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Environmental Protection of International River Basins

PILOT PROJECT

FLOOD RISK ASSESSMENT AND MAPPING OF UPPER DNIEPER BASIN, INCLUDING DETERMINATION MOST AT RISK AREAS, FIELD SURVEYING OF CRITICAL SITES, MAPPING AND INITIAL DESIGN OF PROTECTION MEASURES BELARUS



REPORT ON DELIVERABLE 2

“Dobrush watercourses flow calculations, outlining maximum water discharges of spring floods of 0.5%, 1%, 10%, 25% probability and maximum water discharges of flash floods with 10% probability”

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ABBREVIATIONS

CRICUWR.....	Central Research Institute for Complex Use of Water Resources, Minsk, Belarus
BS.....	Baltic System of coordinates
HPP.....	Hydro Power Plant
Pilot project.....	Flood risk assessment and mapping of the Upper Dnieper Basin, including determination most at risk areas, field surveying of critical sites, mapping and initial design of protection measures
RCM.....	Republican Center Minpryroda, Minsk, Belarus
RHC.....	Republican Hydrometeorological Center, Minsk, Belarus
RCRCM.....	Republican Center of Radiation Control and Environmental Monitoring, Minsk, Belarus
TCP.....	Technical Code of Practice (national)

INTRODUCTION

The presented report on deliverable 2 “Dobrush watercourses flow calculations, outlining maximum water discharges of spring floods of 0.5%, 1%, 10%, 25% probability and maximum water discharges of flash floods with 10% probability” is prepared by RCM with assistance of its partners CRICUWR, RHC and RCRCEM, under the contract for flood risks assessment and mapping of the Upper Dnieper basin, including determination most at risk areas, field surveying of critical sites, mapping and initial design of protection measures for the needs of EU funded project “Environmental Protection of International River Basins” implemented by consortium led by Hulla and Co. Human Dynamics KG.

Methodology of watercourses flow calculation for the different hydrological conditions based on the following guidance national documents:

- TCP 45-3.04-168-2009 “Calculated hydrological characteristics Procedure of determination”;
- Guidance document #2.01.14-83 “Determination of hydrological characteristics”.

Hydrological calculations include hydrological data proceeding for the all period of measurement (from 1992 to 2013 years.) on the hydrological monitoring station “Dobrush” (pictures 1,2). This station is situated on the river Iput 0.5 km upstream of river Horoput (Iput tributary) in the tail-water of Dobrush Hydro Power Plant. Initial hydrological data include daily water discharges and water levels for the periods of spring floods and flash floods.



Picture 1 – Hydrological monitoring station “Dobrush”

