

# **Vltava River Reservoirs Cascade**

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## **Effect on the Flood 2002**

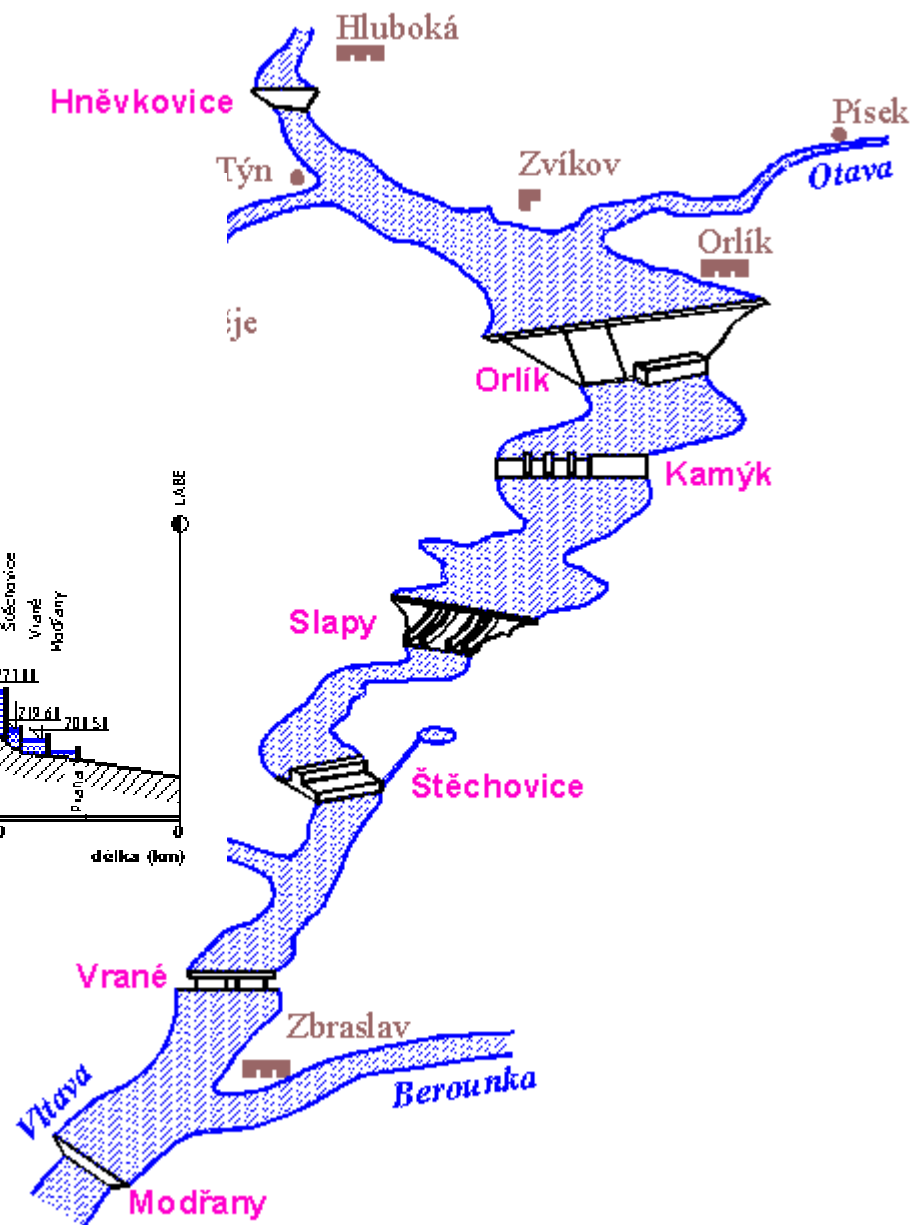
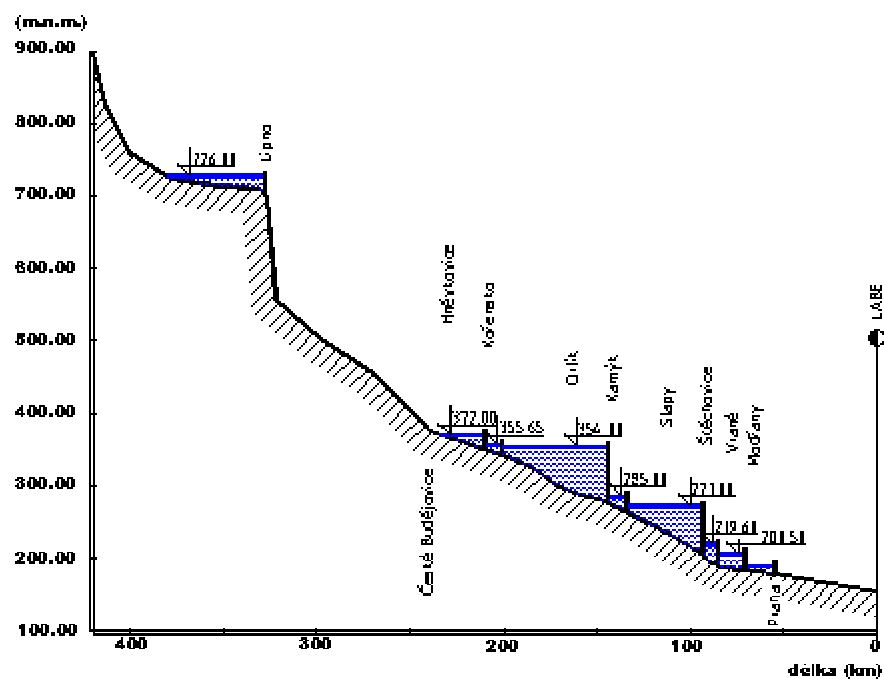
**Czech Hydrometeorological Institute**

