WATER UTILIZATION AND WATER MANAGEMENT BALANCES OF THE LOM RIVER BASIN IN BULGARIA

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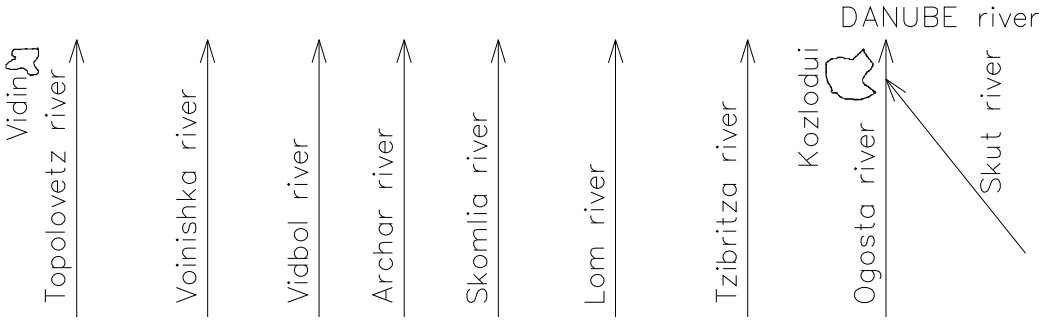
Abstract

The paper present the received results from water management balance (WMB) for existing multi - purpose water resources system (WRS) in the Lom river basin – one important feeder of Danube river in North-West Bulgaria.
It is done a short description and are marked the specific features of present water resources use in the river valley.
For certain points from the river network are determined the main statistical characteristics of natural river flow (for the period 1961 - 2004 year).
Based on the developed scheme for water use and different variants of the individual users needs are made water management balances (WMB).
Experimental simulations researches for WMB are carried out with prepared input information for the inflow and water demand. Sequences for the inflow and irrigation demand in the relevant points are 44 years long by months.
The results for different variants of WMB are analyzed and it is made assessment of water availability of different users. The Lom river basin problems in result of the economical, political and climate changes are discussed.

Keywords: *river basin, water management balance, water supply availability, water resources management, operation, management, computer model, simulation, climate change.*

1 INTRODUCTION

The implementation of the European directive for water (Directive 2000/60/EU) and the Law for water in Bulgaria makes necessary the developing of Plans for water management of river basins (PMRB). That is why it needs to be done an assessment for the condition of the water resources and to develop water management balances (WMB) in the river basins.
Main river basins in north-west Bulgaria (from west to east) are: Topolovetz, Voinishka, Vidbol, Archar, Skomlia, Lom, Tzibritza, Ogosta, Skut. Their total water area is 8022 km^2 and they form their river flow between West Stara planina mountain , Timok river and Iskar river and then go to Danube river.



The Lom river basin is one of the most complicated in this region. Its water is used for irrigation, domestic and industrial water supply, hydro power, preservation of the river ecosystem, fish-farming etc. Main feeders are Nechinska bara river, Chuprenska river, Stakevska river and Medovnitza river. Water resources are regulated with reservoirs,water catchments, hydro power electrical stations (HPS) etc. In the upper Lom river and its feeders are constructed many HPS on fluent water and in the last years the interest in using the energetic potential of Lom river water resources is rising. In the lower Lom river are situated the irrigation systems and the irrigation fields. The main facilities and water users in the river basin are not uniformly situated on the river network, and some of the feeders are with more complicated scheme of water management use. This change a lot the natural regime of the river flow and complicate the developing of WMB for the river basin, described in this paper.