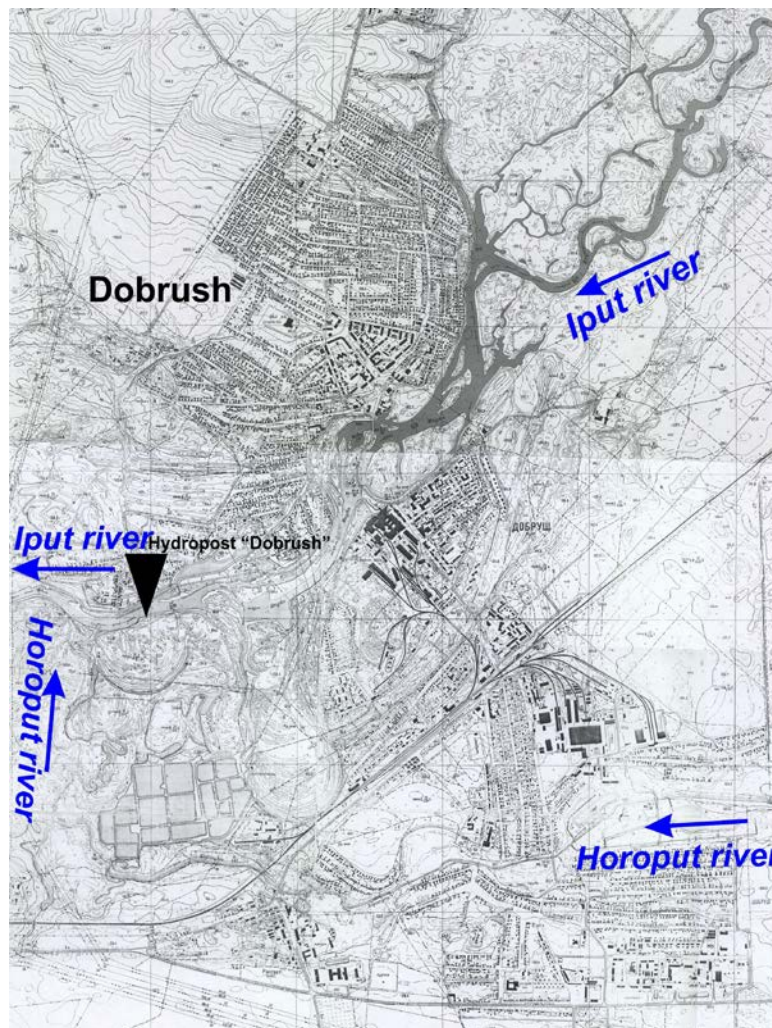
The first step of data proceeding includes determination of the maximum water discharges and maximum water levels of spring and flash floods during the year.

Second step includes determination of empirical curves of probability and determination of the statistical coefficients of these curves: coefficient of variation C_V , coefficient of asymmetry C_S .

Third step includes calculation of the distributions of probabilities of the maximum water discharges of spring and flash floods theoretical curves with using of the three-parametrical gamma-distribution, empirical curves and their statistical coefficients.

Finally the required maximum water discharges of spring floods of 0.5%, 1%, 10%, 25% probability and maximum water discharges of flash floods with 10% probability are calculated with using theoretical curves of probabilities.

For the river Horoput required maximum water discharges are determined with using theoretical approach take into account mentioned above guidance documents because of there are no any measurement and monitoring stations on this small river. In this case its watershed characteristics are used including more important from theirs: catchment area is 528 km², length of the river is 45 km, average slope of the river is 0.8 ‰, percentage of forest land is 15%, percentage of lakes land is 0%, percentage of swamps land is 0%.



Picture 2 – Dobrush watercourses: rivers Iput and Horoput

Photo on the cover – river Iput upstream of Dobrush town, represented by Kanstantsin Tsitou

1 Results of the hydrological Dobrush watercourses flow calculations

1.1 River Iput

1.1.1 Hydrological data proceeding

Hydrological data proceeding for the all period of measurement (from 1992 to 2013 years) on the hydrological monitoring station “Dobrush”. Initial hydrological data include daily water discharges and water levels for the periods of spring floods and flash floods. Maximum water discharges and maximum water levels of spring and flash floods are determined (see figures 1,2), detail results of hydrological data proceeding are presented in the attachment A.