**Czech Agricultural University**

**AquaLogic**

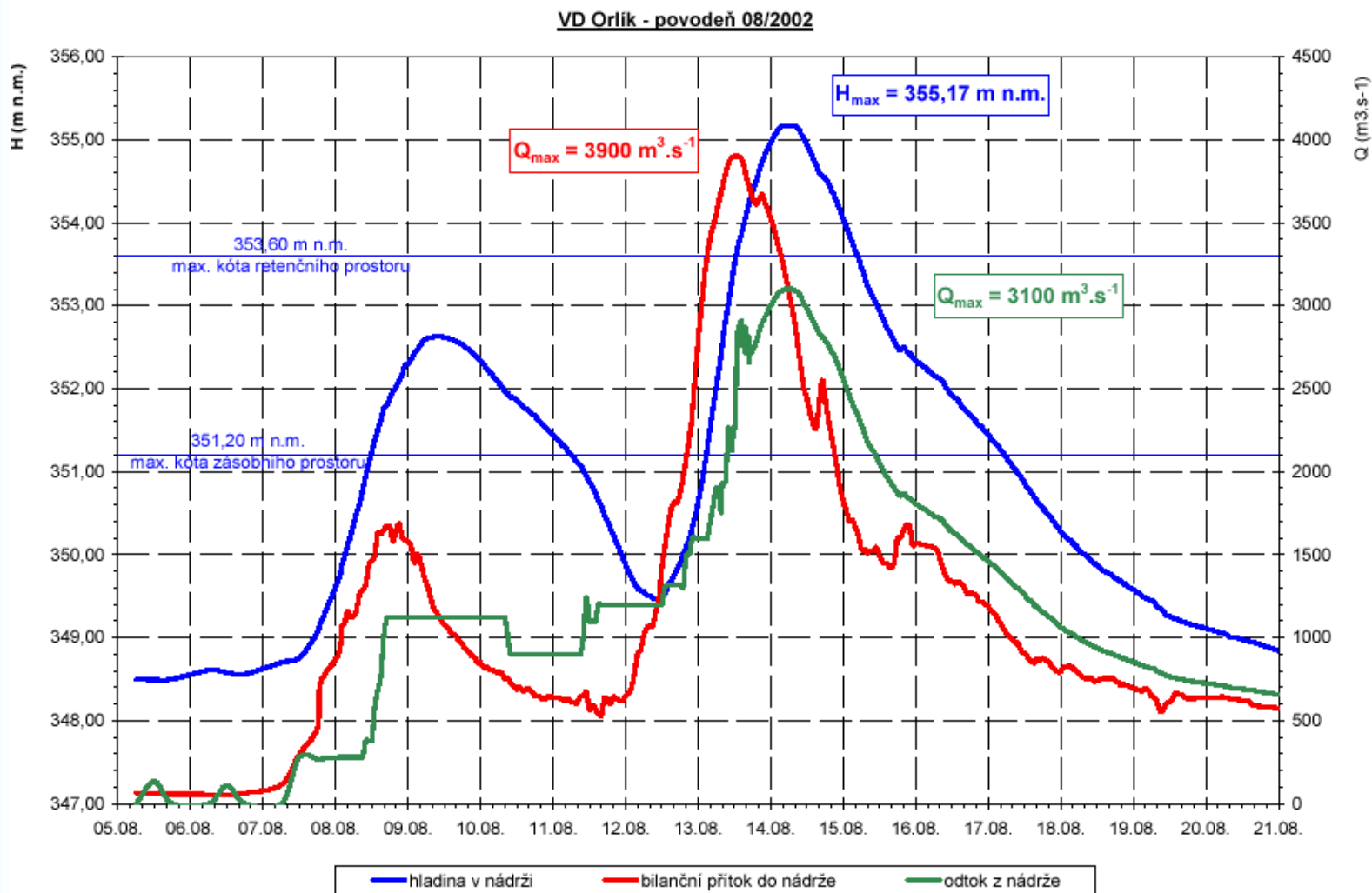
**RNDr. Jan Daňhelka, Ph.D.**

**Ing. Jakub Krejčí, Prof. Jiří Zezulák**



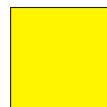


# Orlík Reservoir – August 2002 Flood

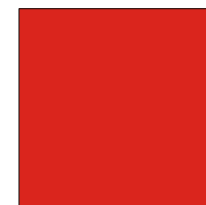
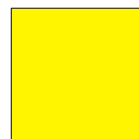


	Flood protection designed	Free operational s storage	Other used s storage		Total used s storage
	mil.m3	mil.m3	mil.m3		mil.m3
<b>LIPNO</b>	12.06	32.49	3.40	*	47.95
<b>HNĚVKOVICE</b>		0.74	4.50	*	5.24
<b>ORLÍK</b>	62.07	63.54	41.66	*	167.28
<b>KAMÝK</b>		3.80	2.88	*	6.68
<b>SLAPY</b>		7.49	0.81	*	8.31
<b>ŠTĚCHOVICE</b>		2.02	0.93	*	2.95
<b>VRANÉ</b>		0.58	2.80	*	3.38
<b>NECHRANICE</b>	36.56	14.10			27.30

