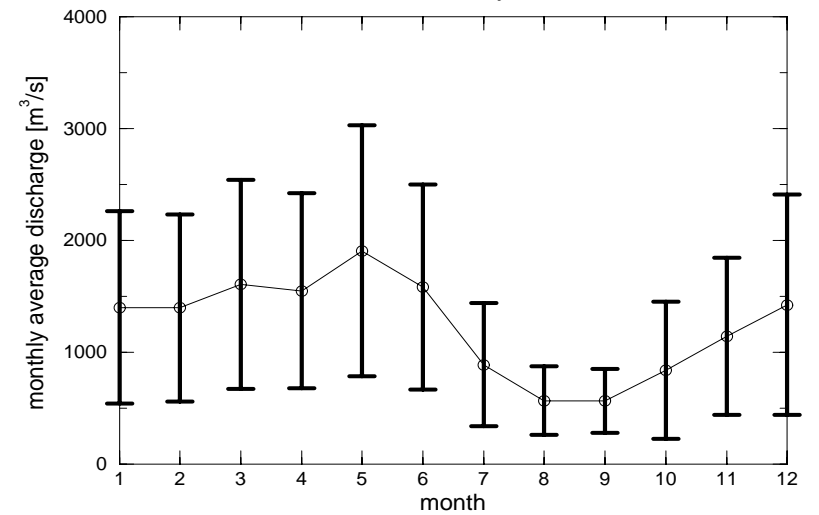
based on: 149 years

**DON (RAZDORSKAYA)**

based on: 94 years

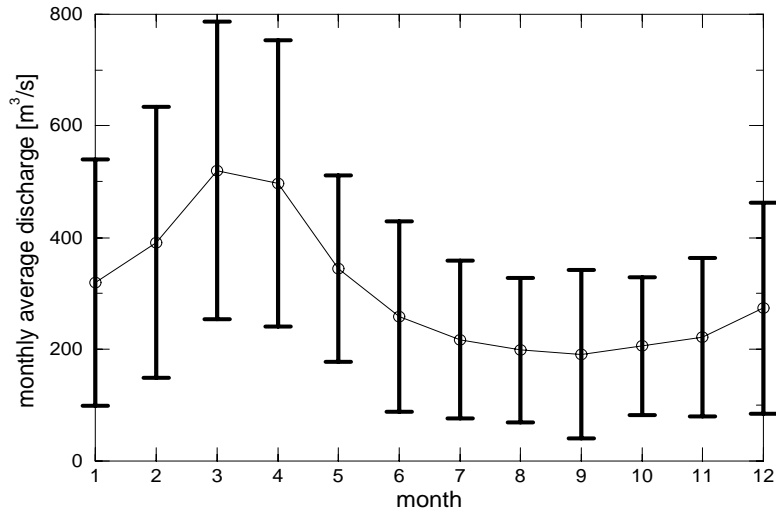
**EBRO (TORTOSA)**

based on: 72 years



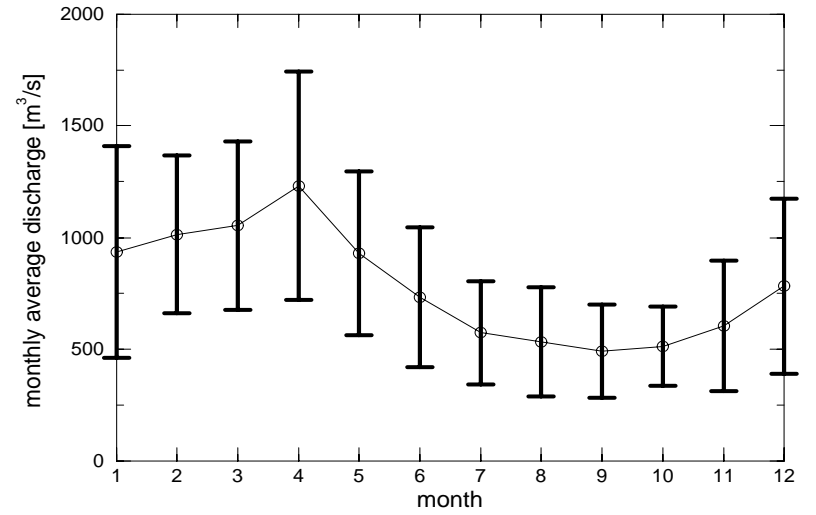
ELBE (DECIN)

based on: 134 years



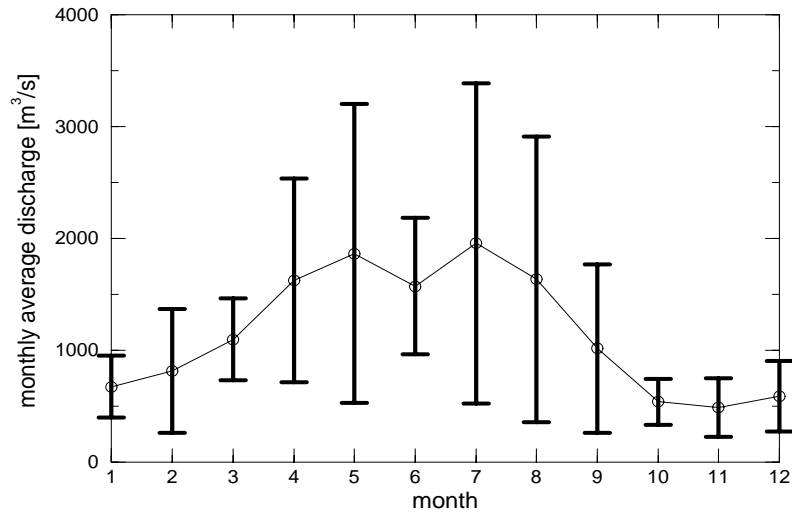
ELBE (NEU-DARCHAU)

based on: 24 years



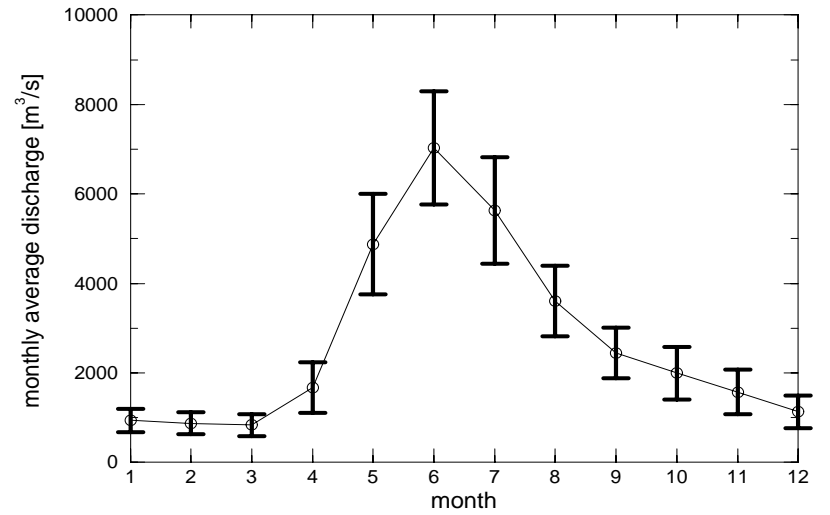
EUPHRATES (HIT D.S.)

based on: 8 years



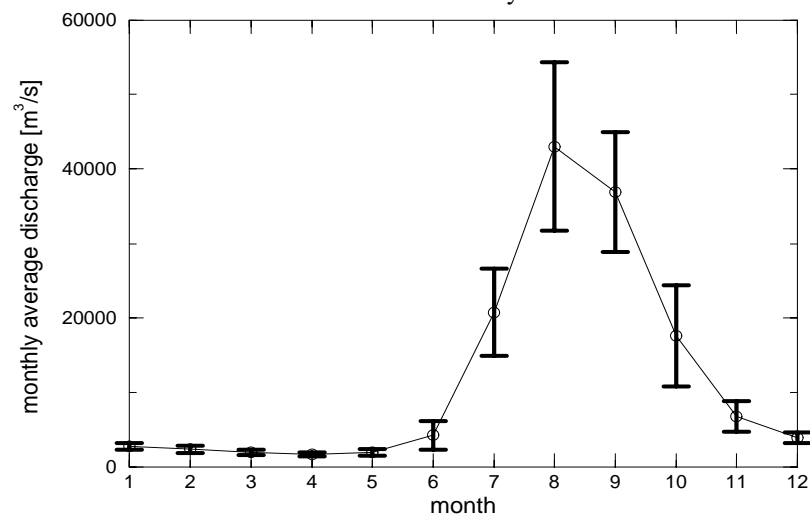
FRASER (HOPE)

based on: 73 years



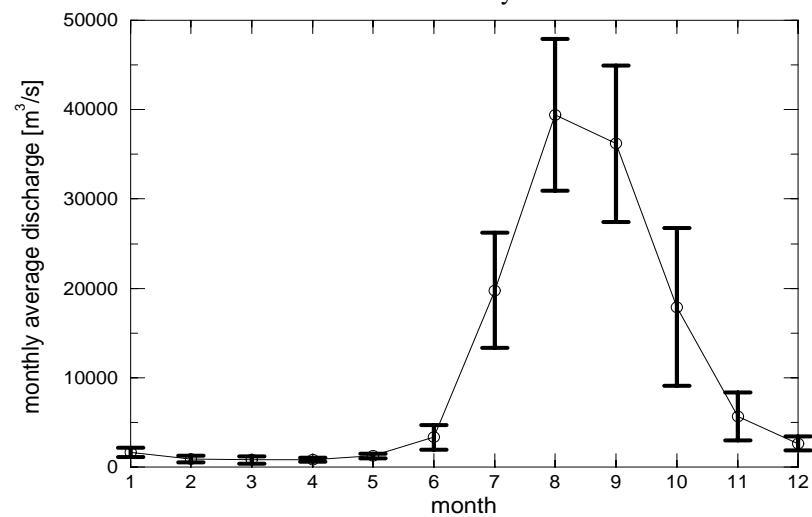
GANGES (FARAKKA)

based on: 25 years



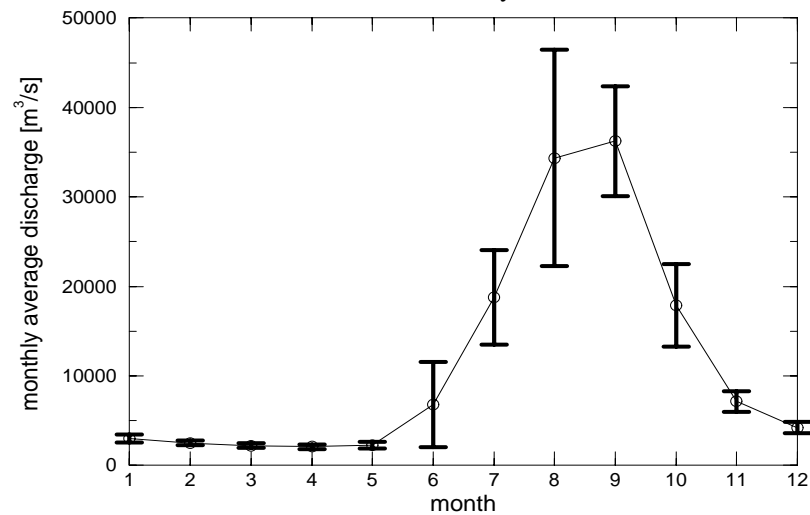
GANGES (HARDINGE BRIDGE)

based on: 8 years



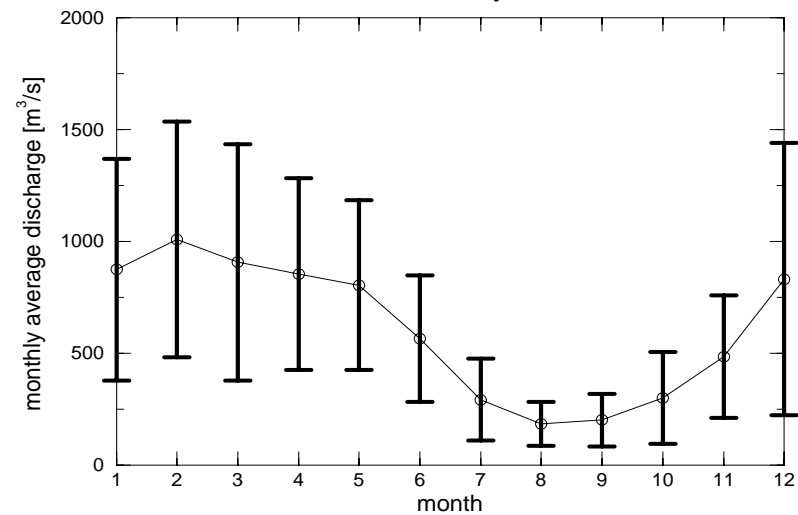
GANGES (PAKSEY)

based on: 7 years



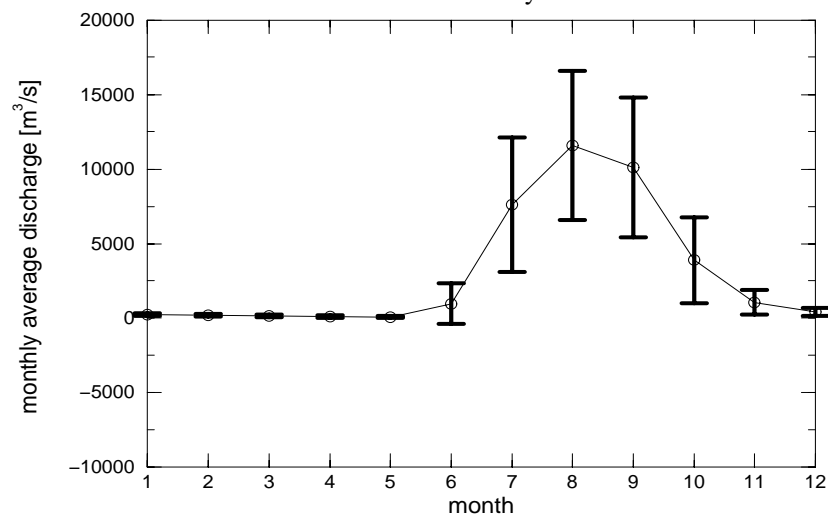
GARONNE (MAS D'AGENAI)

based on: 60 years



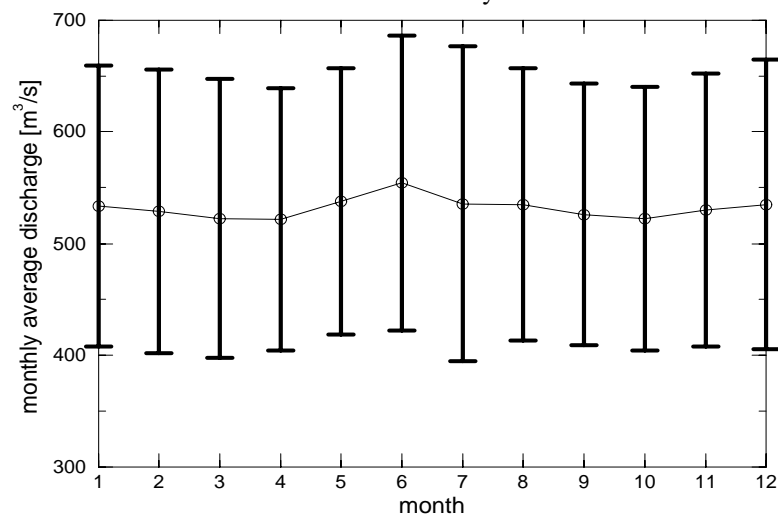
GODAVARI (POLAVARAM)

based on: 79 years



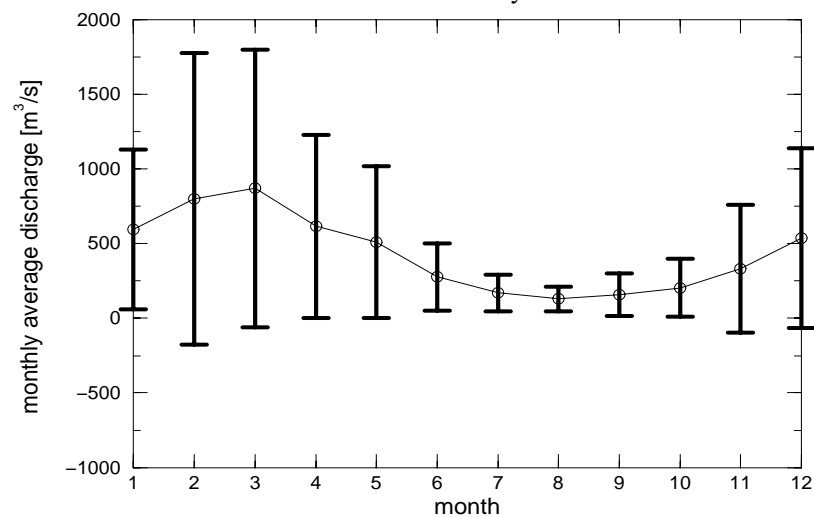
GOETA-VAENERN (VAENERSBORG)

