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PROBABLE MEAN MONTHLY, HALF-YEARLY, AND YEARLY DISCHARGES IN THE TYWA RIVER BASIN (1961-1995)

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Abstract

The work presents mean monthly, half-yearly and yearly discharges at the defined probability. The estimation was worked out for four hydrometric cross sections in the Tywa river basin. The estimation of characteristic discharges was based on hydrological analogy method with many-years gauge station observations and was worked out for years 1961-1995.

Key words: hydrology, probable discharges

INTRODUCTION

The following work presents the mean monthly, half-yearly and yearly discharges with the definite predominance probability p [%]. The estimations were worked out for the multiple-year period 1961-1995 and four hydrometric cross sections located in the Tywa river basin (Fig. 1).

Drainage area location

The Tywa river is a right tributary of the Eastern Odra (map). The area of the Tywa river basin equals 256.4 km^2 (IMGW 1980, 1983). The basin abuts the Płonia, Myśla and Rurzyca basins.

The areas of the individual smaller basins assumed in the hydrometric cross sections equal No 1 - A-16 km^2, No 3 - A-17,2 km^2, No 4 - A-118 km^2, No 5 - A-252 km^2 (Duda et al. 1991).

The detailed informations on the general characteristics of the Tywa river basin were presented in Duda et al (1991).

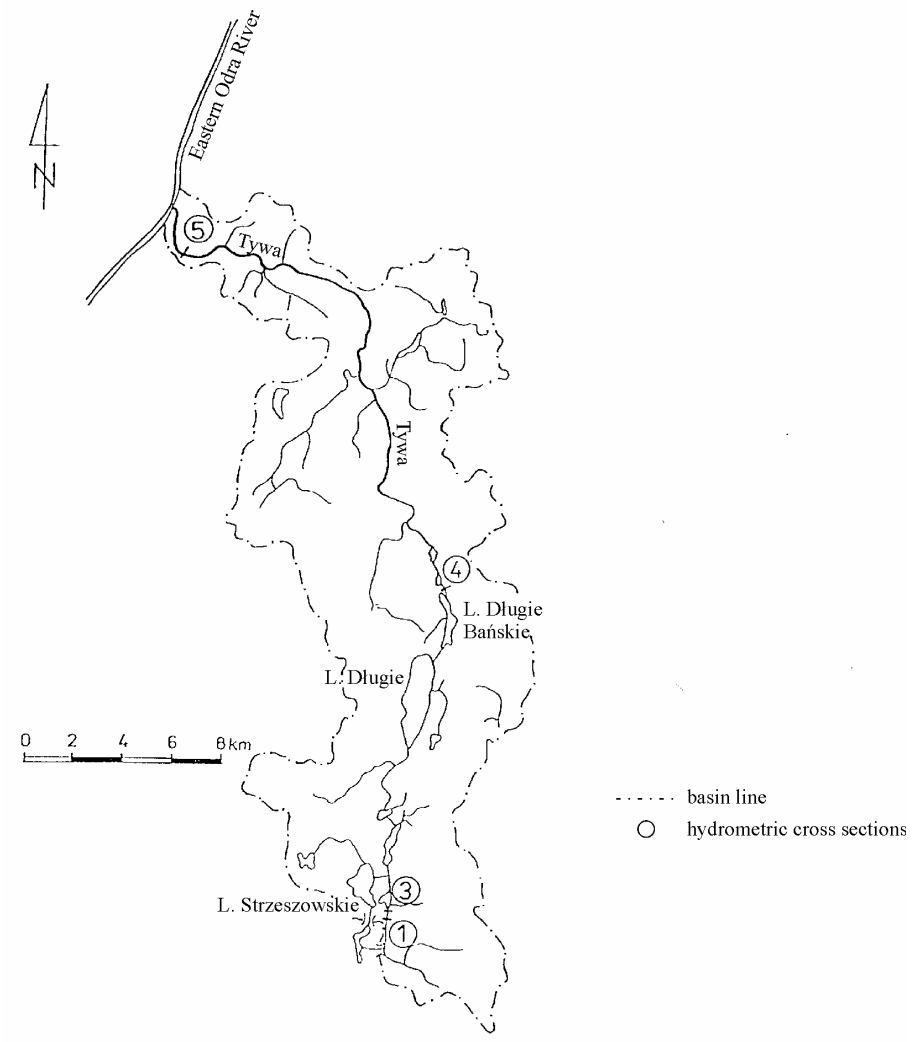

Fig. 1. Hydrographic map of Tywa river basin

Mean singular discharges and run-offs

The mean singular discharges and run-offs have been estimated by means of the method suggested by Duda (1978) for the northern part of Szczecin region. The method consists in the simultaneous measurement of the water discharges in the investigated hydrometric cross sections as well as in the water-gauge cross section of the river observed for many years (water states and discharges). Successive estima-