2 GENERAL PRINCIPLES IN DEVELOPING WMB

WMB is the correlation between a inflow and water consumption (for fixed territorial unit and fixed time interval with recognizing water human activity), which are its income and outcome part. WMB is not only simple arithmetic operation, simple accounting balance, simple water balance, but a decisión in which are reflecting the main parts of the versatile and in the same time unified process of using and distributing the water resources in the economy. The juxtaposing of income and outcome parts (inflow- water consumption) is done in the space (in territory and in height), in quantity and quality (correspondence with the requirements of the consumers), in time (for given level of economy development and for given time interval). WMB water management scheme for using the water resources, main requirement for converting the water balance for given territorial unit in WMB. There is definited scheme for water use in the base of every WMB.
This paper considers the results from the developed WMB:

- for the water management scheme for the water resources of LOM river basin;
- for different developed variants of inflow and water consumption, for two stages of developing: contemporary and in perspective till 2015-2020;
- the juxtaposition of the inflow - water consumption is in months

3 SCHEME FOR WATER USE OF WATER RESOURCES IN THE LOM RIVER BASIN

- **From water management point of view the important rivers in the LOM river basin are (Fig. 1):** Lom river, Stakevska river, Chuprenska river, Medovnica river and Nechinska bara river
- In 10 points on the river network is restored the natural regime of the river flow (rows in months from 1961 to 2004 for: Lom river – mouth, Stakevska river, feeder of Lom river (Falkovetz village); Medovnitza river – Drenovetz reservoir (the

damn wall); Chuprenska river – Ripliani water catchment; Lom river – Lomska derivation water catchment; Nechinska river – Hristo Smirnenski reservoir (the damn wall); Nechinska river – mouth (right feeder of Lom river); Medovnitza river – mouth (left feeder of Lom river); Chuprenska river – mouth (left feeder of Lom river); Stakevska river (before the mouth of Chuprenska river)

- Five reservoirs are included (volume over 0.5 mln.^{3}) (Drajinci reservoir, Gurgich-big reservoir, Drenovetz reservoir, Hristo Smirnenski reservoir, Kiselevo reservoir)
- The irrigated areas in the river basin are separated to 4 Irrigated fields (Drenovetz reservoir (IF canal p-13; IF canal p-13'; IF canal M-3, total 15232 dka irrigated areas) and "Lom-West" Irrigation system - total 56136 dka irrigated areas); Lomska derivation and Drenovetz reservoir – IF "Lomska derivation" - total 6770 dka irrigated areas); "Hristo Smirnenski" reservoir (IF "Hristo Smirnenski" Pump station and IF canal m-1 - total 15723 dka irrigated areas); Kiselevo reservoir (IF "Kiselevo" - total 1200 dka irrigated areas)
- The following groups of water consumers are defined:

WATER USERS with WATER LICENCE from:

1. SURFACE WATER (arranged in groups and localized in 16 outlets) for**:**

a) Domestic water supply (DWS) – 1 item (on Fig. 1. blue circle, next to it outlet number and red ellipse).

b) Industrial water supply – 1 item (blue circle, next to it outlet number and orange rhomb).

c) Hydropower – 13 item (red crossed rectangle and next to it name of HPP)

d) Fish-farming - 1 item (electric blue hexagon)

2. UNDERGRAUND WATER (arranged in groups and localized in 1 outlets) for**:**

a) Industrial water supply – 1 item (purple circle, next to it outlet number and orange rhomb)

WATER USERS WITHOUT WATER LICENCE (arranged in groups and localized in 12 outlets) for:

a) Domestic water supply (DWS) – 7 item (red circle, cipher next to it and red ellipse with the cipher incide corresponding to the municipality in which are situated the group of villages and towns attached to one outlet).

b) Industrial water supply – 1 item (blue circle, next to it outlet number and orange rhomb)

c) Irrigation – 4 item. (green rectangle and the name of Irrigation Field)

4 RESULTS FROM WATER MANAGEMENT BALANCES (WMB)

For water resources assessment in Lom river basin are developed WMB in different variants for water demand and river flow. In this case are disposed only the results from:

- **Variant I (**water demand for *Domestic water supply* (DWS) and *Industrial water supply* is given from database of issued water licences from the Danube River Basin District; *Irrigation water supply* is fixes for all irrigated areas; restored natural regime of the river flow in every of the 10 points in the region is given in months for the whole 44 years period) with two sub-variants : **Sub-variant I.1** (calculated for hydrology forecast given with the whole row 1961-2004); **Sub-variant I.2** (for 10 years dry period -extract 1985 – 1994).
- **VARIANT III** with **Sub-variant III.1 (**water demand for Domestic water supply is given with the water use norms; the total water losses in the system are 60 %).