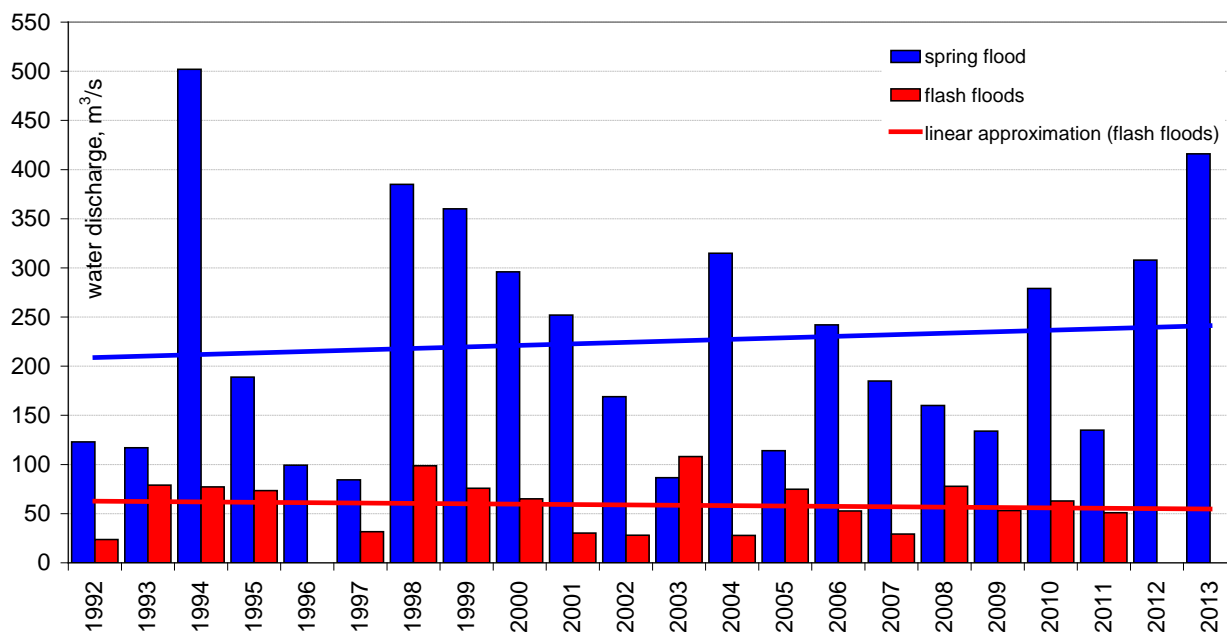


Figure 1 - Maximum water discharges of spring floods and flash floods in the river Iput on the territory of Dobrush

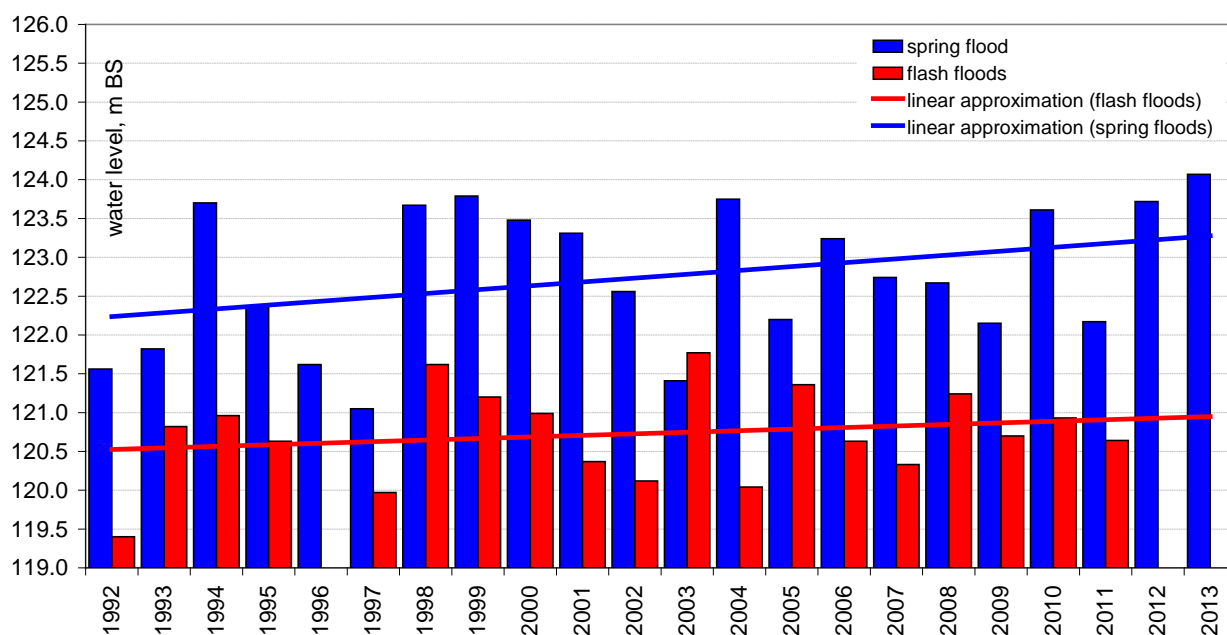


Figure 2 - Maximum water levels of spring floods and flash floods in the river Iput on the territory of Dobrush