tion accounts for the singular run-offs q [1/s·km^2] for the drainage areas into the hydrometric and water-gauge cross sections. For the statistically essential correlations of the singular run-offs into the hydrometric and water-gauge cross sections the regression equations are assumed. They provide the estimation of the singular run-offs for the hydrometric cross section in question. The estimated singular run-offs multiplied by the drainage area into the hydrometric cross section result in the discharges. Such estimations have been worked out for the four hydrometric cross sections for the Tywa river basin and the water-gauge cross section of the Myśla river in Dolsk. The mean discharges of the Myśla in Dolsk were adopted from the yearlies (1961-1983) and the archives of IMGW (1984-1995). The mean singular run-offs were estimated according to the equations suggested by Duda et al (1991).

The estimations of the mean singular discharges and run-offs contained in this study omit the estimations for the hydrometric cross section No 2. They will be worked out in the study on the Rurzyca river - considering the joint estimations of the mean singular discharges and run-offs for two hydrometric cross sections No 2 in the Tywa and Rurzyca basins due to the hydrologic bifurcation phenomenon occuring between the two drainage areas.

Probable mean monthly, half-yearly and yearly discharges.

The mean discharges at the definite predominance probability have been estimated by means of Dębski (1954) decyles. The mean monthly, half-yearly and yearly discharges were imposed on the probability scale. This was followed by the hand-drawn compensation curve, from which the decyles d_1, d_5, and d_9 were read. They allowed to estimate the measurements and statistical coefficients characterizing the frequency of the mean discharges. On this basis the probability curves of the mean discharges were estimated. The distribution consistency was checked by means of Kołmogorow test. Due to Kołmogorow the justness measurement of the adopted hypothesis is that the highest difference between the empirical and theoretical probability (D_{max}) should not exceed the one, calculated by the formula:

$$D_{\max} < \frac{136}{\sqrt{N}} = \frac{136}{\sqrt{35}} = 23\%$$

where:

N - size of distributive sequence (N = 35)

D_{max} - absolute value of the maximum result between the abscissa of the point of the distributive sequence, most distinct from the theoretical curve, and the abscissa of the point on the theoretical curve with the same ordinate.

Each case resulted in the $D_{max} < 23\%$, which proves no existing basis for the rejection of the assumed type of distribution. The estimated mean monthly, half-yearly and yearly discharges with the various predominance probability for the hydrometric cross sections in the Tywa drainage area (1961-1995) have been matched in Table 1.

Table 1

Mean monthly, half-yearly and yearly discharges with probability SQp [m3/s] for some hydrometric cross sections at the Tywa river basin