Orlík  
Reservoir

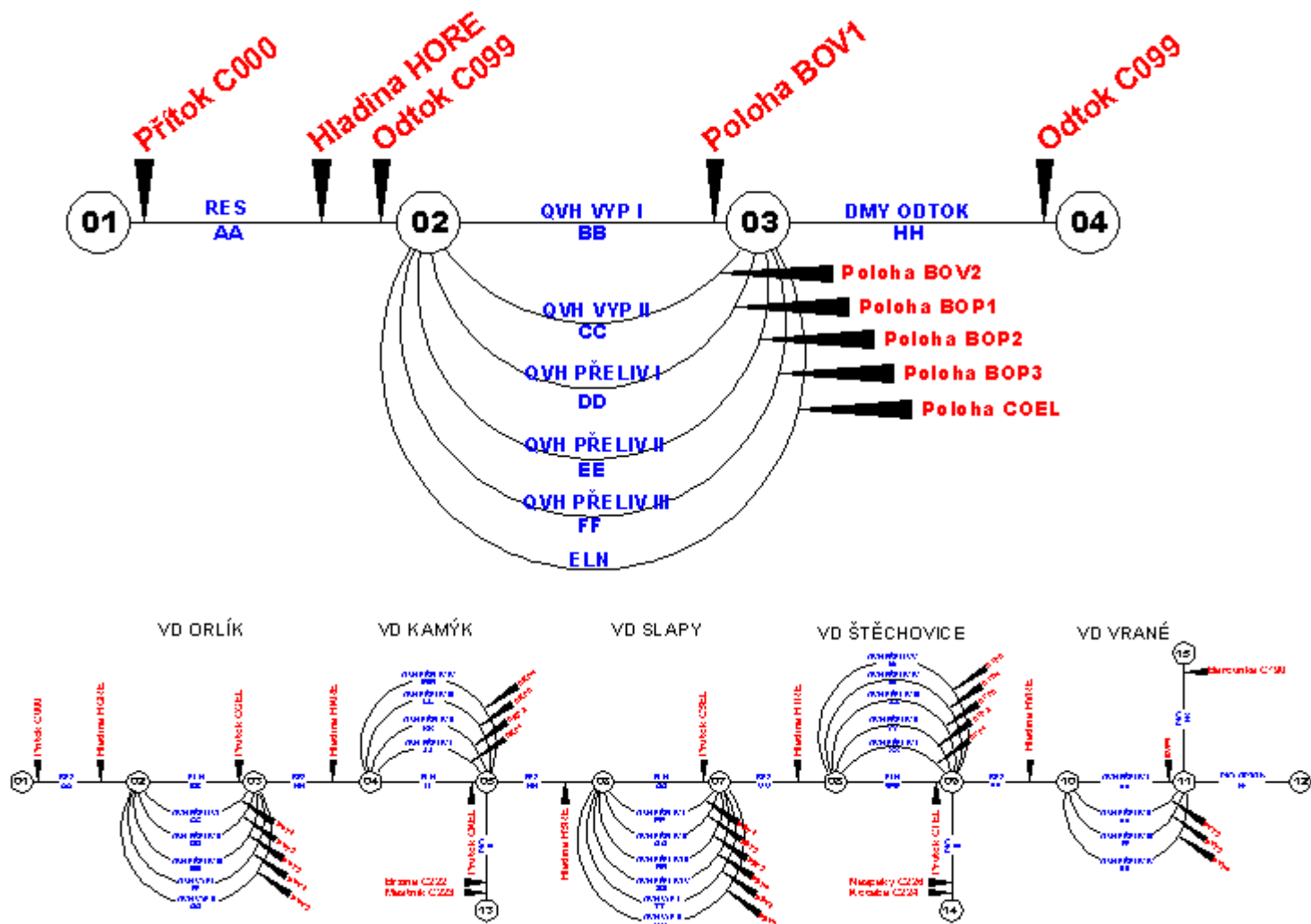


All Vltava  
Cascade  
Reservoirs



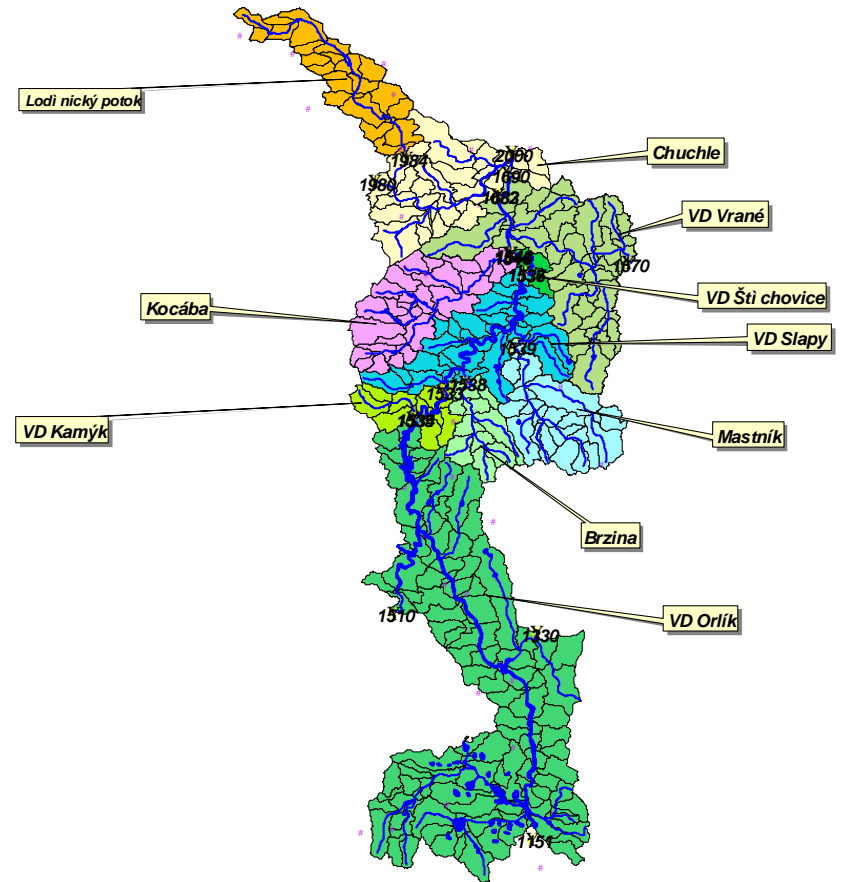
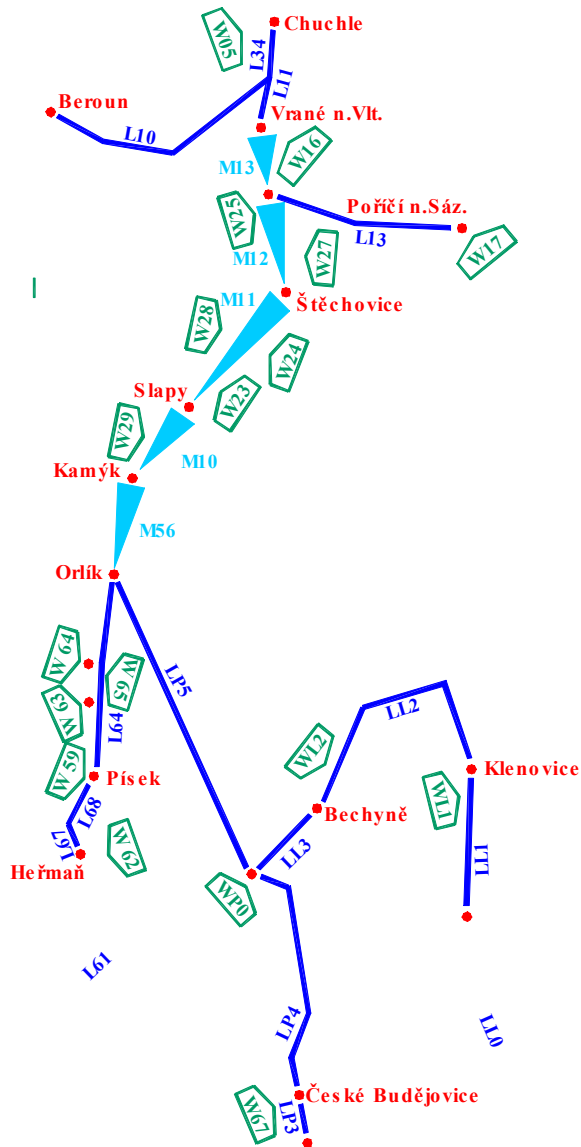
Nechranice  
Reservoir