It is accepted the water for ecological preserving of river system to respond to the temporary instruction of the Ministry of Environment and Water of Bulgaria.
The WMB results, obtained from the experiments with the help of the software SYMIL (network simulation-optimization computer program) are given in Tables № 1, № 2 and № 3

Table № 1

WMB OF LOM RIVER BASIN - VARIANT I.1

WATER DEMAND : IRRIGATION WATER SUPPLY, DOMESTIC WATER SUPPLY (from Water Licences and Data of National Statistical Institute for 2004), *INDUSTRIAL WATER SUPPLY* (from Water Licences)

DATA			PERIOD (1961 – 2004)					
					EXCEEDENCE PROBABILITY %			
Node №	Water user	Average annual demands [100m^3]	$W_{start,}$, average [100m^3]	Average shortage [100m^3]	In volumes	In years	In months	Index
1	**p16SWS**	2207	0	0	100	100	100	0
8	**p9sI**	50	0	0	100	100	100	0.281
26	**NSHrSmir**	29106	70175	0	100	100	100	0
37	**7WS**	26052	0	0	100	100	100	0
39	**1WS**	1406	0	0	99.93	95.45	99.62	0.002
42	**3WS**	1540	0	0	100	100	100	0
43	**2WS**	2396	0	11	99.54	86.36	98.30	0.018
53	**5WS**	866	0	0	100	100	100	0
55	**4WS**	891	0	0	100	100	100	0
57	**NSLomDr**	12872	0	0	100	100	100	0
58	**NSDrevec**	42297	0	0	100	100	100	0
61	**6WS**	5042	0	0	100	100	100	0
62	**ecoLom**	314400	0	0	100	100	100	0
63	**prom**	979	0	0	100	100	100	0
64	**p2sR**	1775	494	0	100	100	100	0

Table № 2

WMB OF LOM RIVER BASIN - VARIANT I.2

WATER DEMAND : IRRIGATION WATER SUPPLY, DOMESTIC WATER SUPPLY (from Water Licences and Data of National Statistical Institute for 2004), *INDUSTRIAL WATER SUPPLY* (from Water Licences)

DATA			PERIOD (1961 – 2004)					
					EXCEEDENCE PROBABILITY %			
Node №	Water user	Average annual demands [100m^3]	$W_{start,}$, average [100m^3]	Average shortage [100m^3]	In volumes	In years	In months	Index
1	**p16SWS**	2207	0	0	100	100	100	0
8	**p9sI**	50	0	3	94	100	100	1.072
26	**NSHrSmir**	37854	50285	0	100	100	100	0
27	**NSKisele**	5366	9603	193	96.4	60	93.1	0.498
36	**1gI**	12	0	0	100	100	100	0
37	**7WS**	26052	0	0	100	100	100	0
38	**p1gI**	979	0	0	100	100	100	0
39	**1WS**	1406	0	1	99.93	90	99.17	0.001
42	**3WS**	1540	0	0	100	100	100	0
43	**2WS**	2396	0	34	98.93	60	94.17	0.009
53	**5WS**	866	0	0	100	100	100	0
55	**4WS**	891	0	0	100	100	100	0
57	**NSLomDr**	12872	0	0	100	100	100	0
58	**NSDrevec**	55457	0	0	100	100	100	0
61	**6WS**	5042	0	0	100	100	100	0
62	**ecoLom**	314400	0	0	100	100	100	0
63	**Prom**	979	0	8	100	100	100	0
64	**p2sR**	1775	475	0	100	100	100	0