based on: 178 years



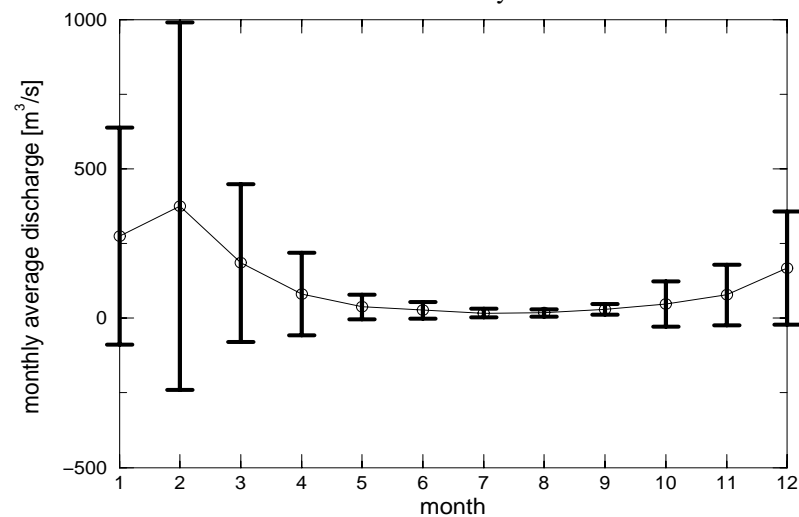
GUADALQUIVIR (ALCALA DEL RIO)

based on: 72 years



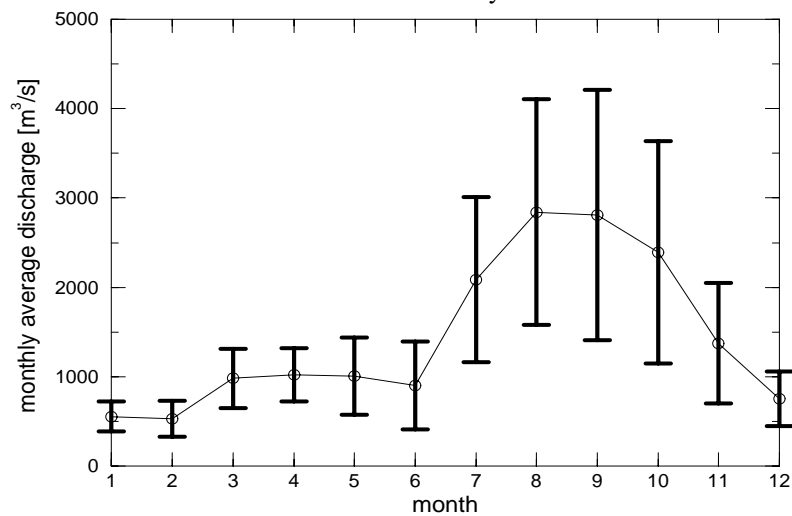
GUADIANA (PULO DO LOBO)

based on: 12 years



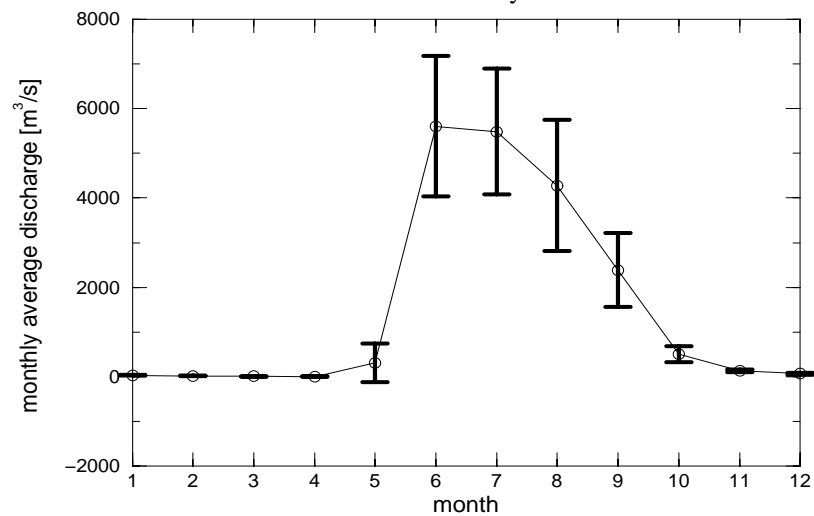
HUANGHE (HUAYUANKOU)

based on: 43 years



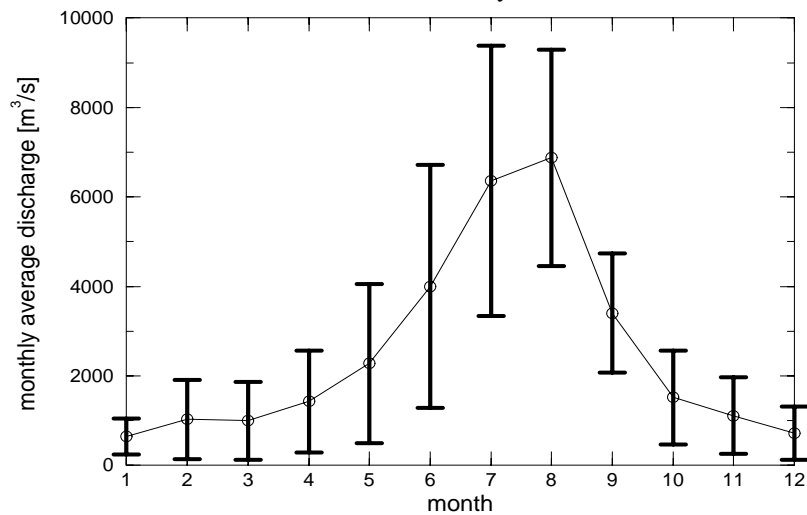
INDIGIRKA (VORONTSOVO)

based on: 48 years



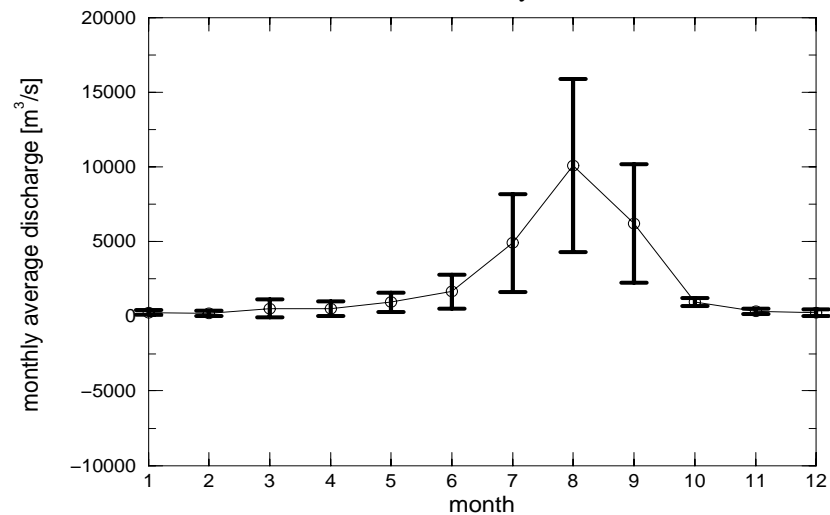
INDUS (ATTOCK)

based on: 7 years



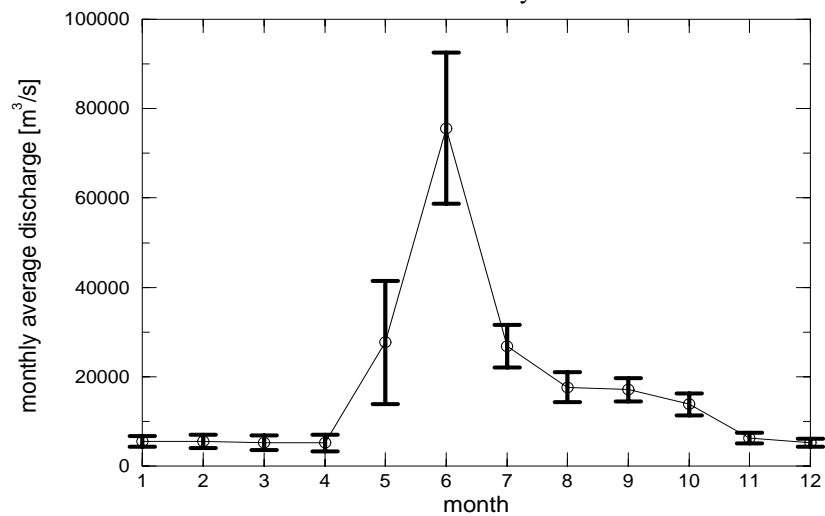
INDUS (KOTRI)

based on: 7 years

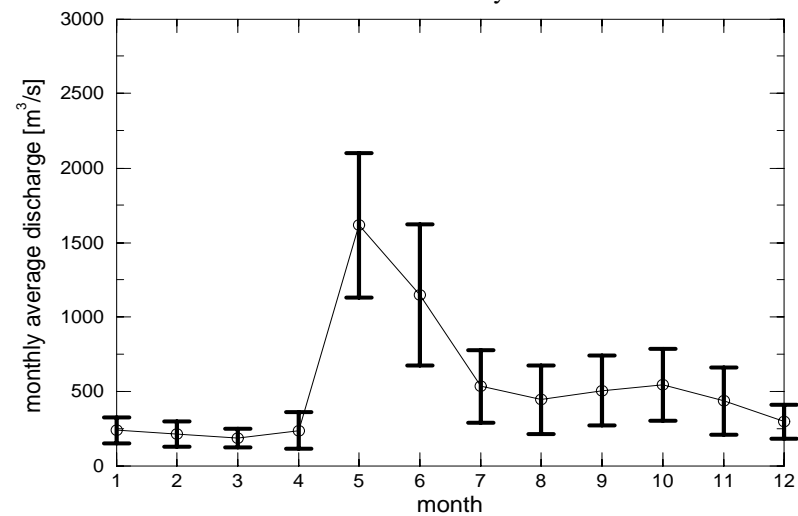


JENISSAI (IGARKA)

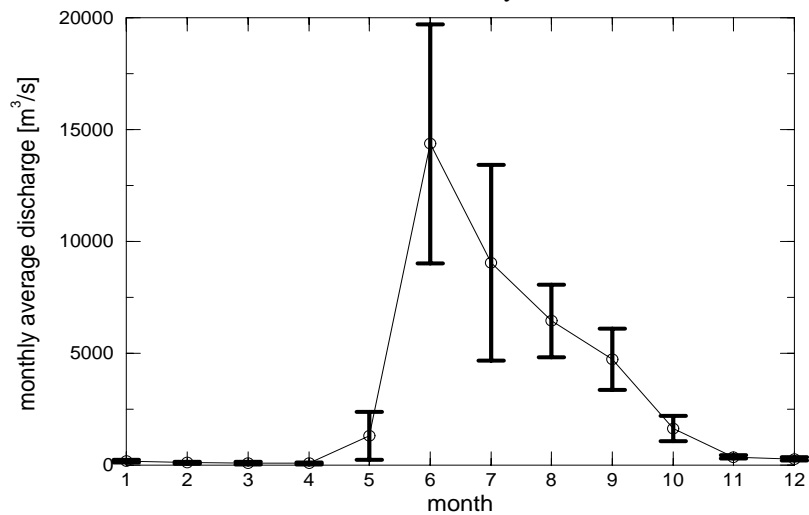
based on: 49 years

**KEMI (TAIVALKOSKI)**

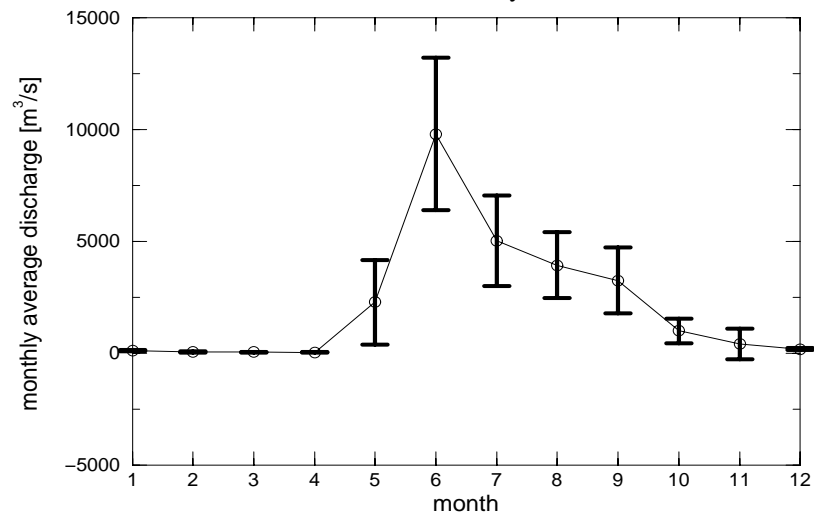
based on: 74 years

**KOLYMA (KOLYMSKAYA)**

based on: 11 years

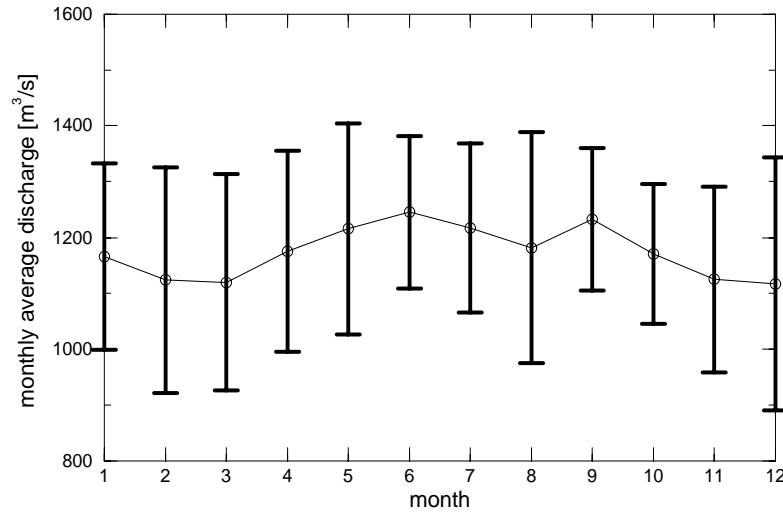
**KOLYMA (SREDNE-KOLYMSK)**

based on: 58 years



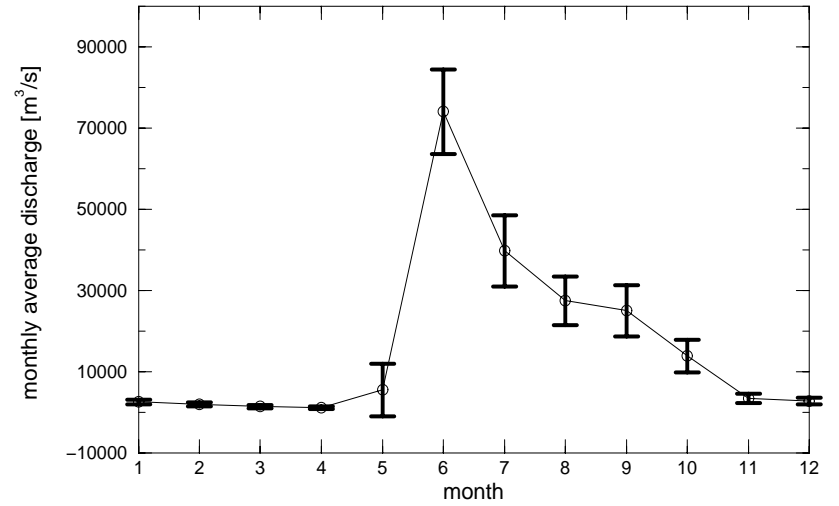
LAKE VICTORIA (OYEAN RES./OWEN FALLS)