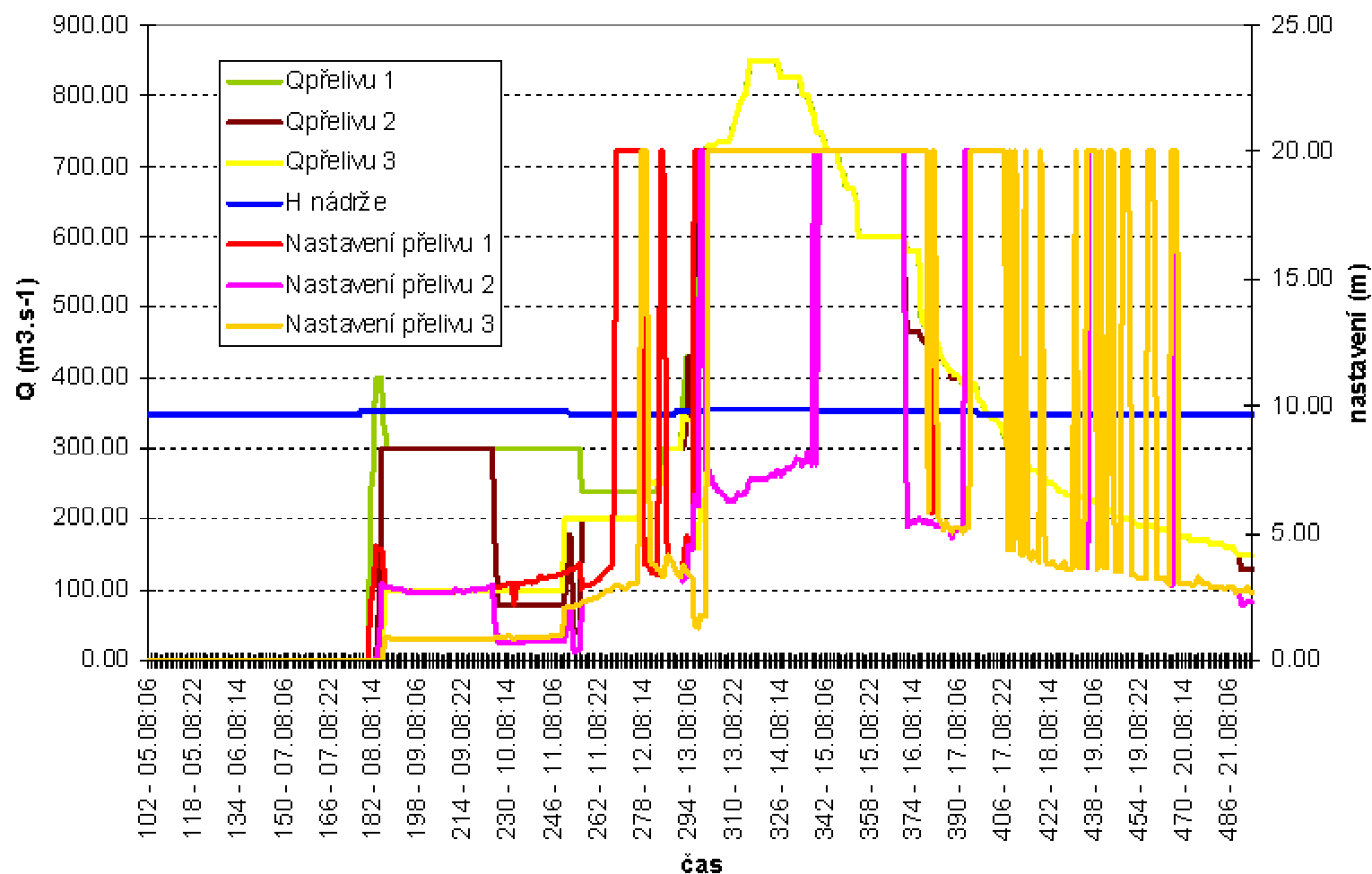


# Model construction



# Orlík reservoir – reconstruction of spillways settings

VD Orlík výpočet nastavení jednotlivých přelivů

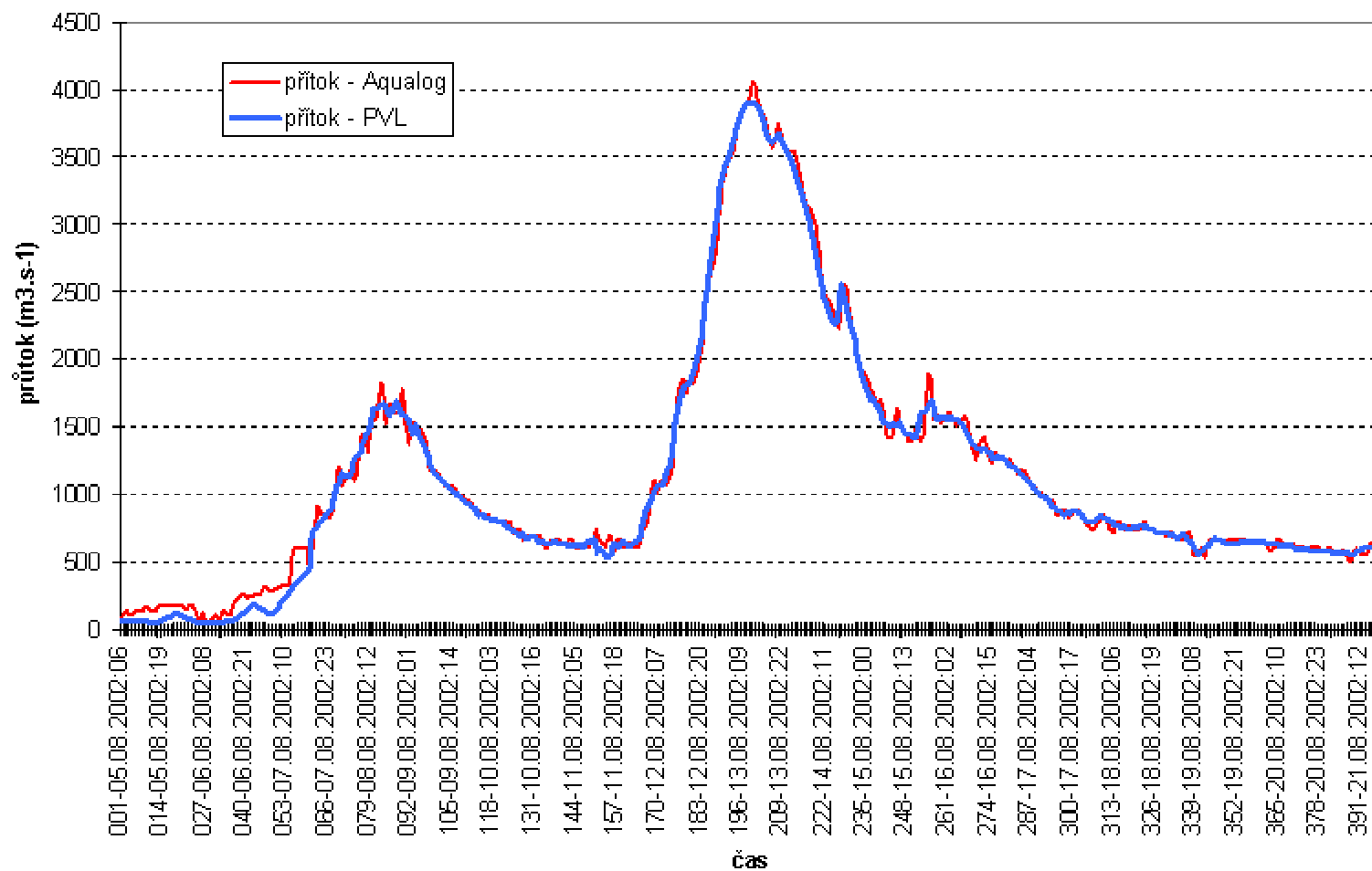




# Orlík reservoir model

## verification - inflow

Simulace VD Orlík výpočet přítoku na základě známého odtoku a hladiny nádrže

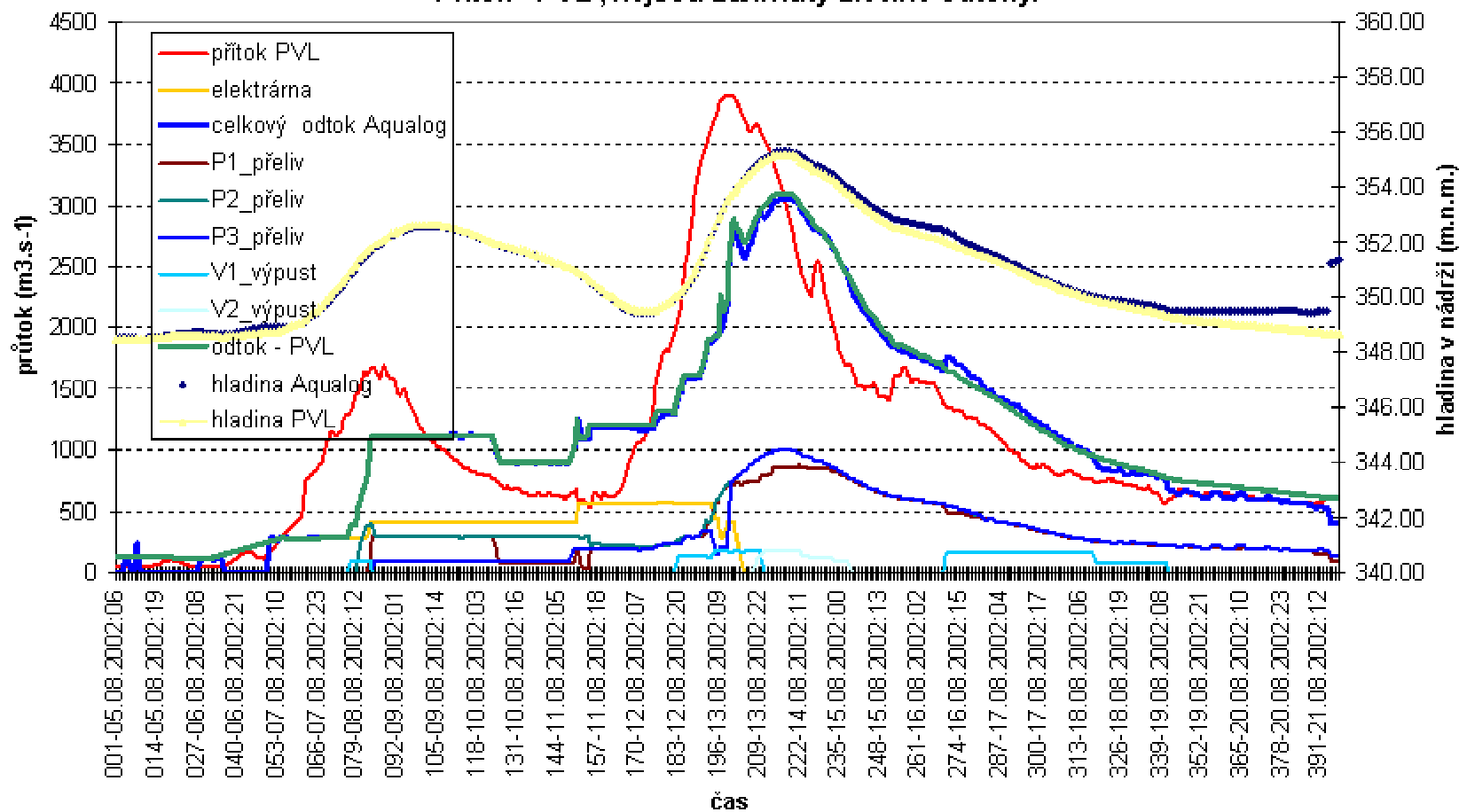


# Orlík reservoir model verification

## Input = inflow

Simulace VD Orlík na základě měrných křivek a skutečného nastavení během, manipulace

Přítok - PVL, nejsou zahrnuty živelné odtoky.



## Simulation variants

Initial water level of Orlík – 348.50 a.s.l.  
345.60 a.s.l.  
347.60 a.s.l.  
351.20 a.s.l.

„No damage“ Q in Prague – 1 500 m<sup>3</sup>.s<sup>-1</sup>  