p [%]	Months												Half-years		Year
	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI-IV	V-X	XI-X
Hydrometric cross section No.1															
1	0,121	0,166	0,186	0,188	0,210	0,236	0,165	0,101	0,069	0,080	0,079	0,083	0,163	0,081	0,115
5	0,088	0,120	0,140	0,146	0,163	0,180	0,127	0,079	0,057	0,060	0,060	0,063	0,127	0,067	0,094
10	0,073	0,100	0,119	0,127	0,142	0,154	0,110	0,069	0,051	0,051	0,052	0,054	0,111	0,061	0,084
20	0,058	0,080	0,097	0,107	0,119	0,127	0,092	0,059	0,045	0,042	0,043	0,045	0,094	0,054	0,073
25	0,053	0,073	0,090	0,100	0,112	0,118	0,086	0,055	0,042	0,039	0,040	0,042	0,088	0,051	0,069
50	0,037	0,052	0,065	0,076	0,085	0,087	0,066	0,043	0,034	0,029	0,030	0,031	0,067	0,042	0,056
75	0,027	0,039	0,047	0,058	0,065	0,064	0,052	0,034	0,027	0,022	0,023	0,023	0,051	0,034	0,045
80	0,025	0,037	0,044	0,054	0,061	0,060	0,049	0,033	0,026	0,021	0,021	0,022	0,048	0,032	0,043
90	0,022	0,033	0,037	0,046	0,052	0,050	0,043	0,029	0,022	0,019	0,018	0,019	0,041	0,028	0,037
95	0,020	0,031	0,033	0,041	0,046	0,044	0,039	0,027	0,019	0,018	0,016	0,017	0,036	0,025	0,033
99	0,018	0,028	0,027	0,033	0,038	0,036	0,035	0,024	0,015	0,016	0,013	0,015	0,030	0,020	0,027
Hydrometric cross section No. 3															
1	0,157	0,235	0,237	0,271	0,304	0,323	0,248	0,140	0,092	0,098	0,105	0,117	0,238	0,109	0,158
5	0,113	0,166	0,182	0,206	0,230	0,245	0,187	0,105	0,072	0,073	0,077	0,084	0,180	0,086	0,126
10	0,093	0,136	0,156	0,176	0,197	0,210	0,160	0,090	0,062	0,061	0,064	0,069	0,154	0,076	0,111
20	0,073	0,106	0,129	0,145	0,162	0,172	0,131	0,074	0,052	0,049	0,051	0,054	0,127	0,065	0,095
25	0,066	0,096	0,119	0,134	0,150	0,159	0,121	0,068	0,048	0,045	0,046	0,049	0,118	0,061	0,089
50	0,043	0,064	0,086	0,098	0,110	0,115	0,088	0,050	0,036	0,031	0,031	0,032	0,087	0,047	0,069
75	0,027	0,045	0,060	0,071	0,080	0,081	0,063	0,037	0,026	0,021	0,020	0,021	0,065	0,036	0,053
80	0,025	0,042	0,054	0,066	0,074	0,075	0,058	0,034	0,024	0,019	0,018	0,019	0,061	0,033	0,049
90	0,019	0,036	0,042	0,054	0,062	0,060	0,048	0,029	0,020	0,015	0,014	0,015	0,052	0,028	0,041
95	0,016	0,033	0,034	0,047	0,054	0,050	0,041	0,026	0,017	0,012	0,011	0,013	0,047	0,024	0,035
99	0,011	0,029	0,022	0,036	0,043	0,037	0,032	0,021	0,013	0,009	0,008	0,010	0,039	0,019	0,027

continued Table 1

p [%]	Months												Half-years		Year
	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI-IV	V-X	XI-X
Hydrometric cross section No. 4															
1	0,812	1,061	1,214	1,319	1,433	1,489	1,213	0,716	0,507	0,612	0,577	0,622	1,162	0,578	0,752
5	0,609	0,796	0,928	1,015	1,106	1,152	0,919	0,567	0,424	0,464	0,452	0,478	0,905	0,484	0,640
10	0,520	0,680	0,800	0,880	0,960	1,000	0,790	0,500	0,385	0,400	0,395	0,415	0,790	0,440	0,585
20	0,429	0,560	0,667	0,738	0,807	0,840	0,657	0,431	0,343	0,335	0,336	0,349	0,669	0,392	0,524
25	0,398	0,520	0,621	0,690	0,755	0,785	0,613	0,408	0,328	0,313	0,317	0,327	0,628	0,375	0,502
50	0,300	0,390	0,470	0,530	0,580	0,600	0,470	0,330	0,275	0,245	0,250	0,255	0,490	0,315	0,420
75	0,237	0,304	0,362	0,416	0,454	0,463	0,377	0,276	0,231	0,204	0,203	0,206	0,390	0,265	0,347
80	0,226	0,289	0,342	0,395	0,430	0,437	0,361	0,266	0,222	0,197	0,194	0,197	0,371	0,255	0,331
90	0,205	0,260	0,300	0,350	0,380	0,380	0,330	0,245	0,200	0,185	0,175	0,180	0,330	0,230	0,290
95	0,193	0,243	0,274	0,322	0,348	0,343	0,312	0,233	0,185	0,178	0,164	0,169	0,305	0,212	0,260
99	0,178	0,221	0,239	0,285	0,306	0,294	0,289	0,216	0,161	0,170	0,148	0,156	0,270	0,186	0,209
Hydrometric cross section No. 5															
1	1,862	2,677	2,797	3,006	3,518	3,527	2,728	1,581	1,037	1,160	1,169	1,380	2,649	1,222	1,711
5	1,333	1,884	2,081	2,316	2,619	2,684	2,059	1,208	0,820	0,855	0,873	0,976	2,030	0,974	1,400
10	1,100	1,541	1,762	1,999	2,218	2,301	1,761	1,040	0,719	0,720	0,740	0,801	1,749	0,860	1,251
20	0,860	1,196	1,429	1,661	1,803	1,898	1,451	0,863	0,611	0,580	0,599	0,623	1,451	0,738	1,085
25	0,780	1,084	1,316	1,545	1,664	1,760	1,347	0,804	0,573	0,534	0,552	0,565	1,350	0,696	1,026
50	0,520	0,730	0,940	1,140	1,200	1,290	1,000	0,600	0,440	0,380	0,390	0,380	1,000	0,550	0,810
75	0,348	0,526	0,674	0,826	0,879	0,939	0,758	0,451	0,333	0,276	0,271	0,269	0,736	0,436	0,623
80	0,319	0,496	0,625	0,763	0,820	0,871	0,713	0,422	0,311	0,257	0,249	0,252	0,684	0,413	0,581
90	0,260	0,441	0,522	0,619	0,698	0,721	0,621	0,360	0,259	0,220	0,200	0,220	0,569	0,360	0,481
95	0,225	0,412	0,458	0,523	0,625	0,625	0,565	0,321	0,224	0,198	0,169	0,203	0,494	0,325	0,407
99	0,182	0,378	0,374	0,387	0,529	0,491	0,491	0,268	0,172	0,169	0,126	0,183	0,391	0,274	0,287