Table № 3

WMB OF LOM RIVER BASIN - VARIANT III.1 *WATER DEMAND : IRRIGATION WATER SUPPLY, DOMESTIC WATER SUPPLY* (from Water Licences and Data of National Statistical Institute for 2004), *INDUSTRIAL WATER SUPPLY* (from Water Licences)								
D A T A			**PERIOD (1961 – 2004)**					
			$W_{start,}$, average	Average shortage	**EXCEEDENCE PROBABILITY %**			Index
Node №	Water user	Average annual demands [100m^3]	[100m^3]	[100m^3]	In volumes	In years	In months	
1	**p16SWS**	2207	0	0	100	100	100	0
8	**p9sl**	50	0	3	94	100	100	1.072
26	**NSHrSmir**	37854	49935	0	100	100	100	0
27	**NSKisele**	5366	8531	193	96.4	60	93.1	0.498
36	**1gl**	12	0	0	100	100	100	0
37	**7WS**	30976	0	0	100	100	100	0
38	**p1gl**	979	0	0	100	100	100	0
39	**1WS**	1734	0	4	99.17	90	99.17	0.006
42	**3WS**	2876	0	0	100	100	100	0
43	**2WS**	3070	0	78	97.46	60	94.17	0.176
53	**5WS**	1292	0	0	100	100	100	0
55	**4WS**	1946	0	0	100	100	100	0
57	**NSLomDr**	16877	0	0	100	100	100	0
58	**NSDrevec**	55457	0	0	100	100	100	0
61	**6WS**	7704	0	0	100	100	100	0
62	**ecoLom**	314400	0	0	100	100	100	0
63	**Prom**	979	0	0	100	100	100	0
64	**p2Sr**	1775	475	0	100	100	100	0

5 ANALYSES THE RESULTS OF WMB

In **Sub-variant I.1**, **Sub-variant I.2** and **Sub-variant III.1**, the needs of every user are guaranteed totally, only three nodes have shortages with the following exceedence probability (Table № 4):

Node 27 (NS Kiselevo)- **Irrigation water supply** (*IF"Kiselevo*");

Node 39 (1WS) - ***Domestic water supply (DWS)*** (for villages and towns from municipality Belogradchik, Stakevska river basin);

Node 43 (2WS) - ***Domestic water supply (DWS)*** (for villages and towns from municipalities Belogradchik and Chuprene, Krastavichna river basin).

Table № 4

	Sub-variant I.1		**Sub-variant I.2.**			**Sub-variant III.1.**		
	Node 39	**Node 43**	**Node 27**	**Node 39**	**Node 43**	**Node 27**	**Node 39**	**Node 43**
Exceedence probability in volume	99.93	99.54	96.40	99.93	98.93	96.40	99.17	97.46
Exceedence probability in years	95.45	86.36	60.00	90.00	60.00	60.00	90.00	60.00
Exceedence probability in months	99.62	98.30	93.10	99.17	94.17	93.10	99.17	94.17