based on: 10 years



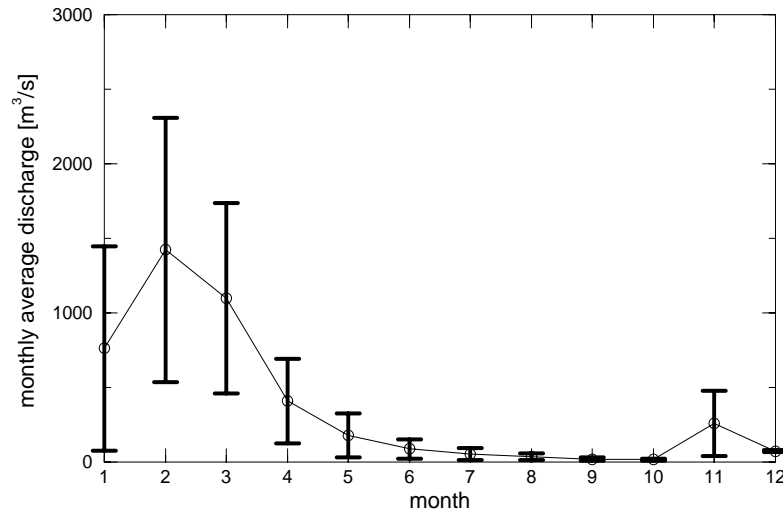
LENA (KUSUR)

based on: 50 years



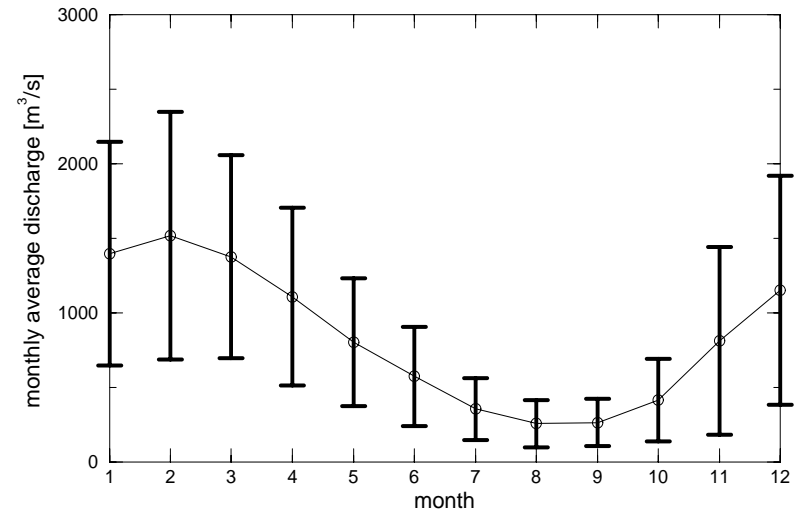
LIMPOPO (CHOKWE)

based on: 4 years



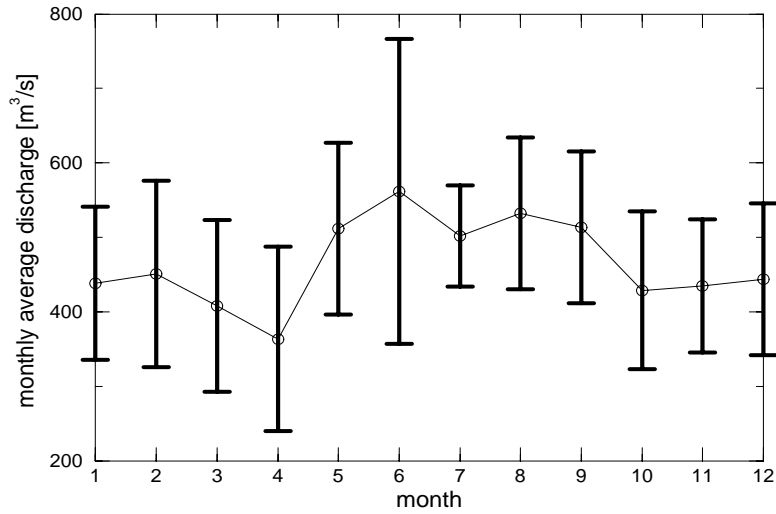
LOIRE (MONTJEAN)

based on: 117 years



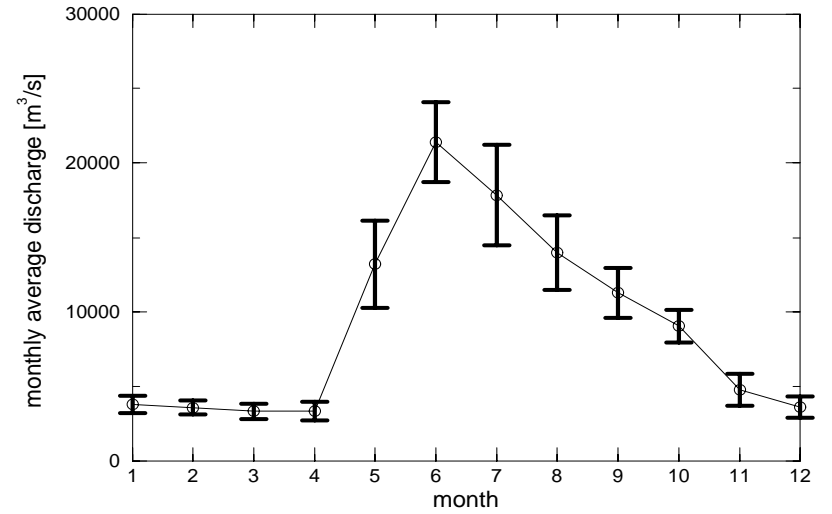
LULEALVEN (BODEN WATERWORKS)

based on: 20 years



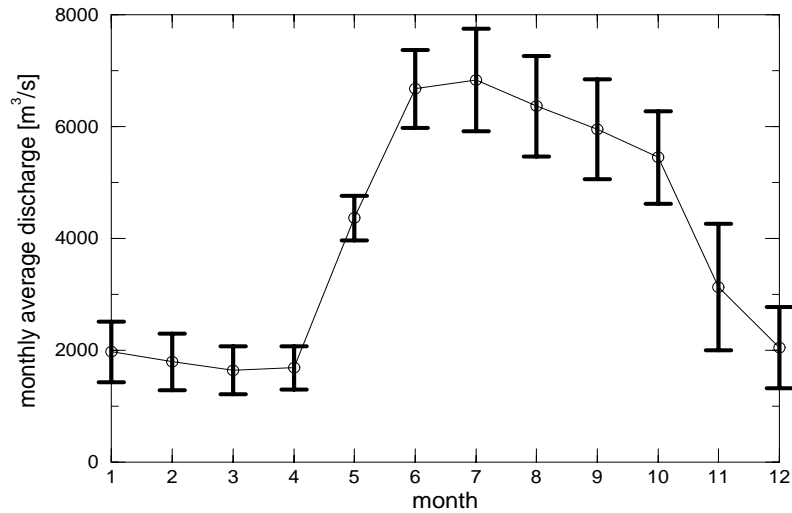
MACKENZIE RIVER (ARCTIC RED RIVER)

based on: 21 years



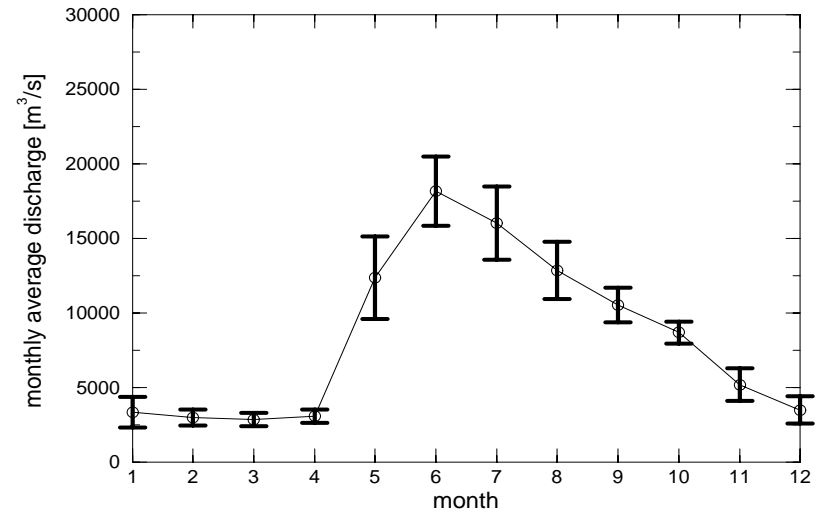
MACKENZIE RIVER (NEAR FORT PROVIDENCE)

based on: 10 years



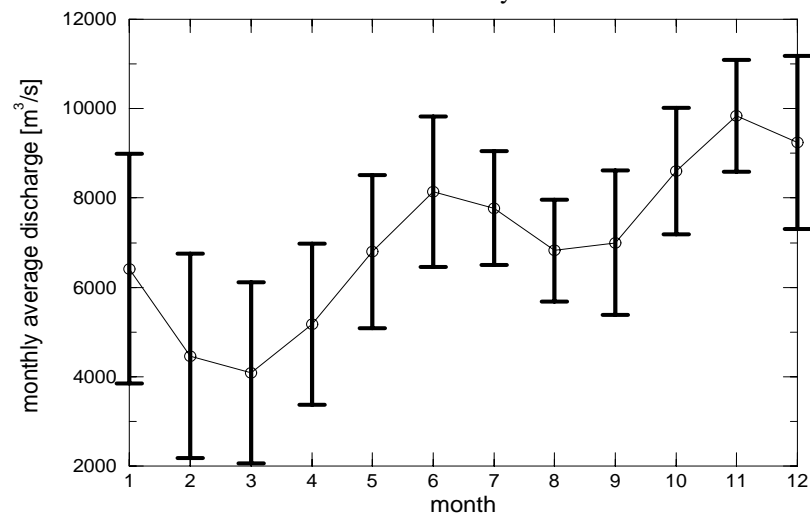
MACKENZIE RIVER (NORMAN WELLS)

based on: 19 years

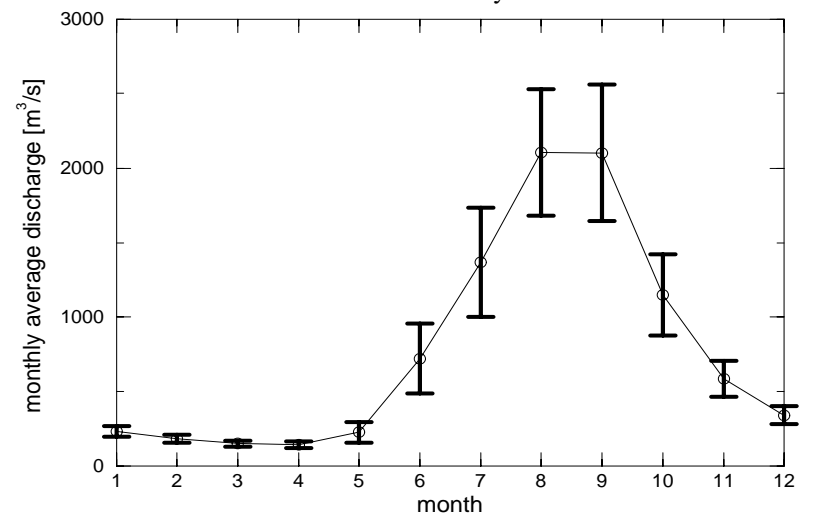


MAGDALENA (CALAMAR)

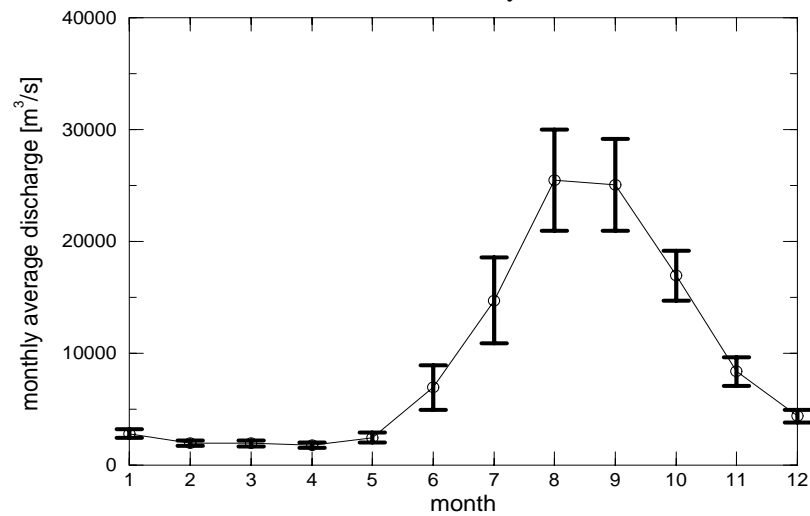
based on: 9 years

**MEKONG (MUKDAHAN)**

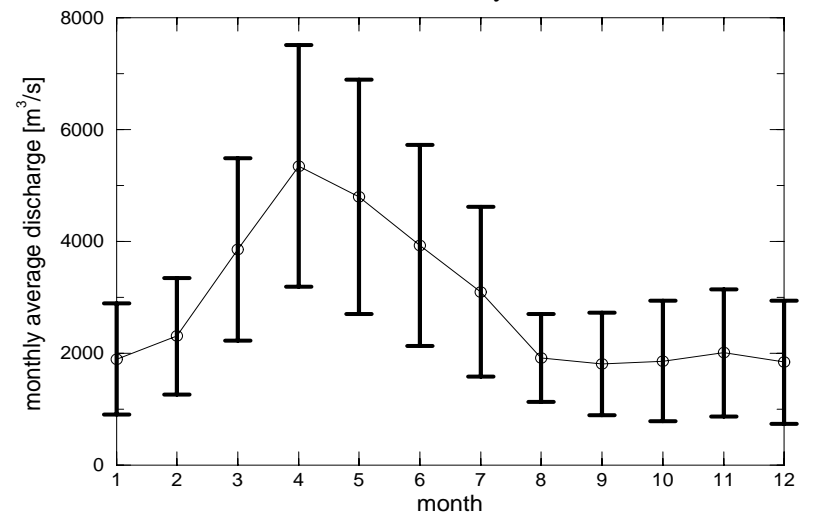
based on: 41 years

**MEKONG (PAKSE)**

based on: 12 years

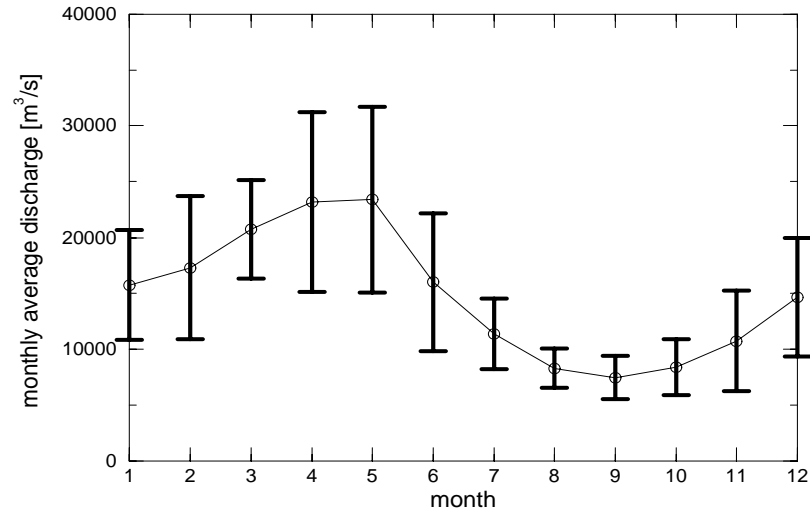
**MISSISSIPPI (ALTON, ILL.)**

based on: 58 years

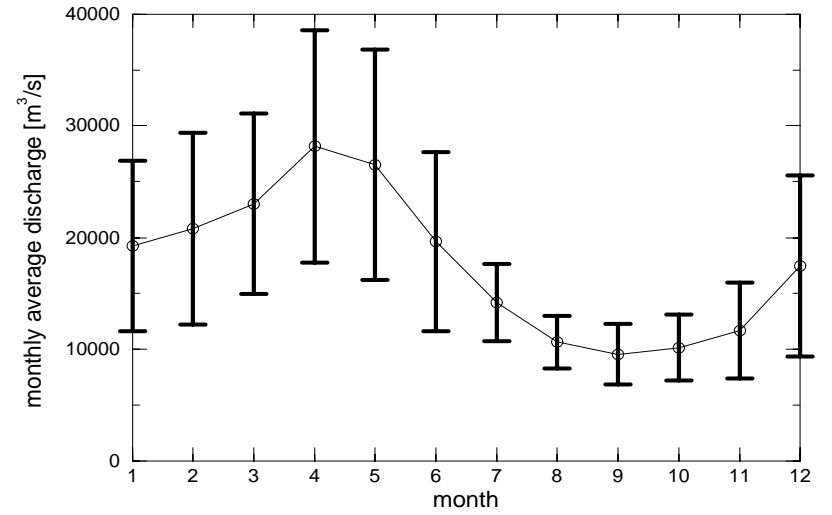


MISSISSIPPI (TARBERT LANDING)