1.1.2 Determination of empirical and theoretical curves of probability, statistical coefficients and required maximum water discharges.

Calculated empirical and theoretical curves of probability are presented in figures 3-6.

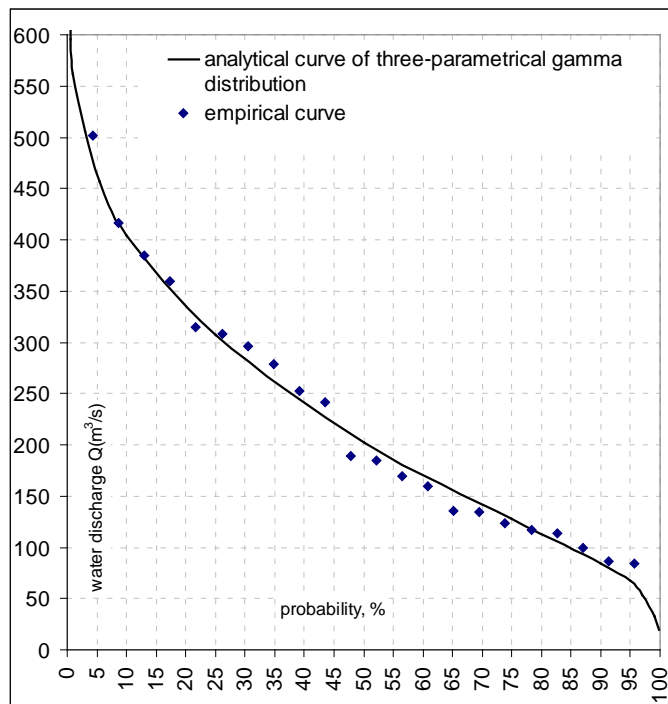


Figure 3 - Curves distributions of probabilities of the maximum water discharges of spring floods in the river Iput in Dobrush

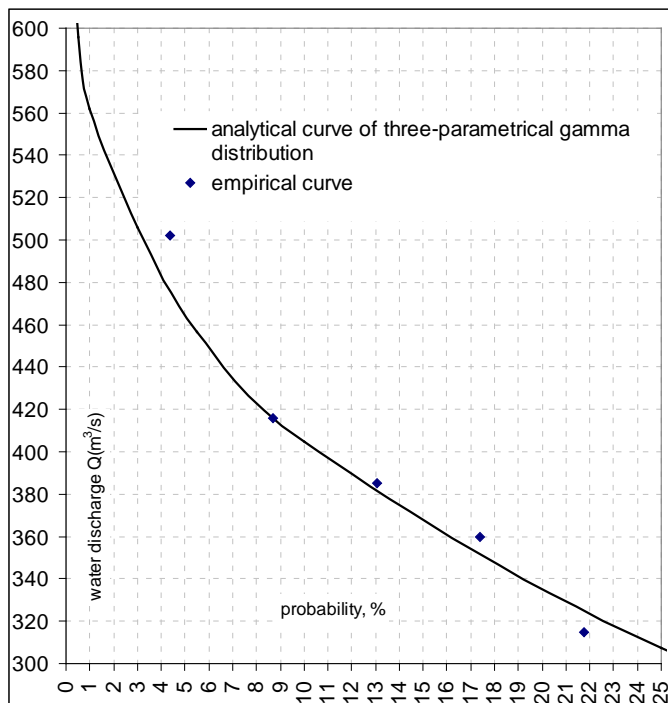


Figure 4 - Curves distributions of probabilities of the maximum water discharges of spring floods in the river Iput in Dobrush (upper part of curves)