In the earlier study (1991), the authors estimated the probable mean half-yearly and yearly discharges for the same hydrometric cross sections based on the mean discharges from the period 1961-1985 (25 years). The estimation of the probable mean discharges from 1961-1995 (35 years) was possible in the present study. The values of the mean yearly discharges (m^3/s) with the predominance probability p=10, 50, 90% estimated for the years 1961-1985 (Duda et al 1991) and 1961-1995 are presented below.

	SQ_p [m^3/s]	
p[%]	years 1961-1985	years 1961-1995
	hydrometric cross section No 1	
10	0,082	0,084
50	0,059	0,056
90	0,036	0,037
	hydrometric cross section No 3	
10	0,109	0,111
50	0,074	0,069
90	0,040	0,041
	hydrometric cross section No 4	
10	0,600	0,585
50	0,430	0,420
90	0,290	0,290
	hydrometric cross section No 5	
10	1,270	1,250
50	0,845	0,810
90	0,495	0,480

The analysis of the values presented above, shows no significant differences between the probable mean yearly discharges estimated on the mean yearly discharges from the periods 1961-1985 and 1961-1995.
It proves that the mean discharges from the multi-year period 1986-1995 are not significantly distinct from their counterparts of 1961-1985.
In the analyzed multi-year period (1961-1995) for the considered hydrometric cross sections:

- the highest mean yearly discharges (WSQ) occurred in 1988 with the predominance probability p=5%,

the lowest mean yearly discharges (NSQ) occurred in 1964 with the predominance probability p=95%.

CONCLUSIONS

The most abundant in water in the Tywa river-basin is the smaller drainage area for the hydrometric cross section No 3 (SSq = 4,21 l/s·km^2). On the contrary, the least abundant in water is the drainage area for the hydrometric cross section No 5 (SSq = 3,33 l/s·km^2).
The highest irregularity of the mean discharges is observed in the discharges for the hydrometric cross section No 3 (K=3,57), whereas the lowest one for the hydrometric cross section No 4 (K=2,41) respectively.
The predominance probability of the mean yearly discharges for the considered hydrometric cross section of the Tywa river basin ranges between 5% (WSQ) and 95% (NSQ).

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PRAWDOPODOBNE ŚREDNIE MIESIĘCZNE, PÓŁROCZNE I ROCZNE PRZEPŁYWY W DORZECZU RZEKI TYWA (LATA 1961-1995)

Streszczenie

W pracy przedstawiono średnie miesięczne, półroczne i roczne przepływy o określonym prawdopodobieństwie przewyższenia. Obliczenia wykonano dla czterech profili hydrometrycznych zlokalizowanych w dorzeczu rzeki Tywa, dla których brak jest obserwacji wodowskazowych, okres objęty obliczeniami to wielolecie 1961 - 1995.