1 700 m<sup>3</sup>.s<sup>-1</sup>  
2 000 m<sup>3</sup>.s<sup>-1</sup>

Power plant operation, perfect inflow forecast ...

Overall **23 variants**

## Selected variants

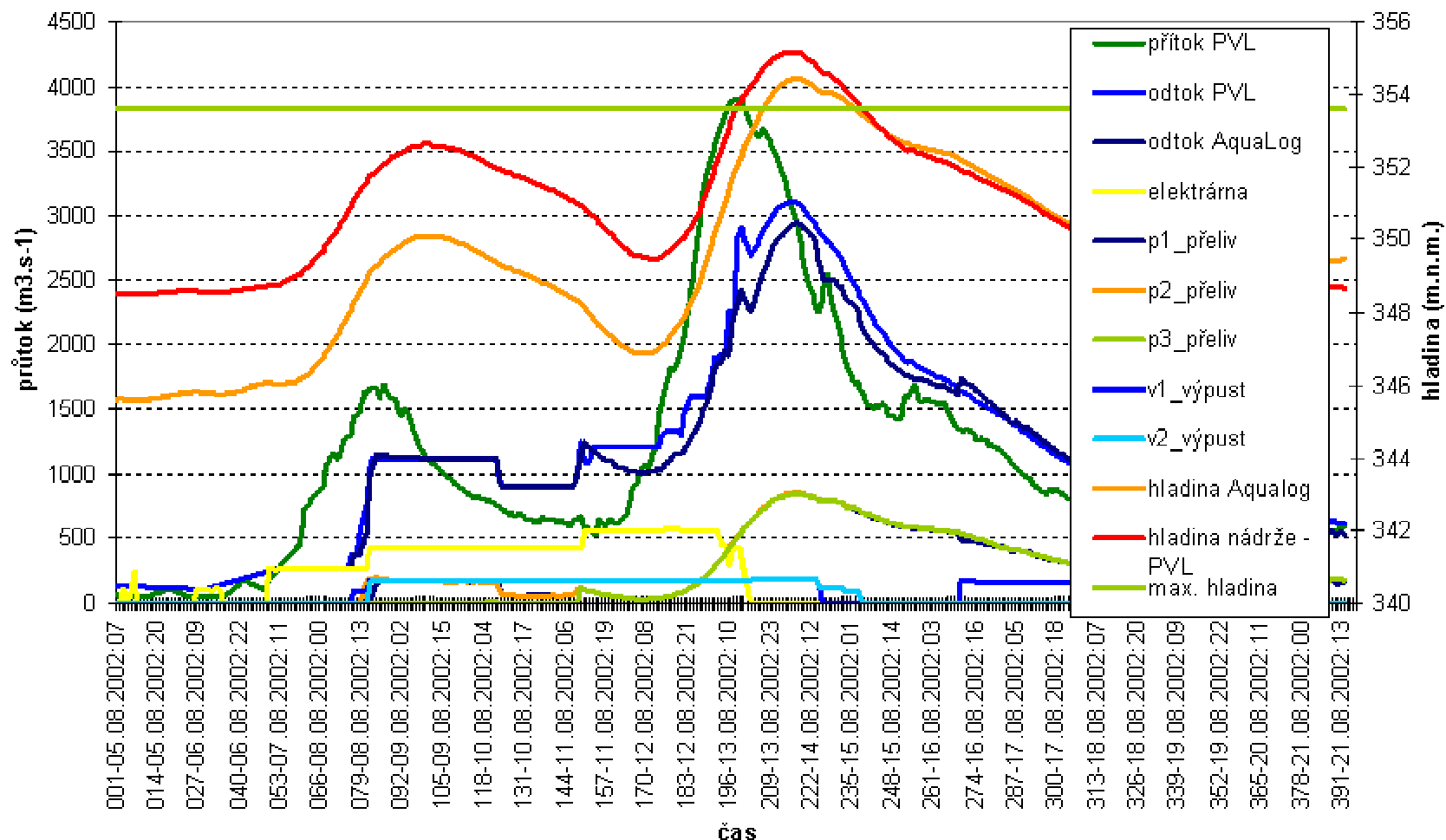
1b -	345.60 a.s.l.	1 500 m <sup>3</sup> .s <sup>-1</sup>
2a -	347.60 a.s.l.	1 500 m <sup>3</sup> .s <sup>-1</sup>
3h -	347.60 a.s.l.	1 700 m <sup>3</sup> .s <sup>-1</sup>
3i -	347.60 a.s.l.	2 000 m <sup>3</sup> .s <sup>-1</sup>
3l -	351.20 a.s.l.	1 500 m <sup>3</sup> .s <sup>-1</sup>
3m -	351.20 a.s.l.	1 700 m <sup>3</sup> .s <sup>-1</sup>
3n -	351.20 a.s.l.	2 000 m <sup>3</sup> .s <sup>-1</sup>
4 -	348.50 a.s.l.	Perfect forecast (no outflow decrease between peaks)
5b -	348.50 a.s.l.	No power plant damage