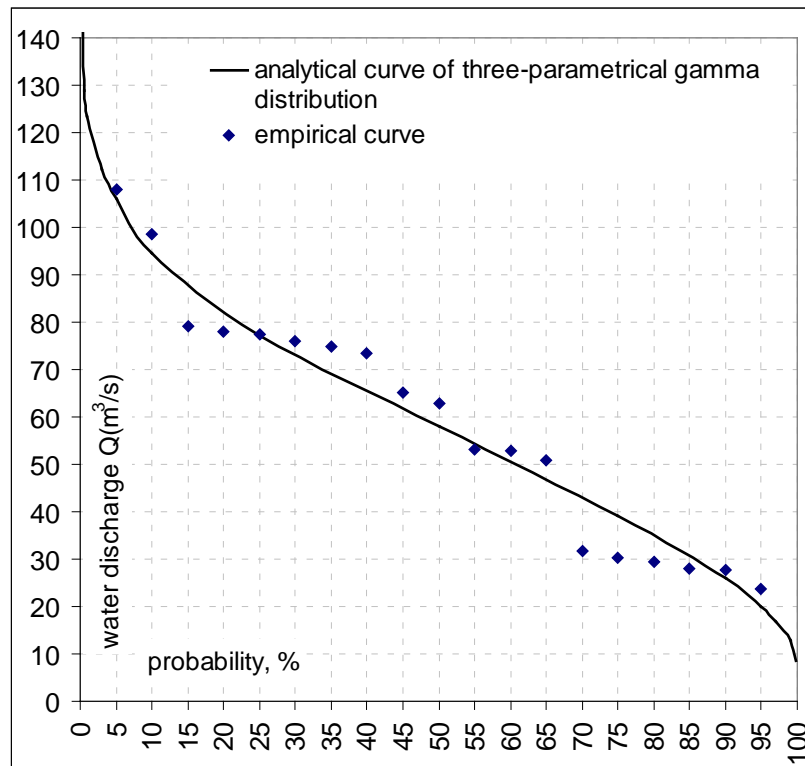


Figure 5 - Curves distributions of probabilities of the maximum water discharges of flash floods in the river Iput in Dobrush