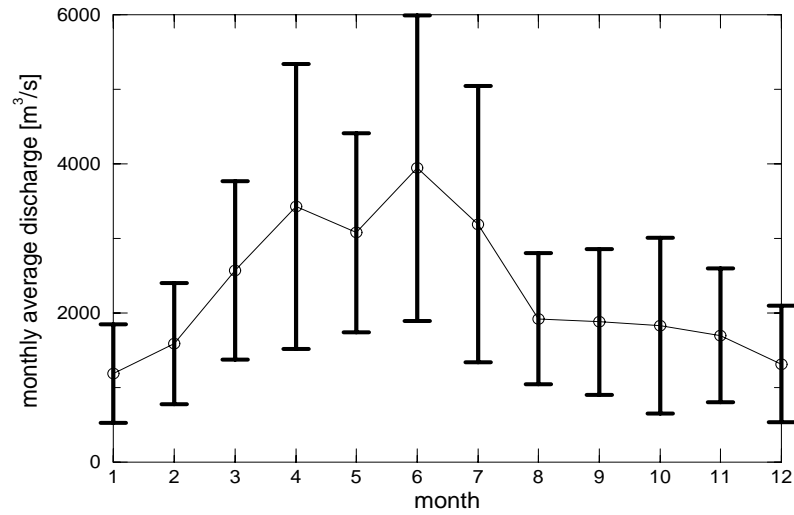
based on: 20 years

**MISSISSIPPI (VICKSBURG, MISSISSIPPI)**

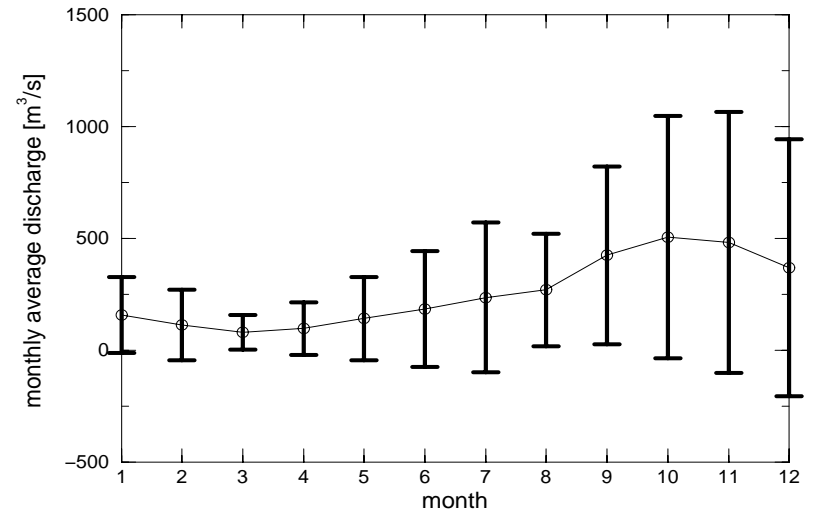
based on: 18 years

**MISSOURI (HERMAN, MONT.)**

based on: 92 years

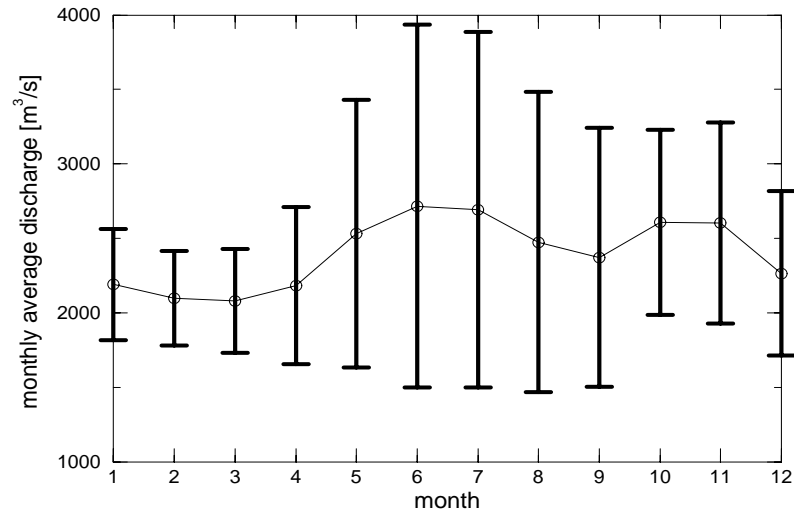
**MURRAY (LOCK 9 UPPER)**

based on: 20 years

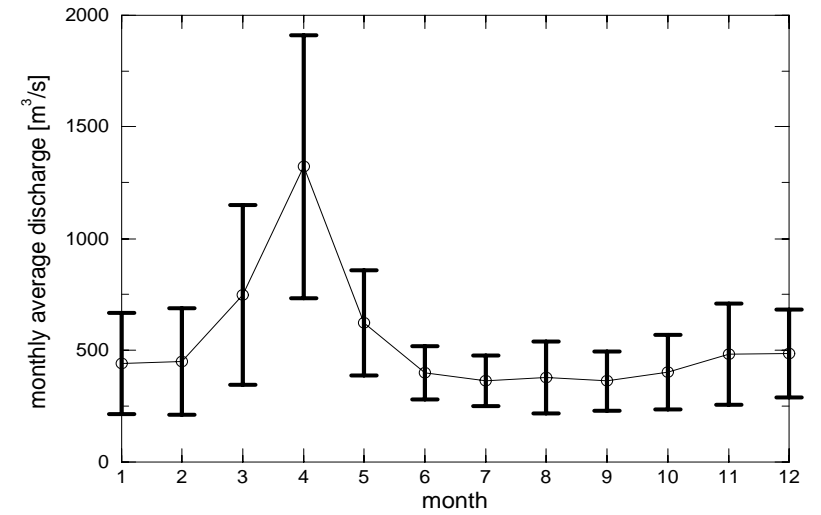


NELSON RIVER (ABOVE BLADDER RAPIDS)

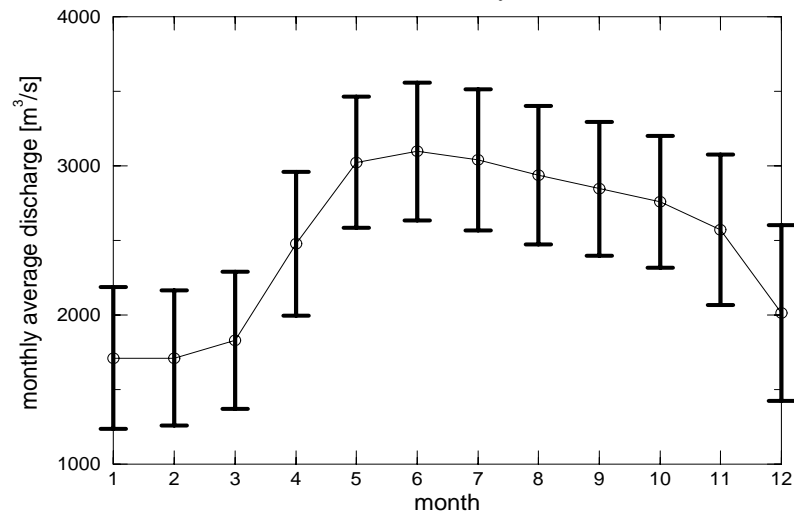
based on: 19 years

**NEMAN (SMALININKAI)**

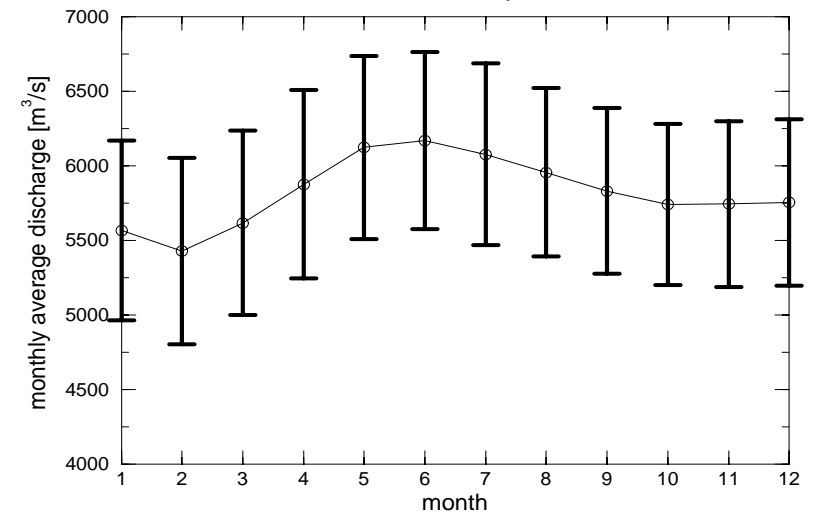
based on: 73 years

**NEVA (NOVOSARATOVKA)**

based on: 126 years

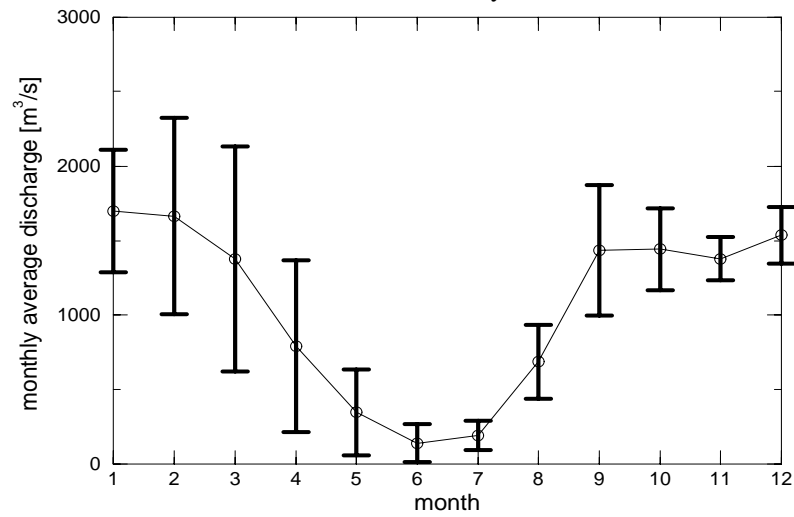
**NIAGARA (QUEENSTON)**

based on: 125 years

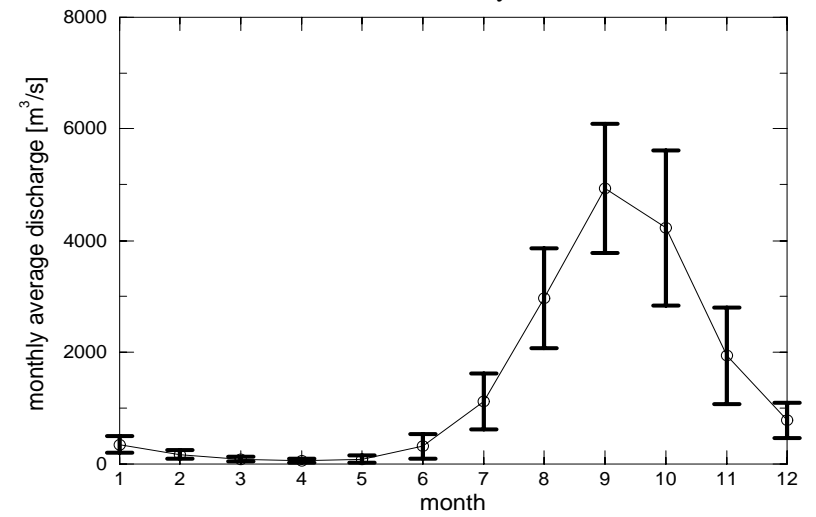


NIGER (GAYA)

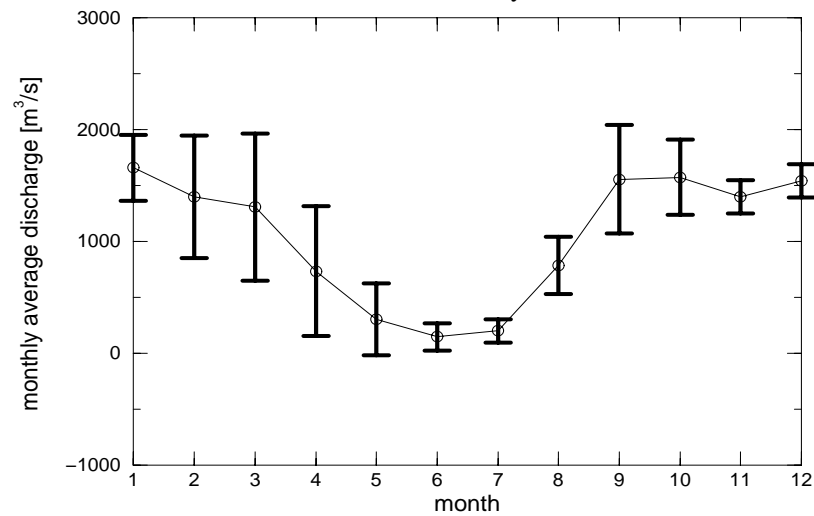
based on: 39 years

**NIGER (KOULIKORO)**

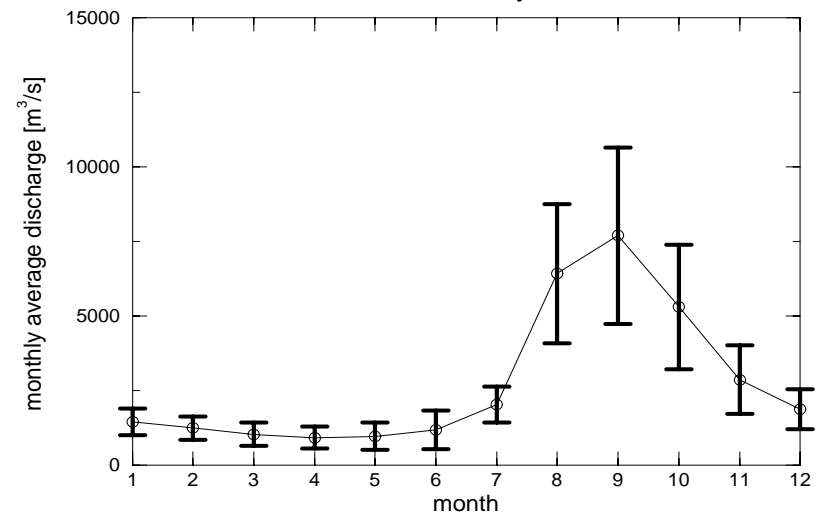
based on: 82 years

**NIGER (MALANVILLE)**

based on: 41 years

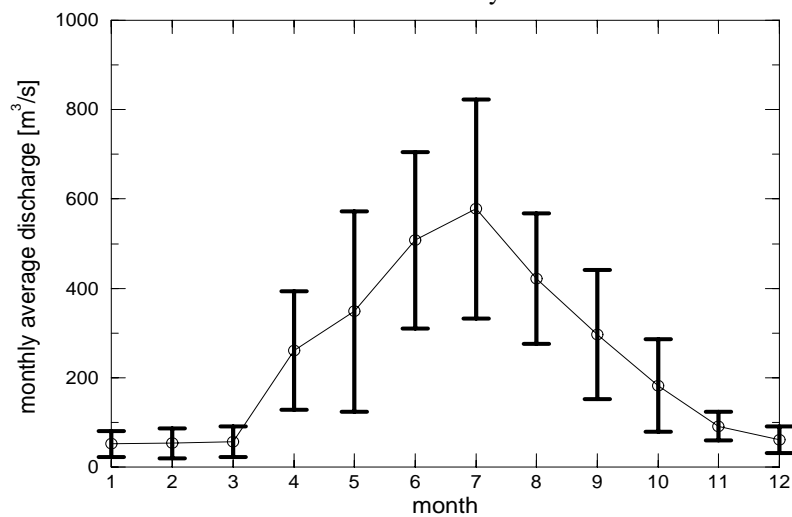
**NILE (ASWAN DAM)**

based on: 116 years



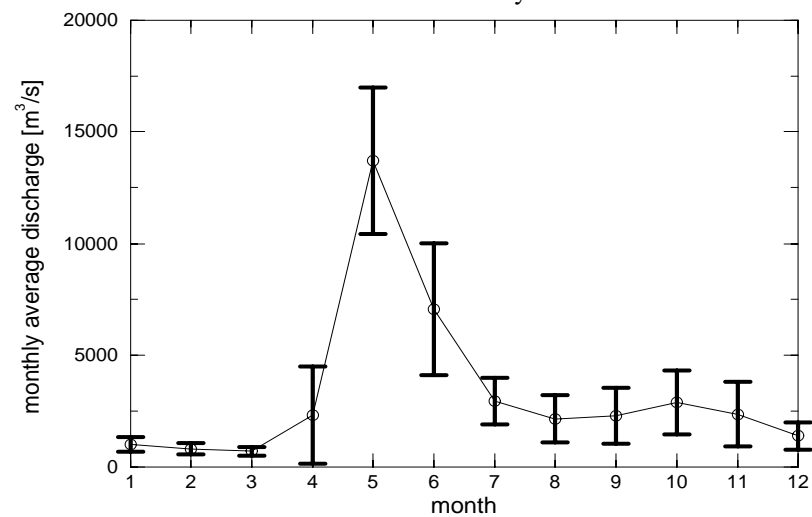
NORTH SASKATCHEWAN (PRINCE ALBERT)