# Selected variants - Results

Var.	initial water level	water level max	$\delta$	$\delta$	Outflow max	$\delta$	$\delta$	Peak discharge	$\delta$	$\delta$
			max water level	from 2002 max water level		from 2002 max outflow	from 2002 max outflow		from 2002 peak discharge	from 2002 peak discharge
	Orlík a.s.l.	Orlík a.s.l.	Orlík (m)	Orlík (m)	Orlík (m <sup>3</sup> .s <sup>-1</sup> )	Orlík (m <sup>3</sup> .s <sup>-1</sup> )	Orlík (%)	Prague (m <sup>3</sup> .s <sup>-1</sup> )	Prague (m <sup>3</sup> .s <sup>-1</sup> )	Prague (%)
<b>1b</b>	345.6	354.42	0.82	-0.75	2935	-165	-5.3	4986	-174	-3.4
<b>2a</b>	347.6	355.19	1.59	0.02	3063	-37	-1.2	5156	-4	-0.1
<b>3h</b>	347.6	354.38	0.78	-0.79	2921	-179	-5.8	4982	-178	-3.4
<b>3i</b>	347.6	354.27	0.67	-0.9	2868	<b>-232</b>	<b>-7.5</b>	4888	<b>-272</b>	<b>-5.3</b>
<b>3l</b>	351.2	354.74	1.14	-0.43	3096	-4	-0.1	5386	226	4.4
<b>3m</b>	351.2	354.45	0.85	-0.73	2952	-148	-4.8	5228	68	1.3
<b>3n</b>	351.2	354.35	0.75	-0.82	2907	-193	-6.2	5117	-43	-0.8
<b>4</b>	348.5	355.08	1.48	-0.09	3012	-88	-2.8	5267	107	2.1
<b>5b</b>	348.5	354.27	0.67	-0.9	3221	<b>121</b>	<b>3.9</b>	5508	<b>348</b>	<b>6.7</b>

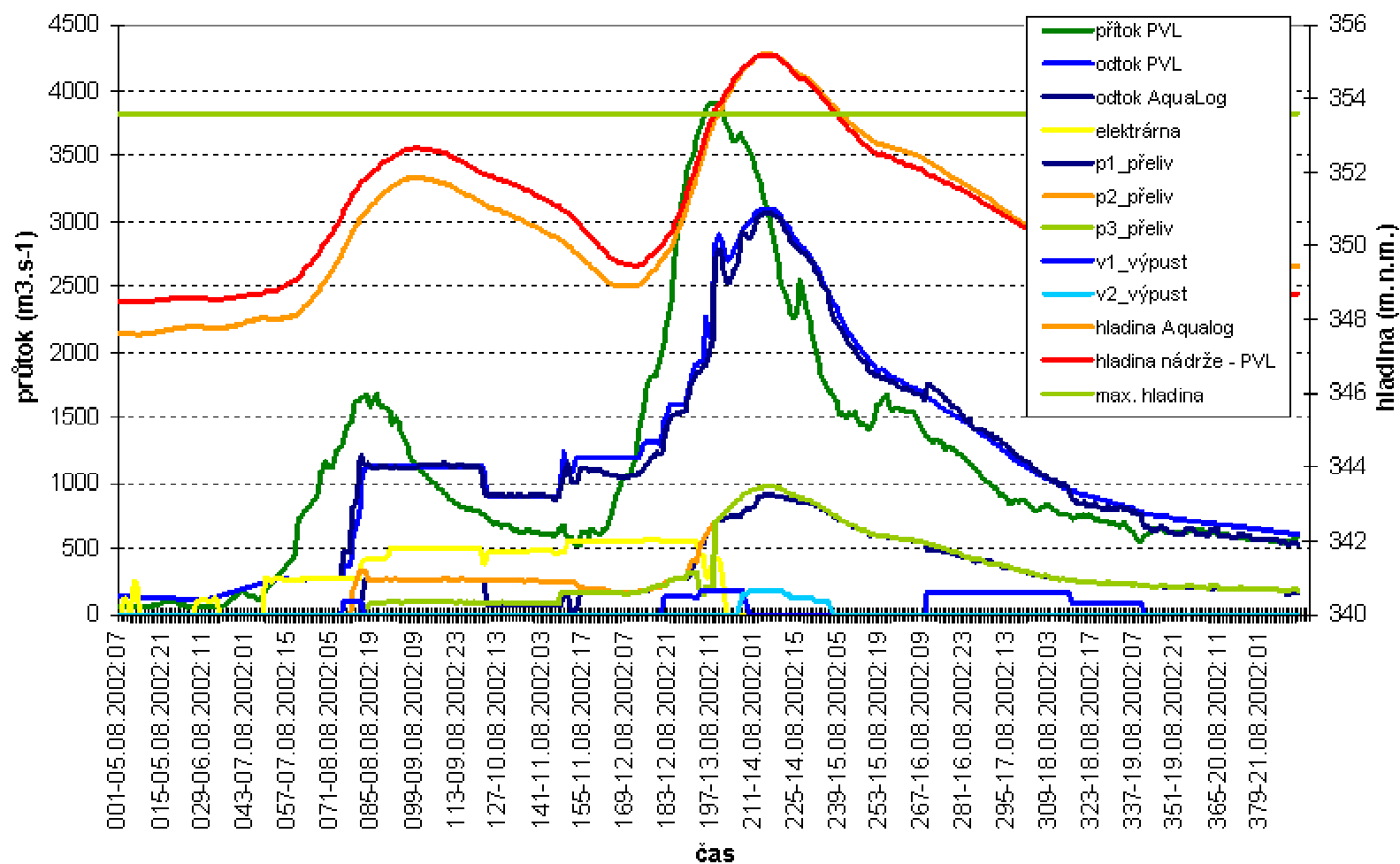
# Variant 1b - Result

Simulace VD Orlík na základě měrných křivek a nastavení během manipulace  
varianta 1b - počáteční hladina 345.6 mn.m.