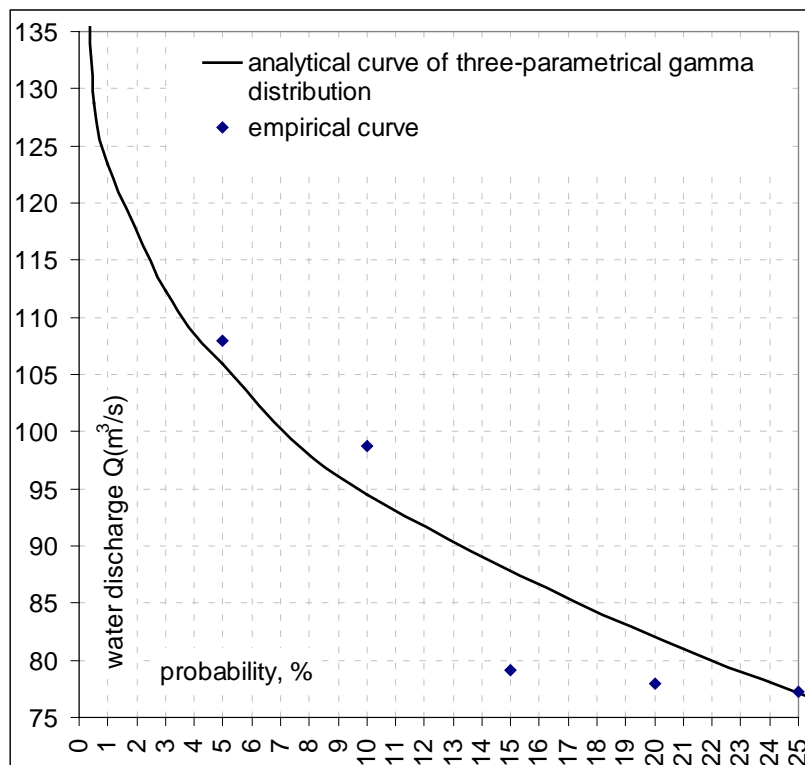


Figure 6 - Curves distributions of probabilities of the maximum water discharges of flash floods in the river Iput in Dobrush (upper part of curves)

Summary of results of calculation of the required maximum water discharges of spring floods of 0.5%, 1%, 10%, 25% probability and maximum water discharges of flash floods with 10% probability are presented in table 1.

Table 1 – Summary of the river Iput flow calculations (downstream of Dobrush town)

Probability, %	Spring floods, m ³ /s	Flash floods, m ³ /s
0,5 (once per 200 years)	595.5	128.7
1 (once per 100 years)	561.8	123.4
5 (once per 20 years)	456.6	105.9
10 (once per 10 years)	404.8	94.45
25 (once per 4 years)	307.4	77.17
Coefficient of variation C _v	0.56	0.45
Coefficient of asymmetry C _s	C _s =1C _v =0.56	C _s =0.56C _v =0.25

1.2 River Horopot

Flow regime of river Horopot in Dobrush in spring and flash floods periods will depend on Iput river water flow regime. It means that inundation zones along Horopot river will be determined by Iput river water levels in Dobrush but summary of flow calculation results for the river Horopot (Iput tributary) with using theoretical approach are presented in the table 2.

Table 2 – Summary of the river Horopot flow calculations (river outlet - inflow in river Iput)

Probability, %	Spring floods, m ³ /s	Flash floods, m ³ /s
0,5	90.90	26.59
1	87.35	25.50
5	58.36	16.78
10	48.43	13.01
25	31.45	8.33

CONCLUSIONS

Results of the Dobrush watercourses maximum water discharges of spring and flash floods hydrological calculations will used as necessary boundary condition for the further mathematical modeling of the river Iput water regime (water levels and average velocities in cross sections) and for the development of the flood hazard maps and flood risk maps.

ATTACHMENT A - DETAILED RESULTS OF HYDROLOGICAL DATA PROCEEDING FOR THE RIVER IPUT

Table A1

Year	Spring floods			Flash floods		
	Q_{MAX} , M ³ /c	H _{MAX} , sm from “Zero” of hydrological post	H _{MAX} , m BS	Q_{MAX} , M ³ /c	H _{MAX} , sm from “Zero” of hydrological post	H _{MAX} , m BS
1992	123	284	121.56	23.6	68	119.4
1993	117	310	121.82	79.1	210	120.82
1994	502	498	123.7	77.3	224	120.96
1995	189	364	122.36	73.4	191	120.63
1996	99.4	290	121.62	-	-	-
1997	84.5	233	121.05	31.6	125	119.97
1998	385	463	123.67	98.7	258	121.62
1999	360	475	123.79	75.9	216	121.2
2000	296	444	123.48	65.1	195	120.99
2001	252	427	123.31	30.3	133	120.37
2002	169	352	122.56	28.1	108	120.12
2003	86.6	237	121.41	108	273	121.77
2004	315	471	123.75	27.8	100	120.04
2005	114	316	122.2	74.8	232	121.36
2006	242	420	123.24	52.8	159	120.63
2007	185	370	122.74	29.3	129	120.33
2008	160	363	122.67	77.9	220	121.24
2009	134	311	122.15	53.2	166	120.7
2010	279	457	123.61	63	189	120.93
2011	135	313	122.17	51	160	120.64
2012	308	468	123.72	-	-	-
2013	416	503	124.07	-	-	-

“-“flash flood was not observed because of absence of evident flush flood