based on: 75 years



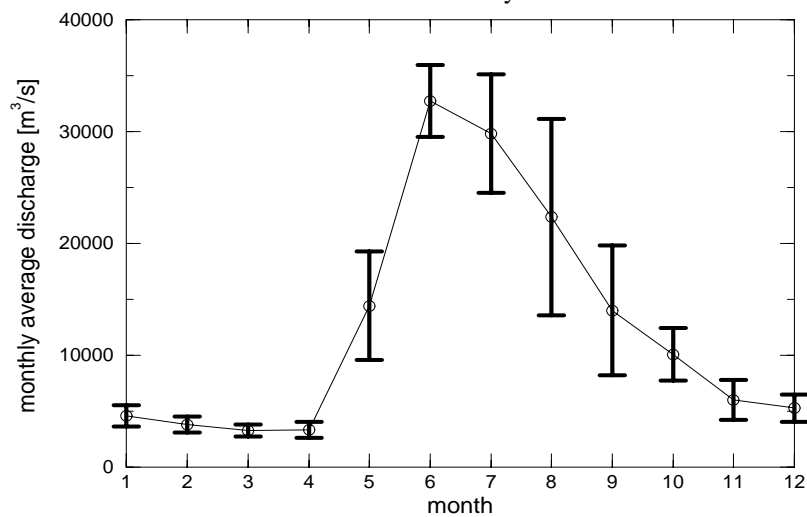
NORTHERN DVINA (UST-PINEGA)

based on: 105 years



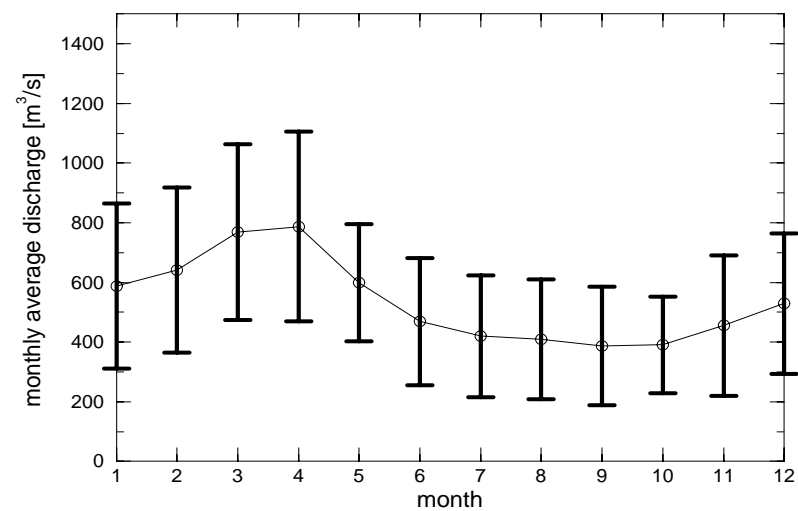
OB (SALEKHARD)

based on: 55 years



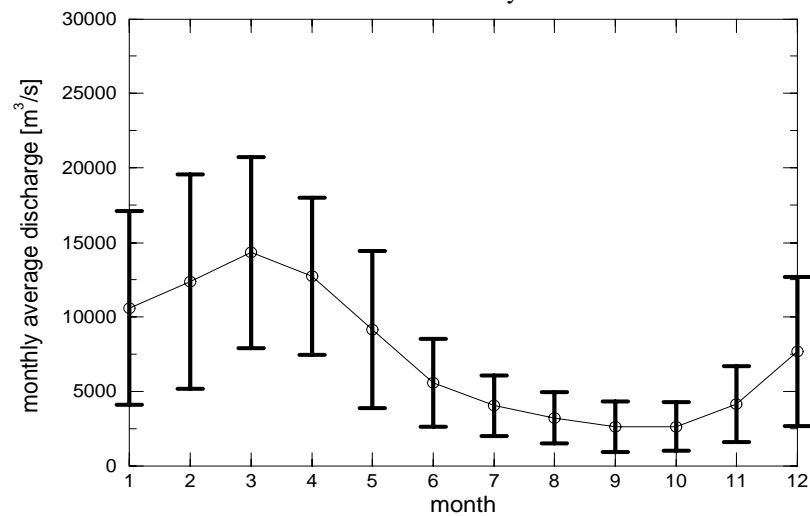
ODRA (GOZDOWICE)

based on: 88 years



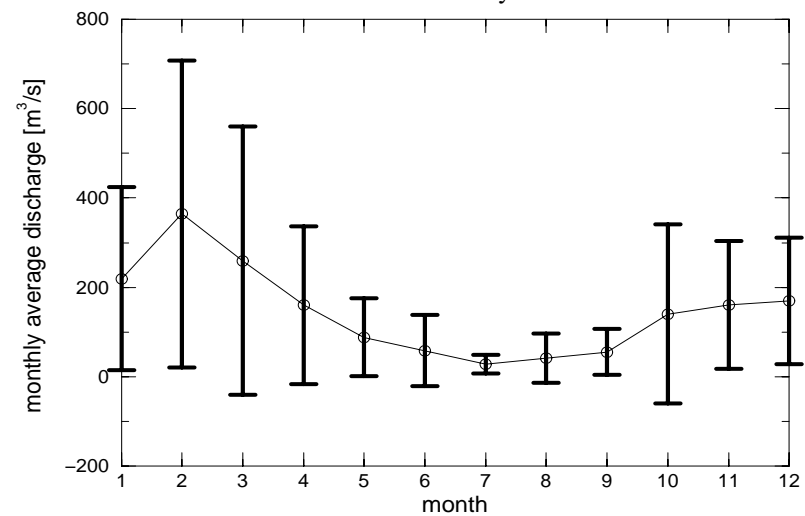
OHIO (METROPOLIS, ILL.)

based on: 57 years



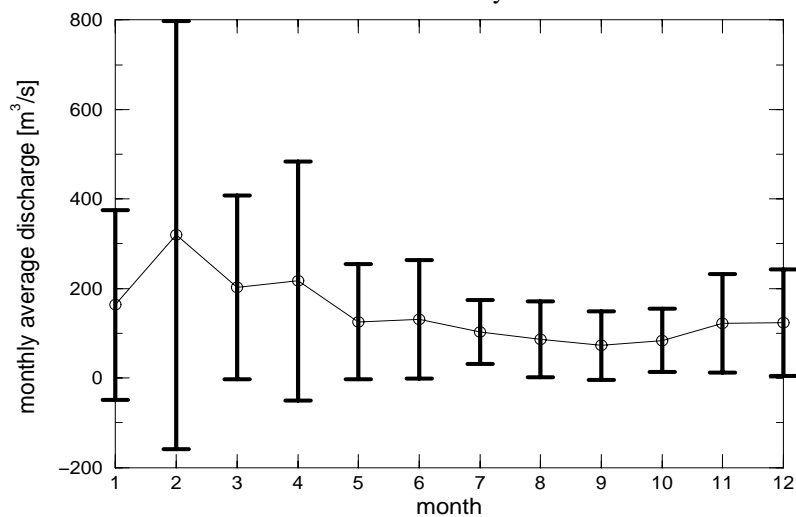
ORANJE (ALI WAL NORTH)

based on: 23 years



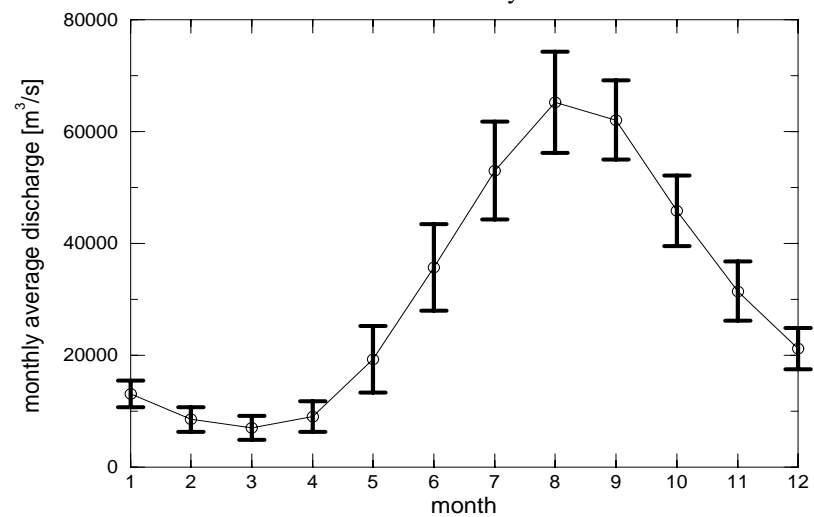
ORANJE (VIOOLSDRIF)

based on: 23 years



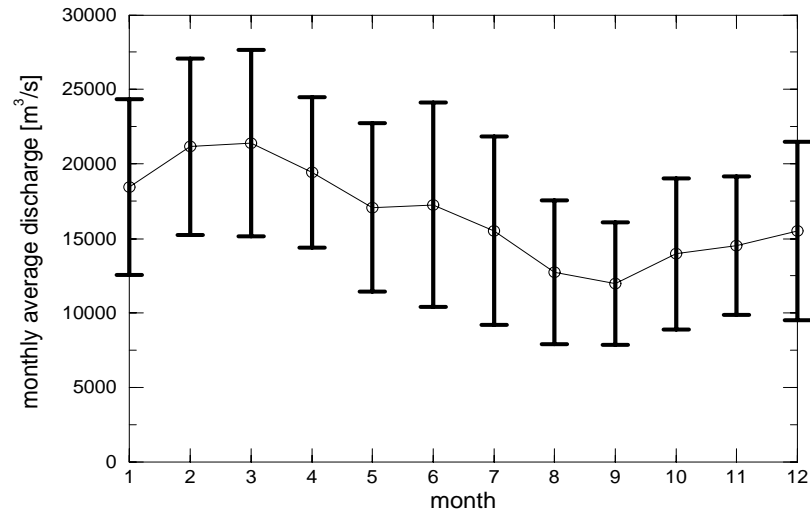
ORINOCO (PUENTE ANGOSTURA)

based on: 67 years

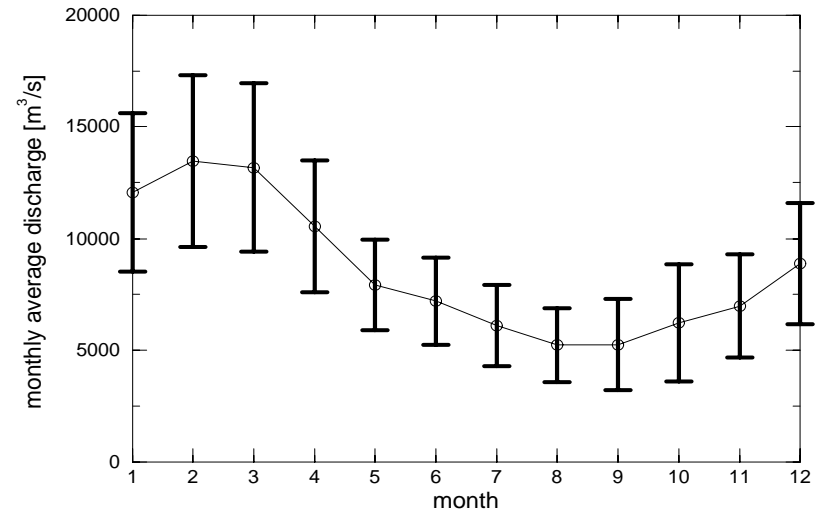


PARANA (CORRIENTES)

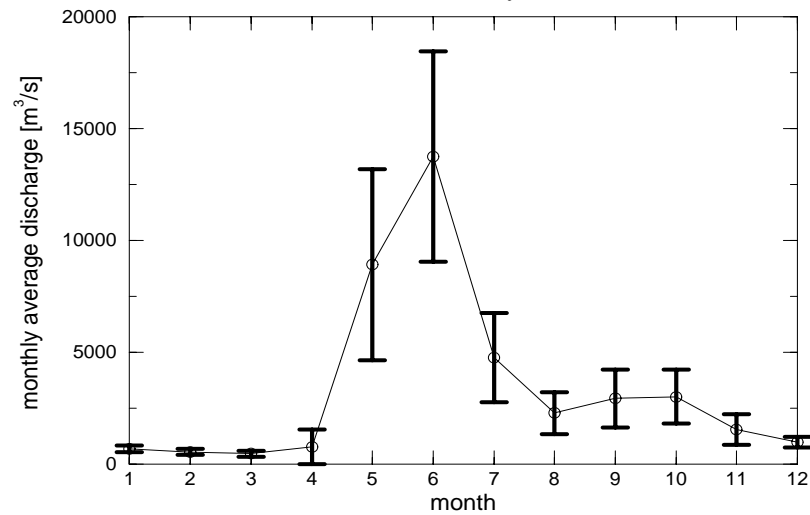
based on: 80 years

**PARANA (GUARIA)**

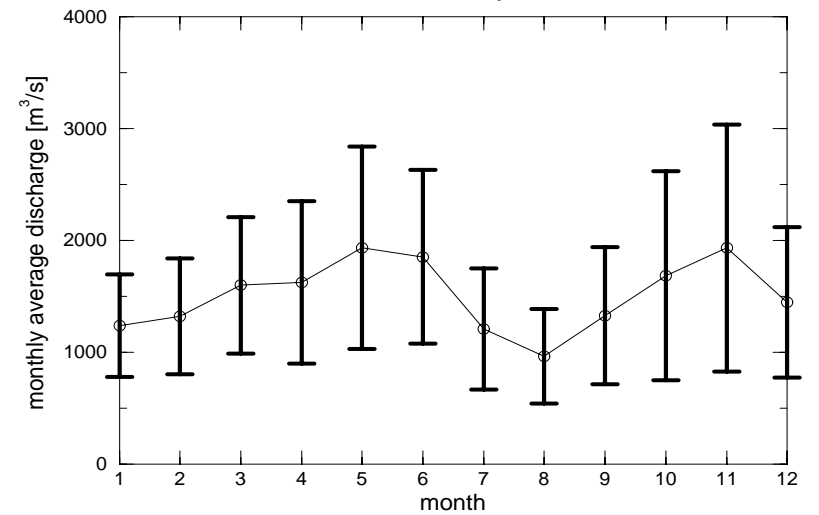
based on: 60 years

**PETCHORA (UST-TSILMA)**

based on: 14 years

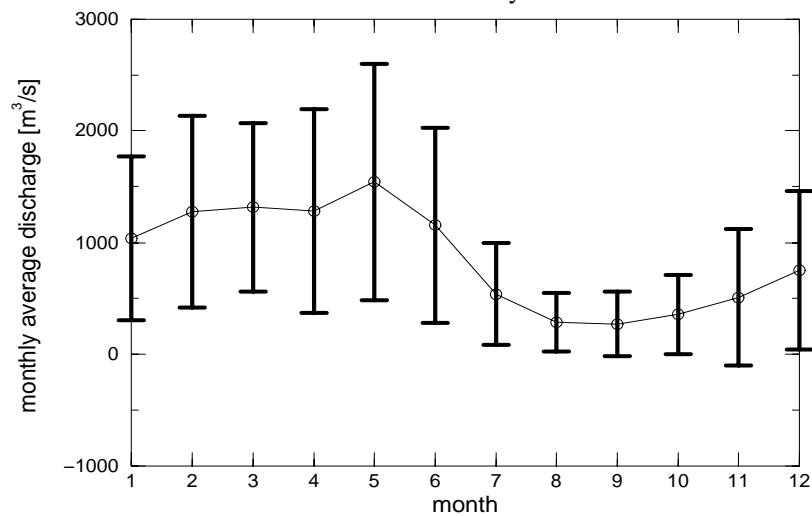
**PO (PONTELAGOSCURO)**

based on: 62 years



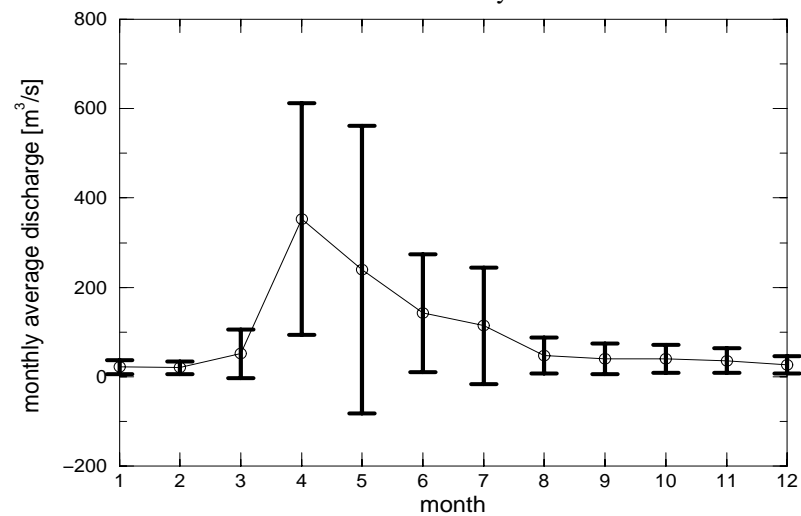
RED RIVER (ALEXANDRIA, LOUISIANA)