# Variant 2a - Result

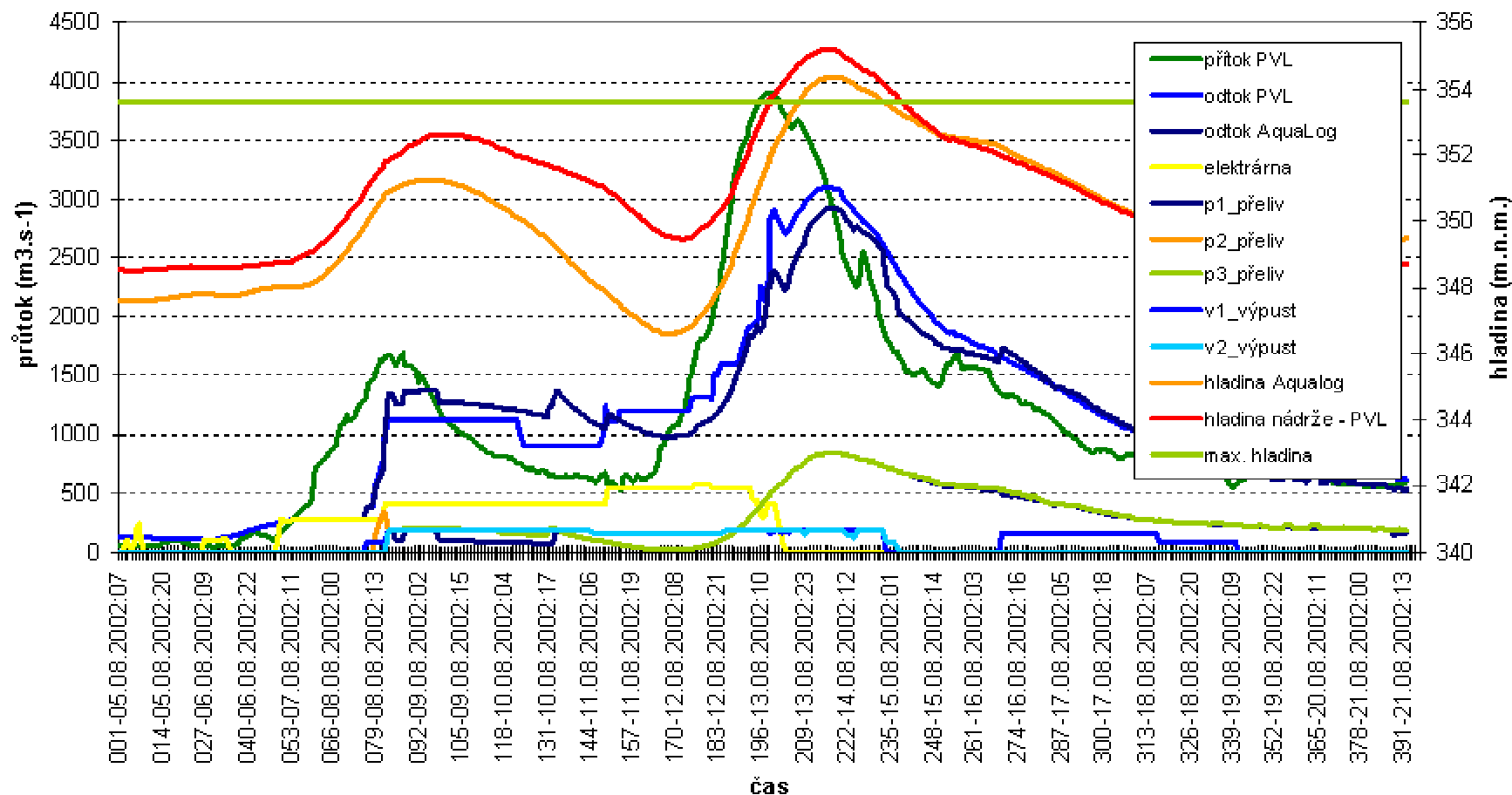
Simulace VD Orlik na základě měrných křivek a nastavení během manipulace  
varianta 2a - počáteční hladina 347.6 mn.m.





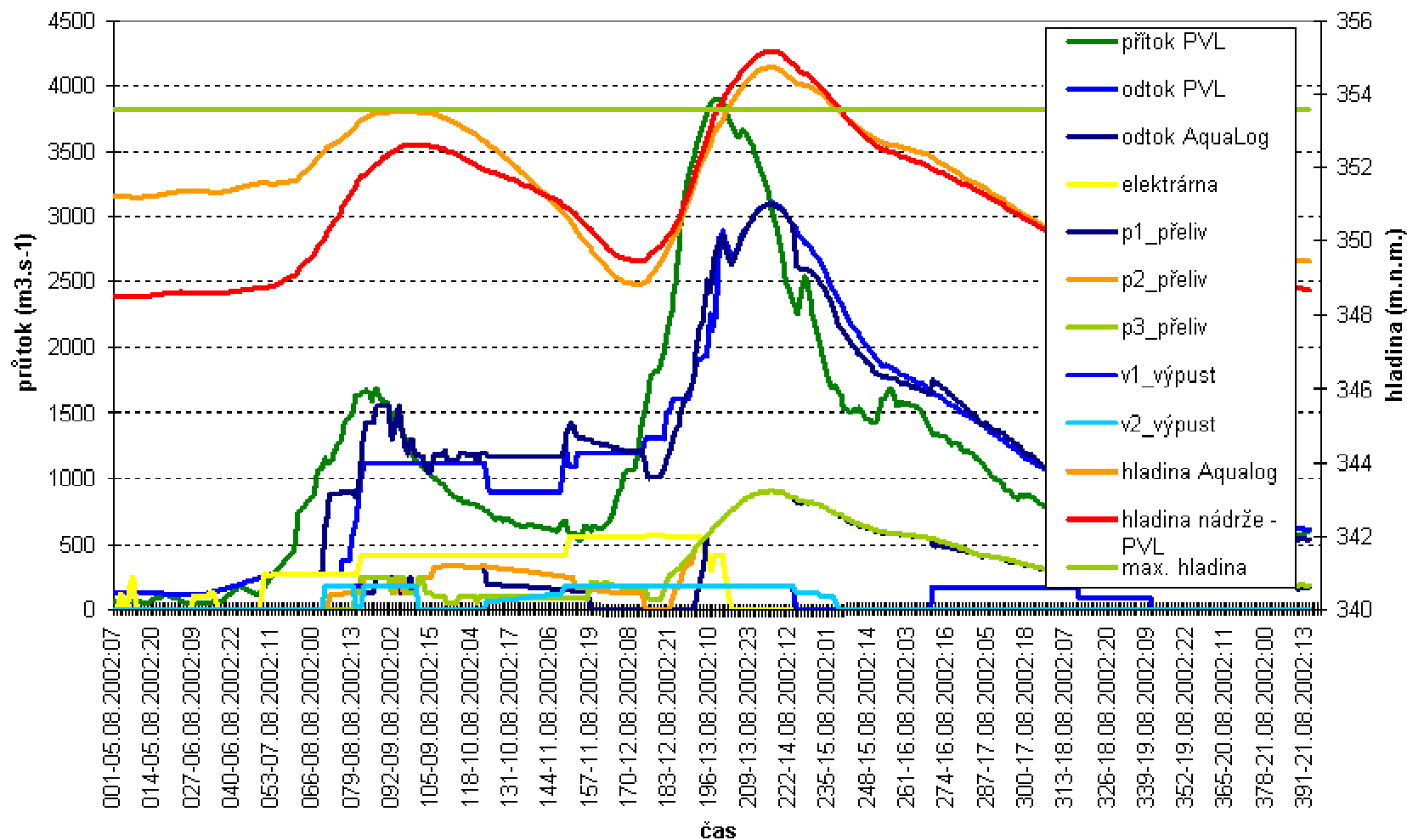
# Variant 3h - Result

Simulace VD Orlík na základě měrných křivek a nastavení  
varianta 3h - neškodný průtok v Praze 1700 m<sup>3</sup>.s-1