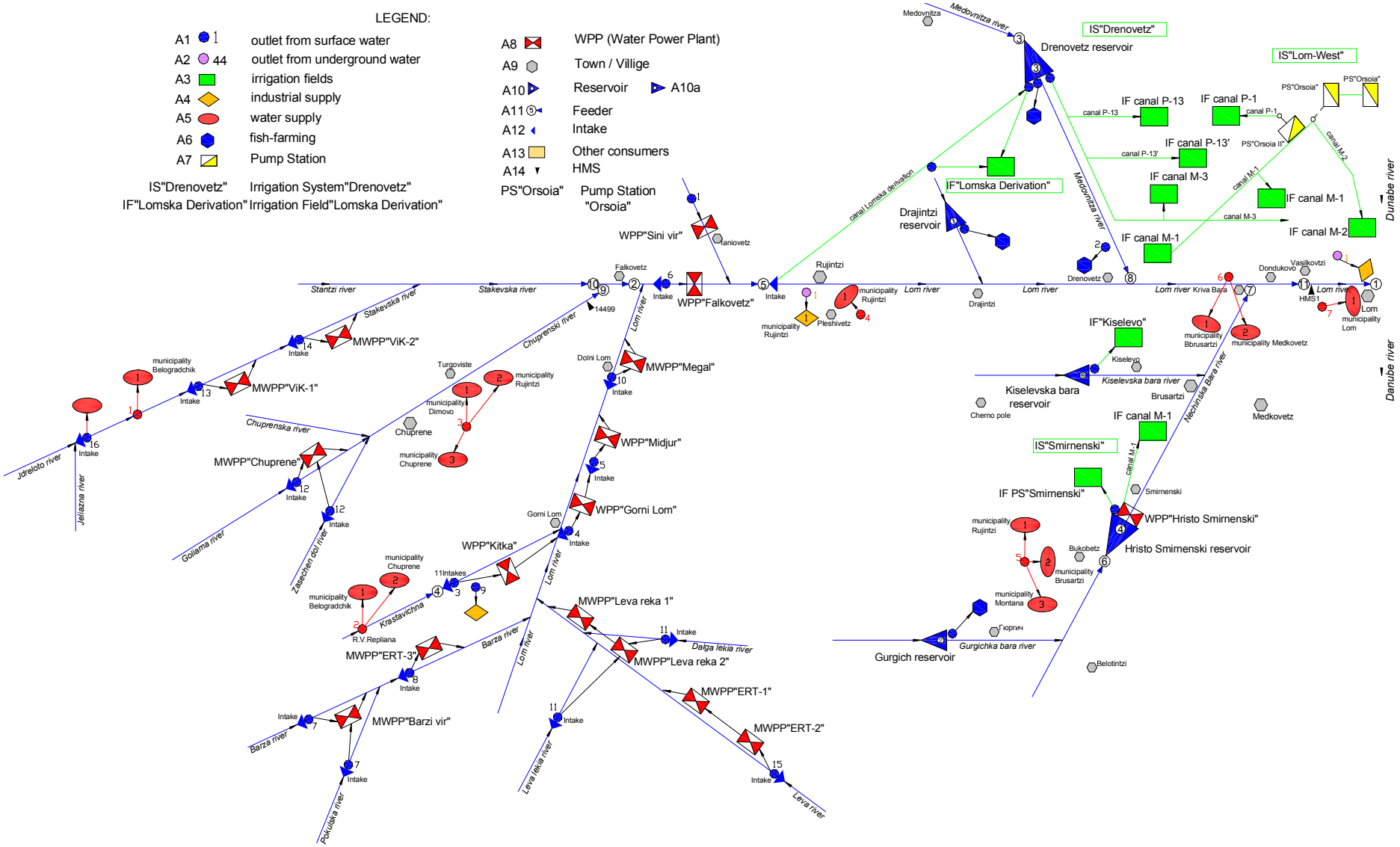


Figure 1: Water Use Scheme of LOM River Basin

6 CONCLUSION

As it is seen from the disposed results for Lom basin, the developed different variants for WMB showed that the water use of every user is guaranteed in the limits of accepted for the country normative exceedence probability for: *Irrigation* – 75%; *Domestic water supply* and *Industrial water supply* – 95-98%. In the points where there are shortages of water, they are not so big and appeared mainly in outlets from stream water for *Domestic water supply* (totally their are 2) and in one Irrigation system. This is the case in:

- -water outlet (Node 39 - 1WS) for *Domestic water supply* (of the villages from the municipality Belogradchik, Stakevska river basin) in the three Sub-variants the exceedence probabilities (only in years) (**95.45%; 90%; 90%**) are less than normative exceedence probabilities;

- water outlet (Node 43 - 2WS) for *Domestic water supply* (of the villages from the municipalities for villages and towns from municipalities Belogradchik and Chuprene, Krastavichna river basin) in the three Sub-variants the exceedence probabilities (only in years) (**86.36%; 60%; 60%**) are less than normative exceedence probabilities .

- *IF"Kiselevo*" (takes water from "Kiselevska bara" reservoir – volume 1.6 mln.m^3, with Irrigated areas – 1 200 dka), in the three Sub-variants the exceedence probabilities (only in years) (**60%; 60%; 60%**).

Obviously in these 3 water catchments is necessary to make ruling decisions leading to reducing the losses in the water supply network, reducing the redundant wasting of water or to constructing of regulating facilities for the flow.A lot of licenece for HPP are issued in the river basin.The total water limit for HPP is 217 mln.m^3/year. All HPP are on running water. Even though the total flow in the mouth of Lom river is 216 mln.m^3/year(with Exceedence probability 75%) the issued water licences will not cause a water shortage in the rest water consumers,because the HPP only use water and do not divert water in other river basins.

In conclusion, the Lom river basin does not have nodes with big breaches, inadmissible shortages and conflict between the users. The presence of shortages is a signal that in these water catchments there is a problem which needs a decision. WMB could bind these water demand with the available water resources.

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