based on: 55 years



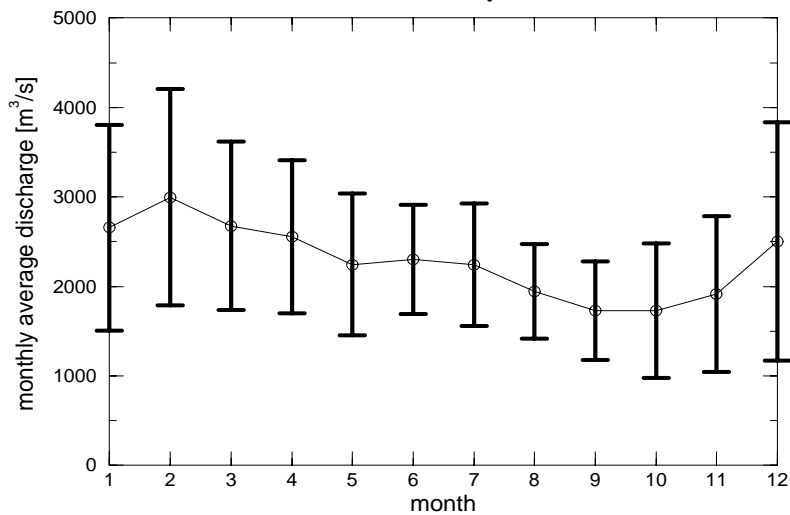
RED RIVER (EMERSON)

based on: 73 years



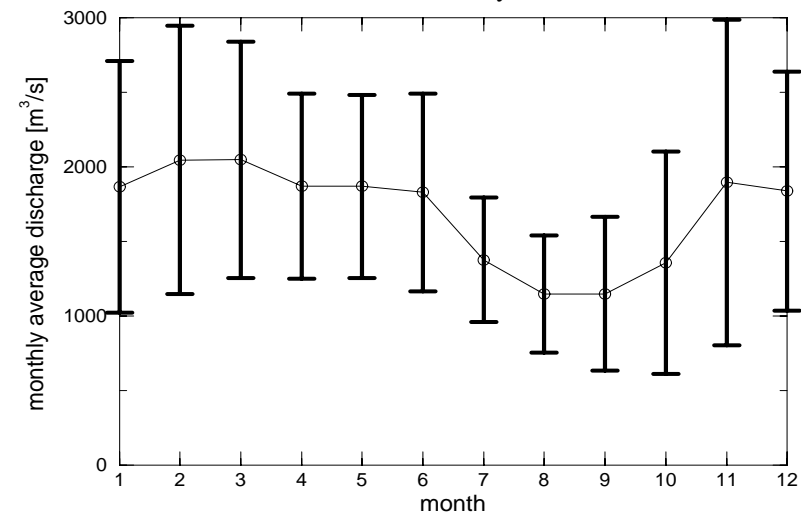
RHEIN (REES)

based on: 49 years



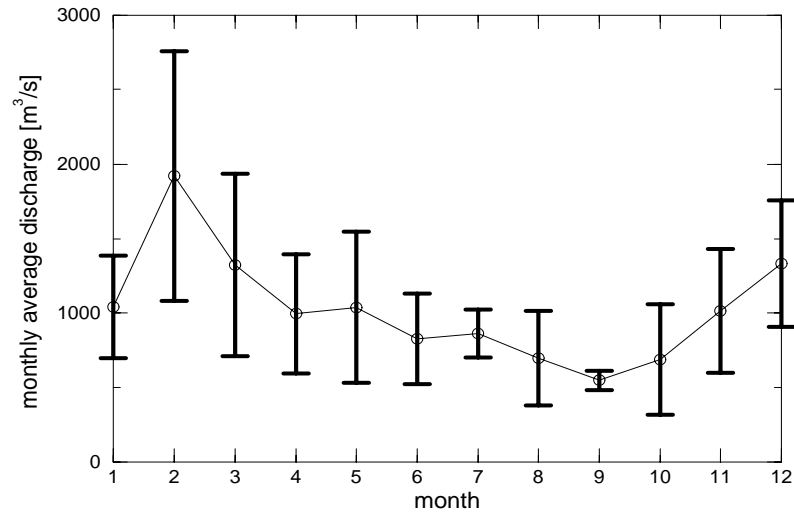
RHONE (BEUCAIRE)

based on: 60 years

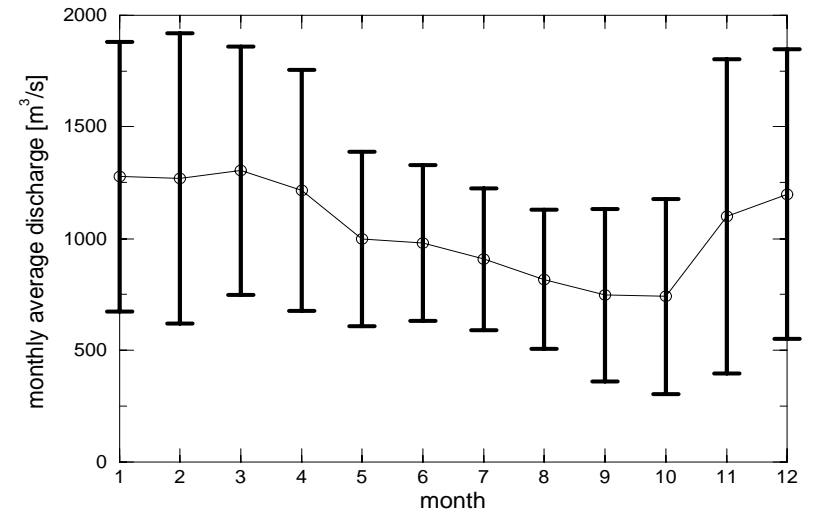


RHONE (GIVORS)

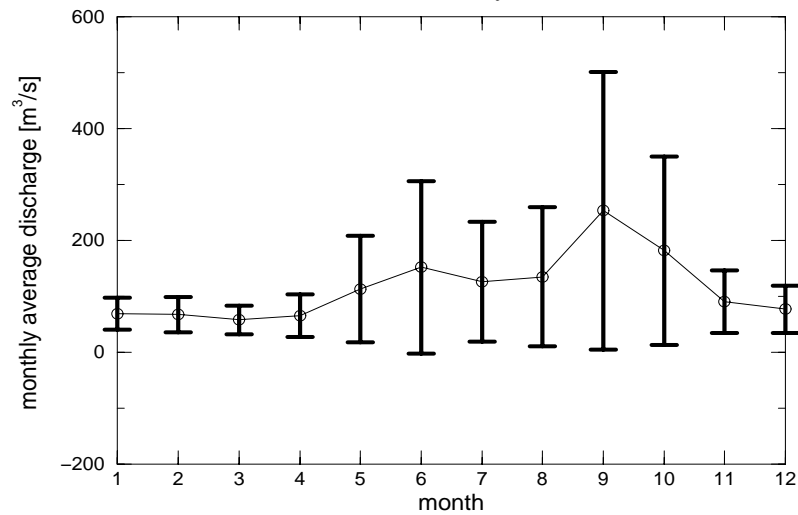
based on: 7 years

**RHONE (LA MULATIERE)**

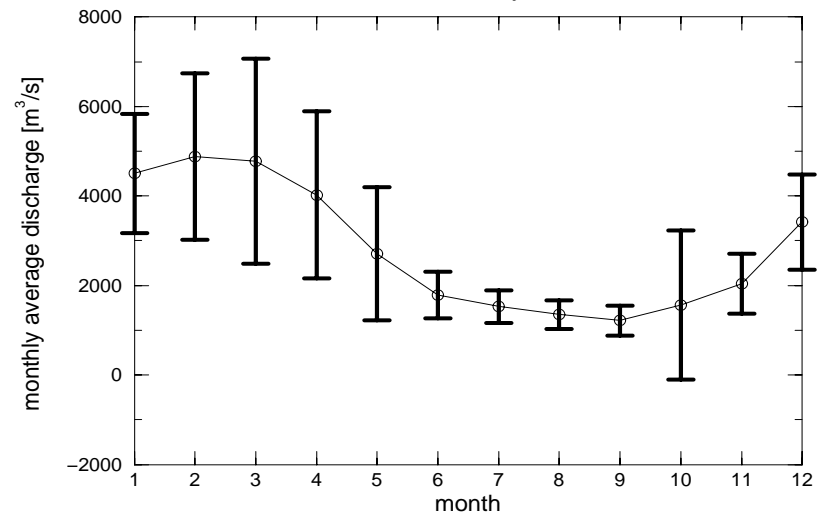
based on: 73 years

**RIO GRANDE (LAREDO, TEXAS)**

based on: 73 years

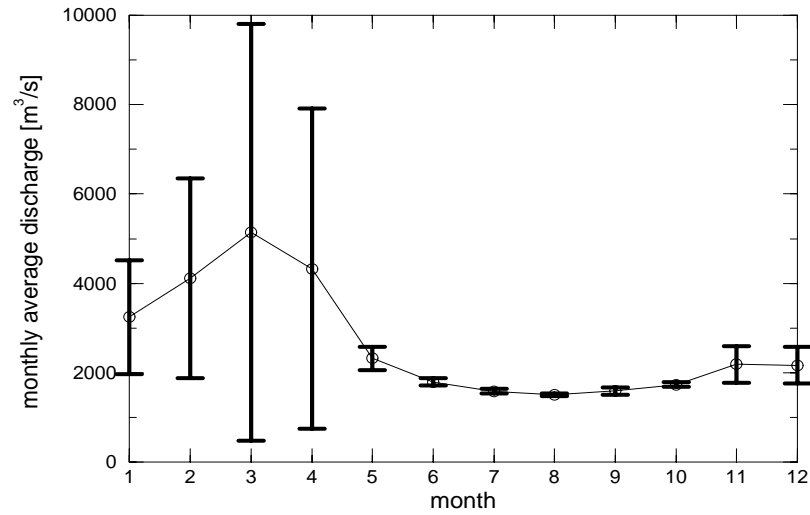
**SAO FRANCISCO (JUAZEIRO)**

based on: 51 years

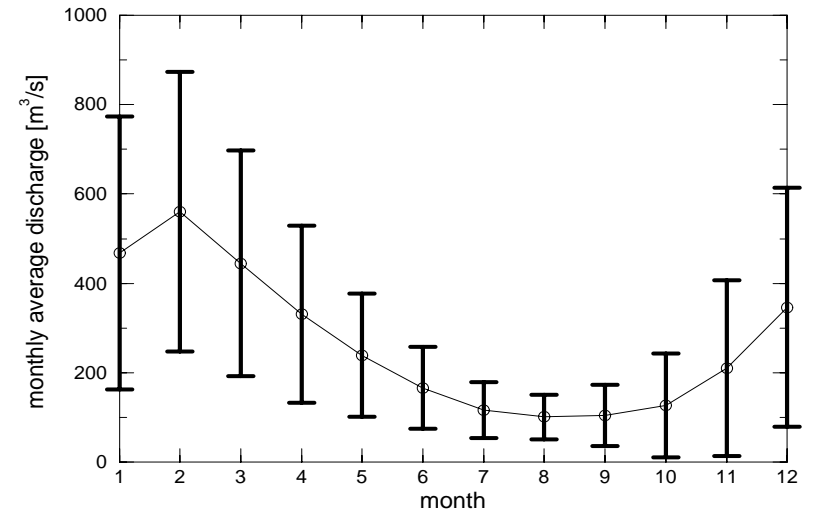


SAO FRANCISCO (TRAIPU)

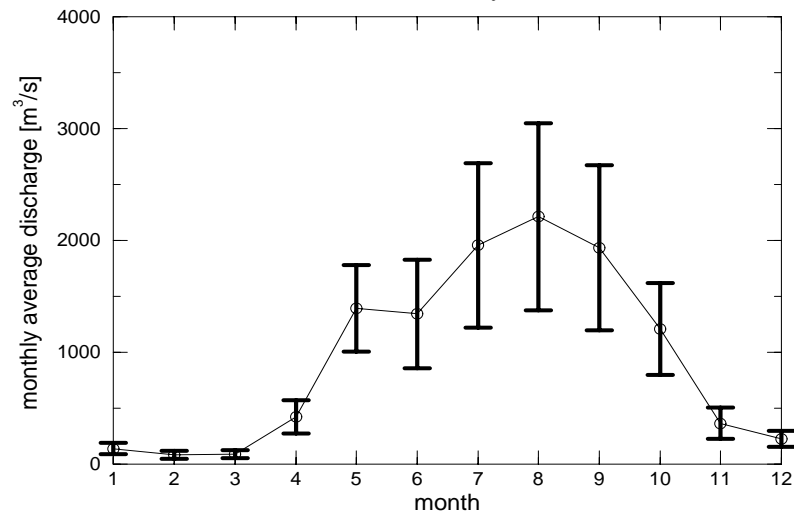
based on: 3 years

**SEINE (PARIS)**

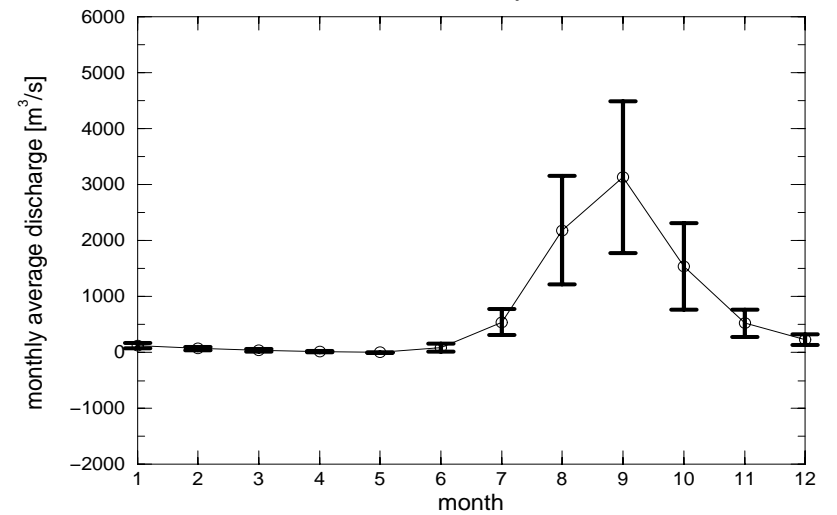
based on: 50 years

**SELENGA (MOSTOVOY)**

based on: 12 years

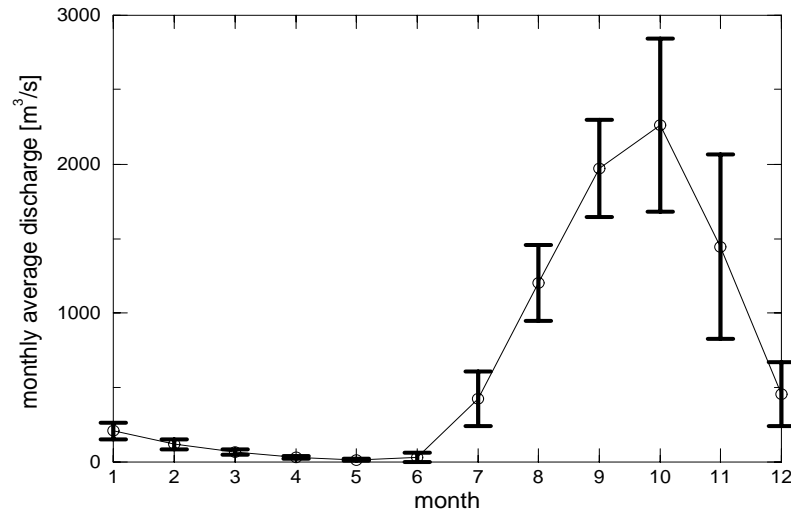
**SENEGAL (BAKEL)**

based on: 81 years

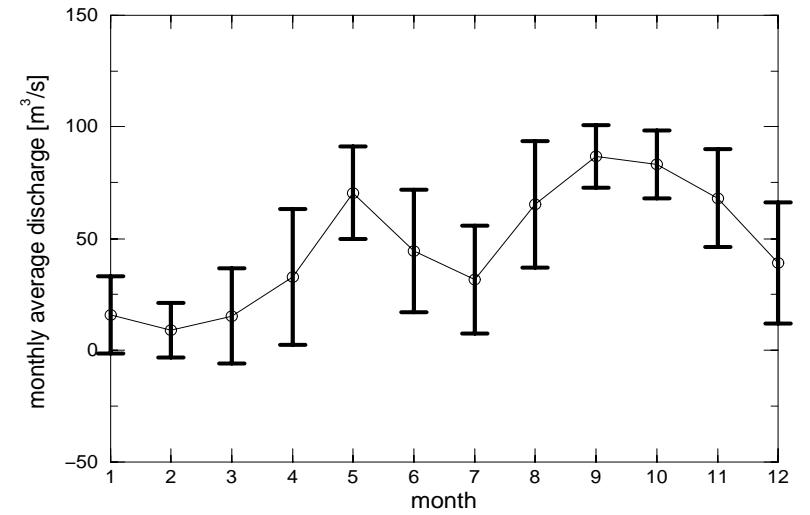


SENEGAL (DAGANA)

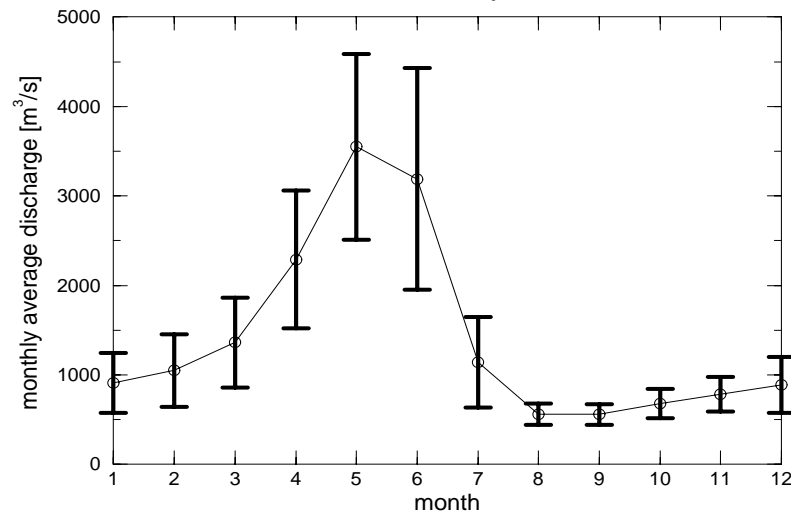
based on: 72 years

**SHEBELE (AFGOI)**

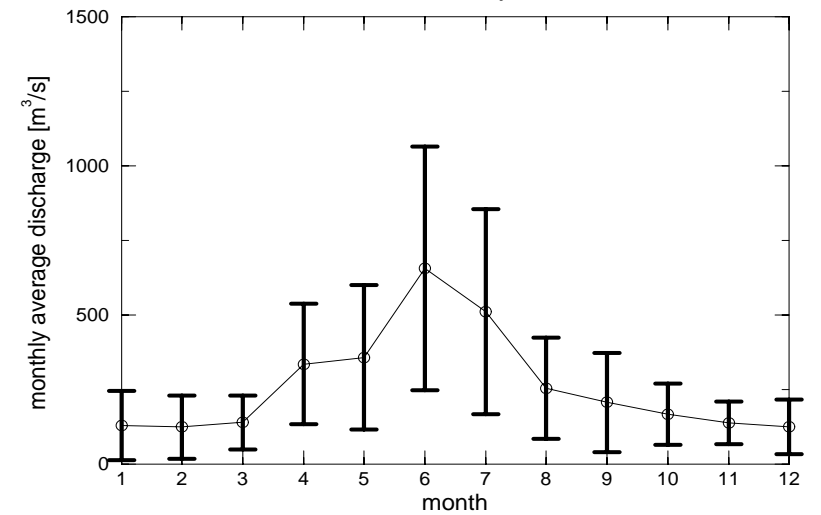
based on: 28 years

**SNAKE (CLARKSTON, WASH.)**

based on: 58 years

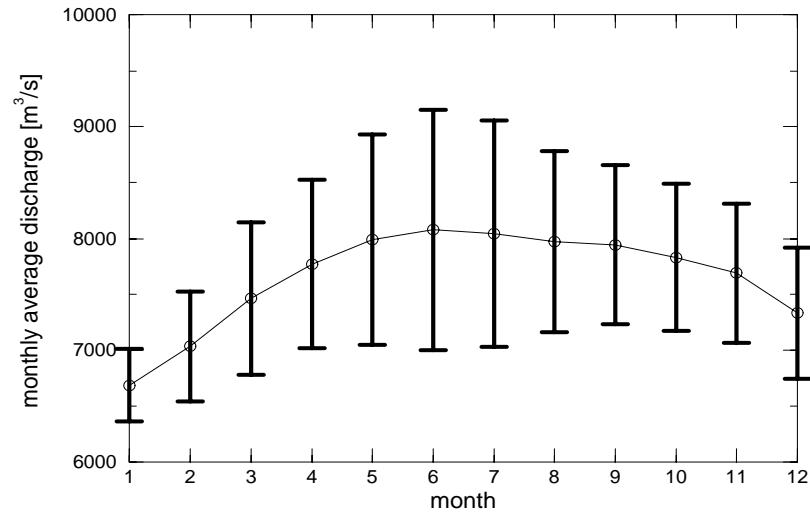
**SOUTH SASKATCHEWAN (SASKATOON)**

based on: 74 years

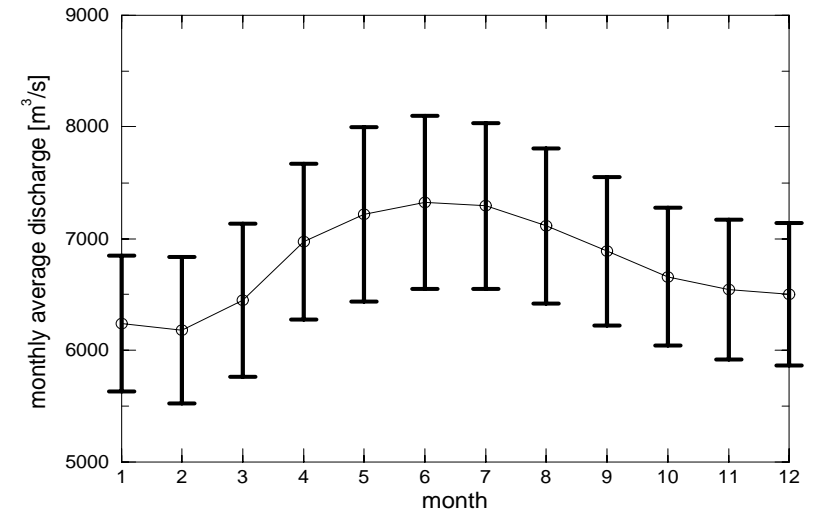


ST. LAWRENCE (CORNWALL, ONT.)

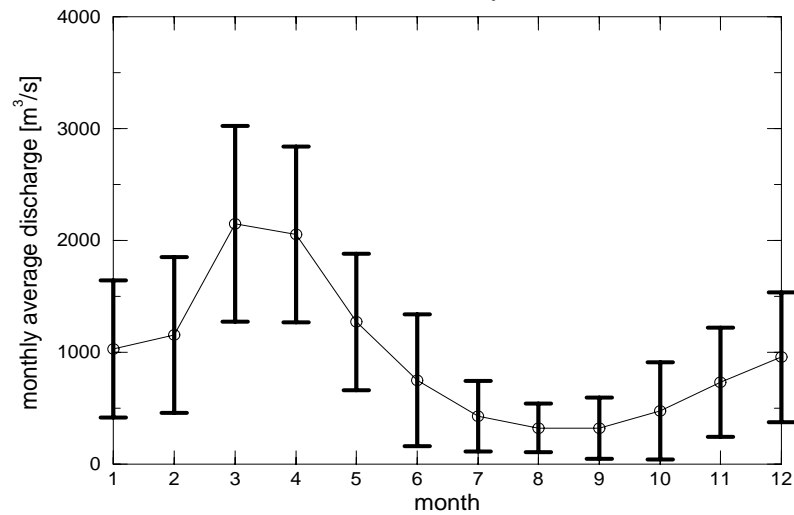
based on: 19 years

**ST. LAWRENCE (OGDENSBURG, N.Y.)**

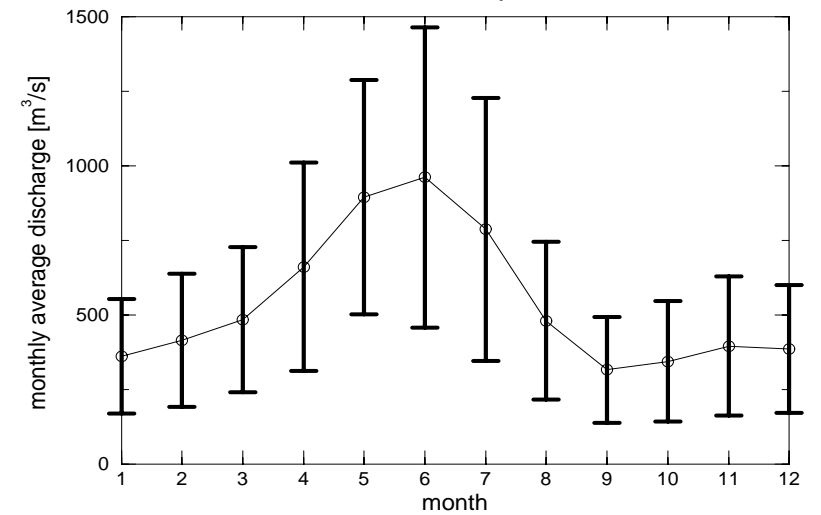
based on: 113 years

**SUSQUEHANNA (HARRISBURG, PA.)**

based on: 98 years

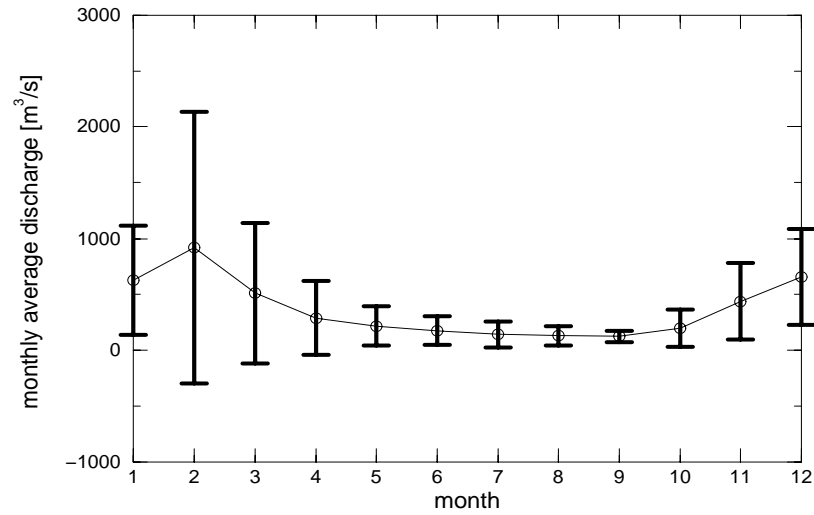
**SYR-DARYA (TYUMEN-ARYK)**

based on: 55 years

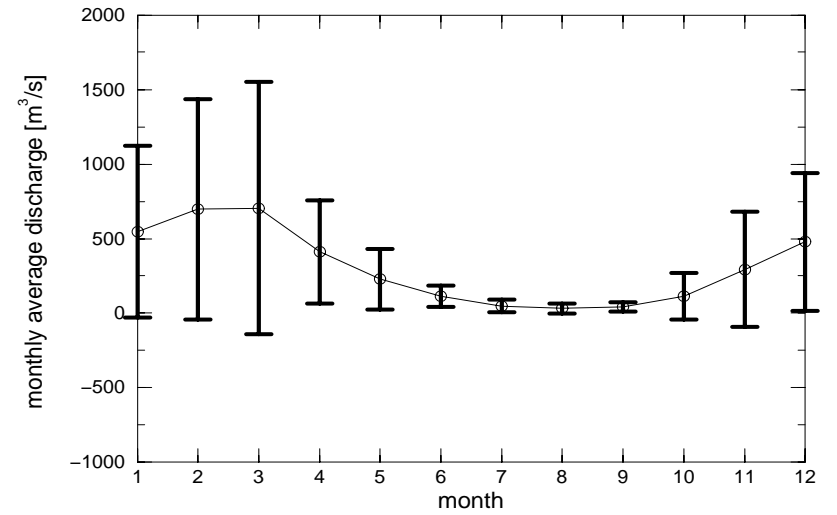


TEJO (ALMOUROL)

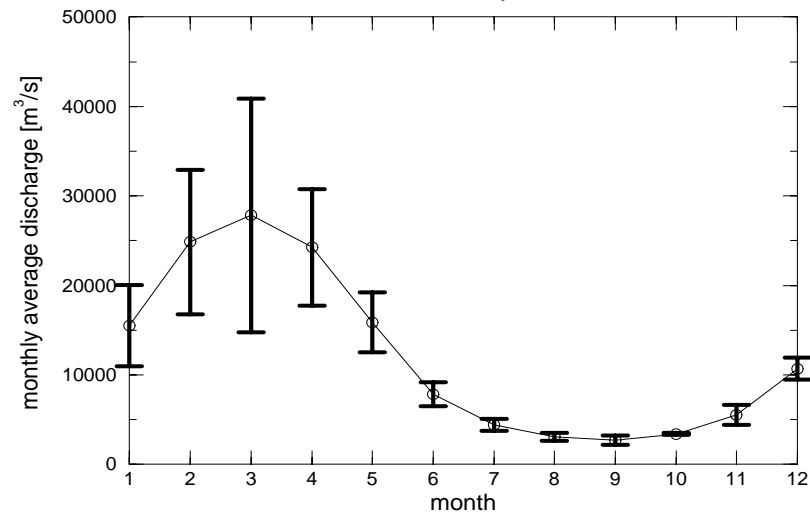
based on: 9 years

**TEJO (V.V. DE RODAO)**

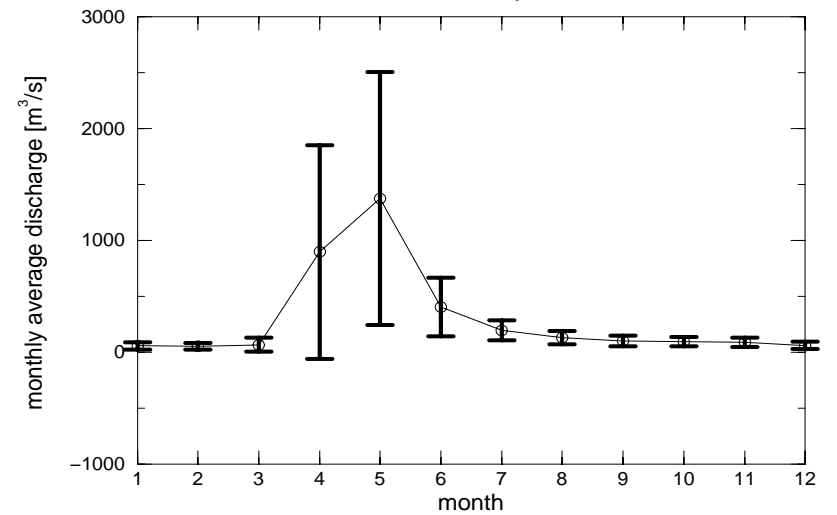
based on: 56 years

**TOCANTINS (ITUPIRANGA)**

based on: 6 years

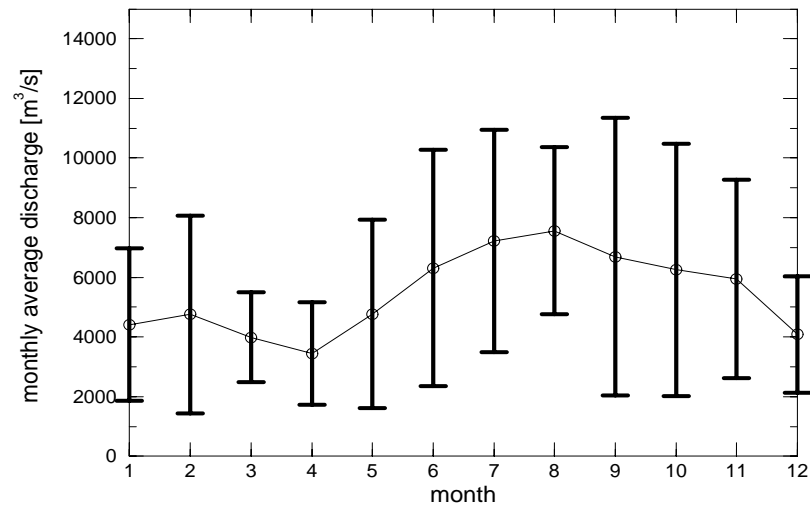
**URAL (KUSHUM)**

based on: 70 years



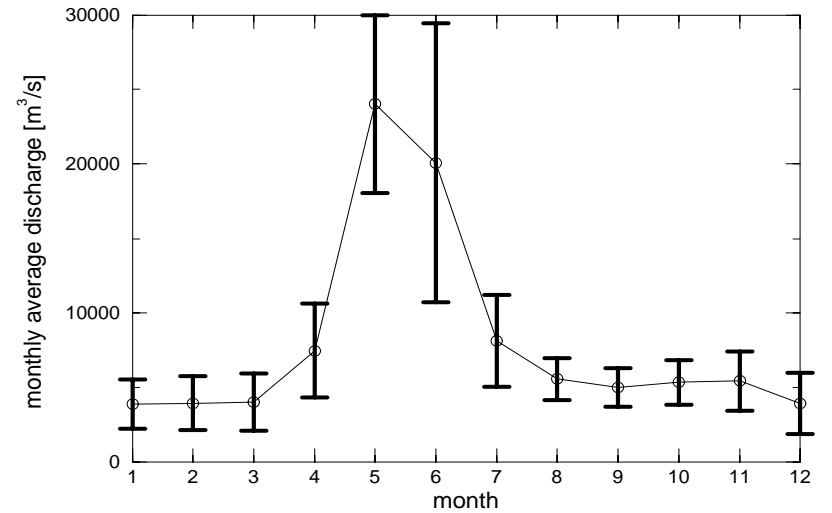
URUGUAY (CONCORDIA)

based on: 11 years



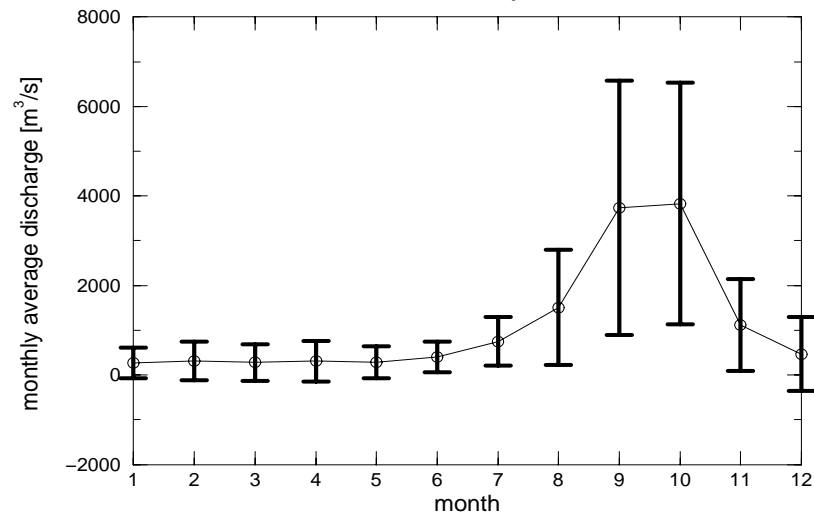
VOLGA (VOLGOGRAD)

based on: 106 years



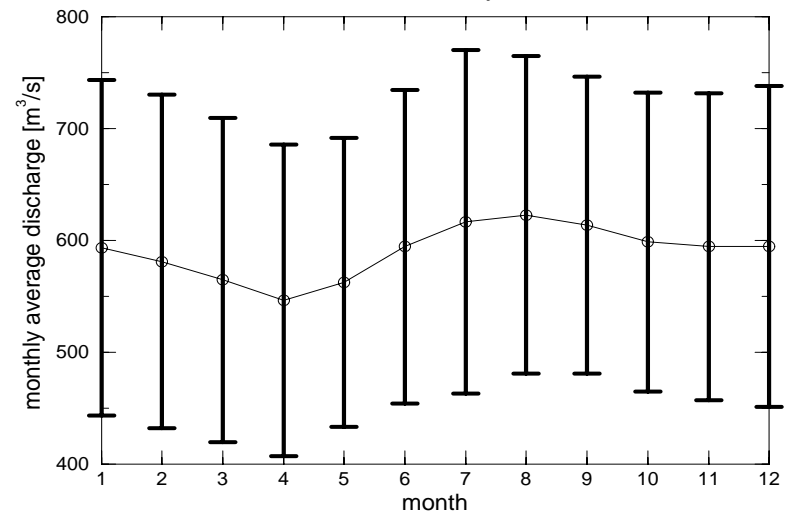
VOLTA (SENCHI)

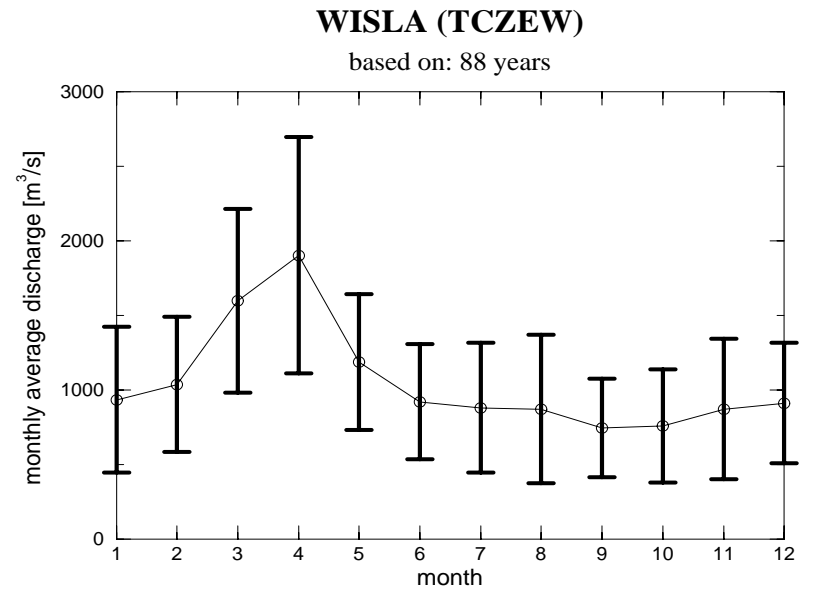
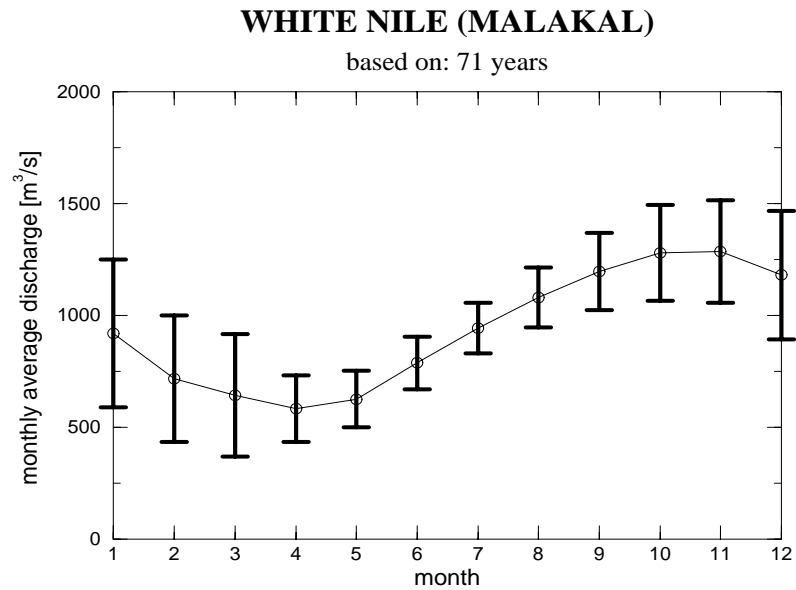
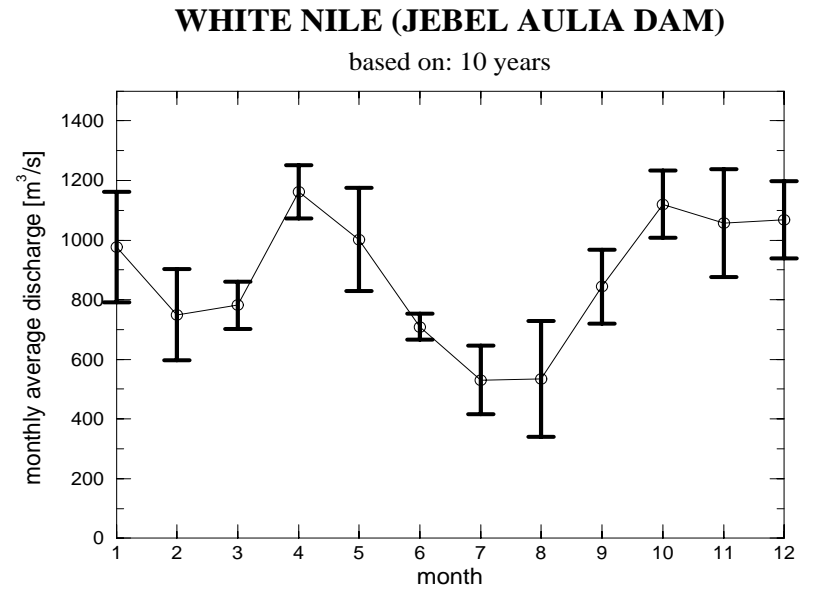
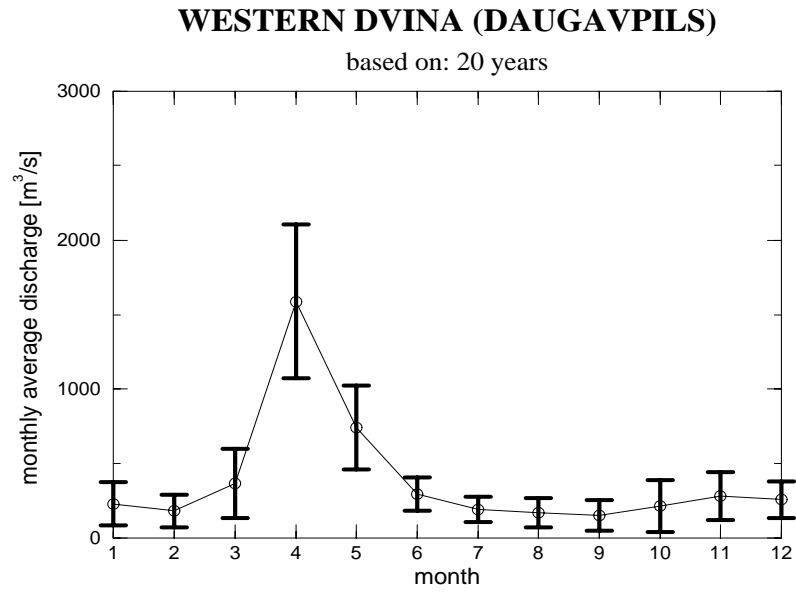
based on: 44 years



VUOKSI (IMATRA)

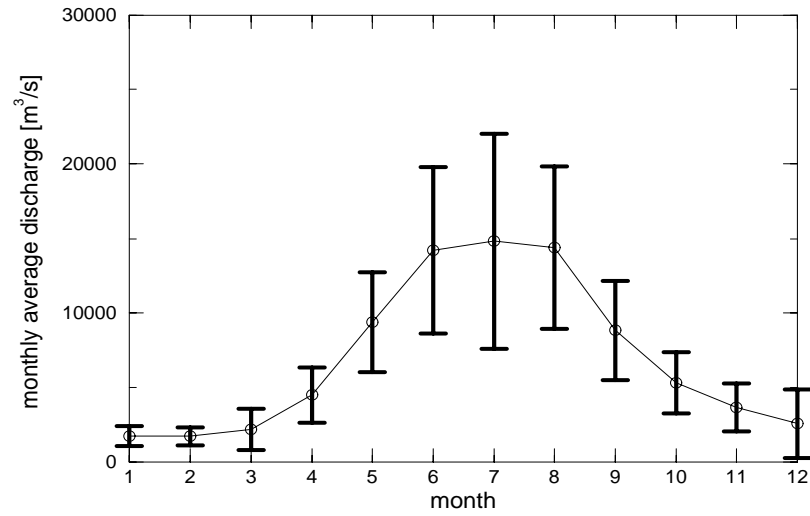
based on: 138 years



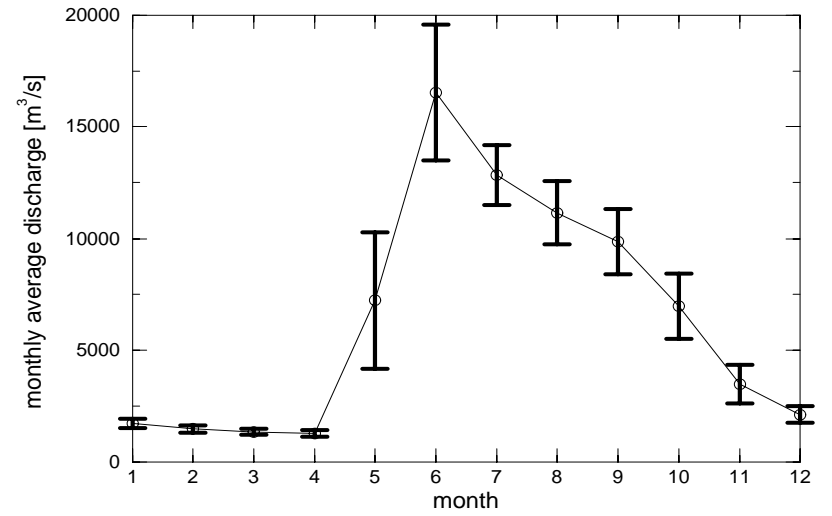


XUN JIANG (WUZHOU)

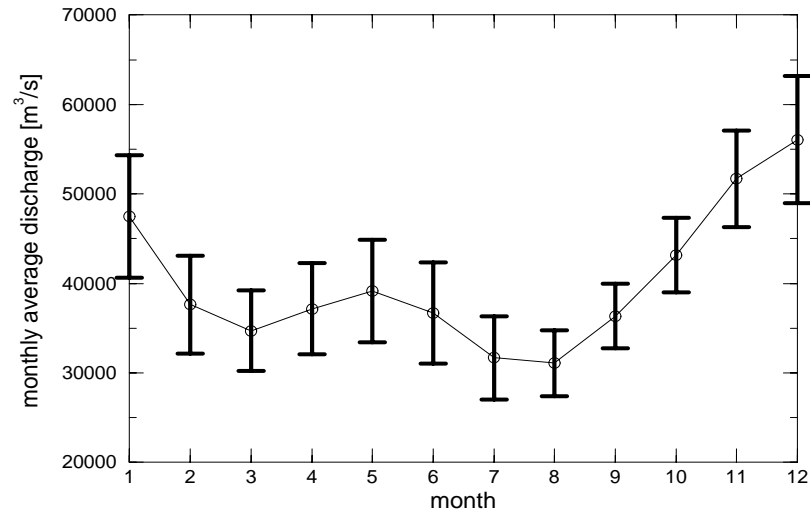
based on: 70 years

**YUKON (PILOT STATION)**

based on: 19 years

**ZAIRE (KINSHASA)**

based on: 81 years

**ZAMBEZE (MATUNDO-CAIS)**

based on: 4 years