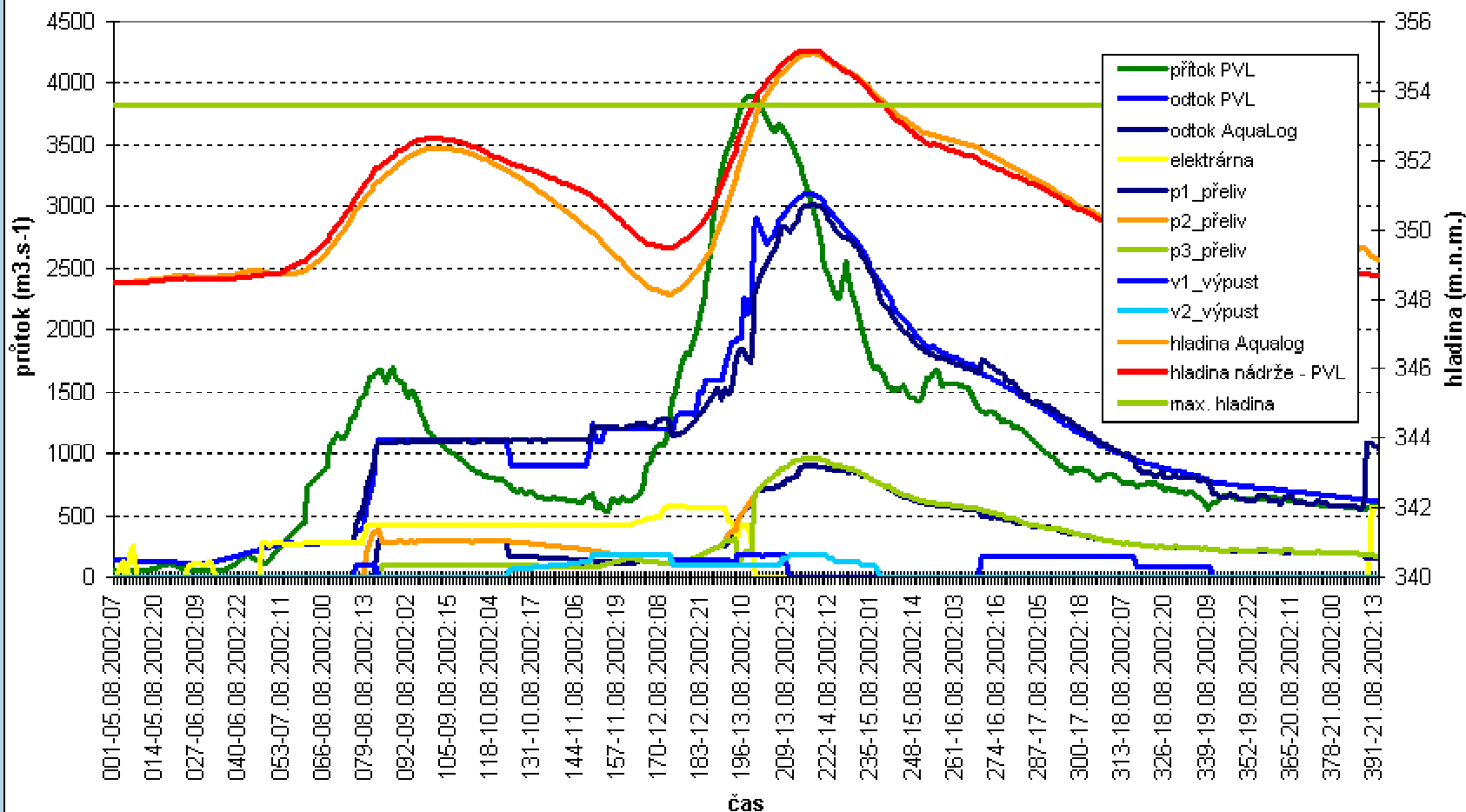
# Variant 3I - Result

Simulace VD Orlik na základě měrných křivek a nastavení  
varianta 3I - neškodný průtok v Praze 1500 m<sup>3</sup>.s<sup>-1</sup>



# Variant 4 - Result

Simulace VD Orlik na základě měrných křivek a nastavení  
varianta 4 - odtok bez poklesu mezi vlnami



# Zero variant – nonexistence of reservoirs

Hydraulic model **HEC-RAS** ver.3.1.1.

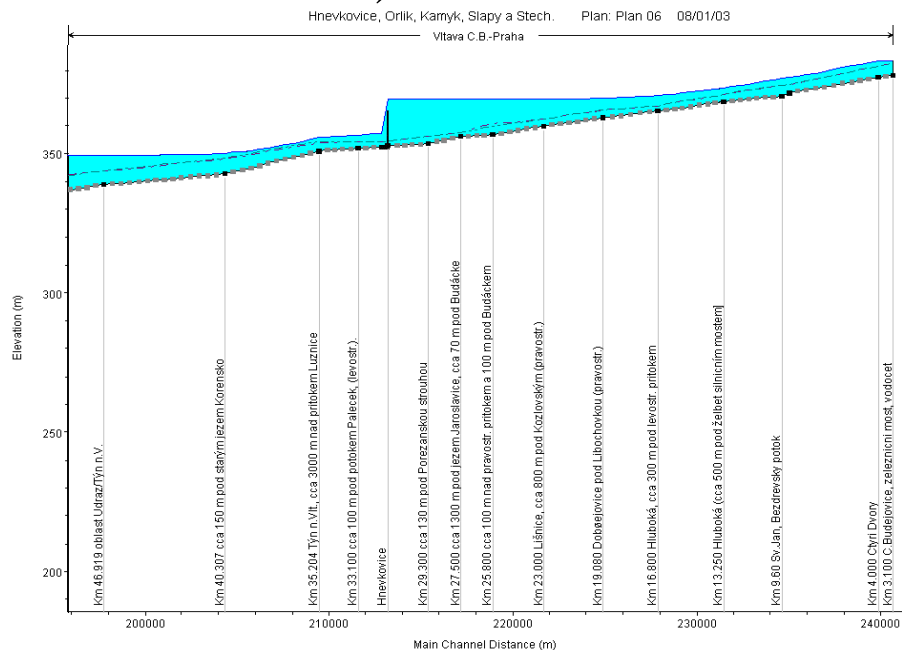
- steady & unsteady flow

Channel data – Study of Vltava river navigability

(from years 1902 - 1911)

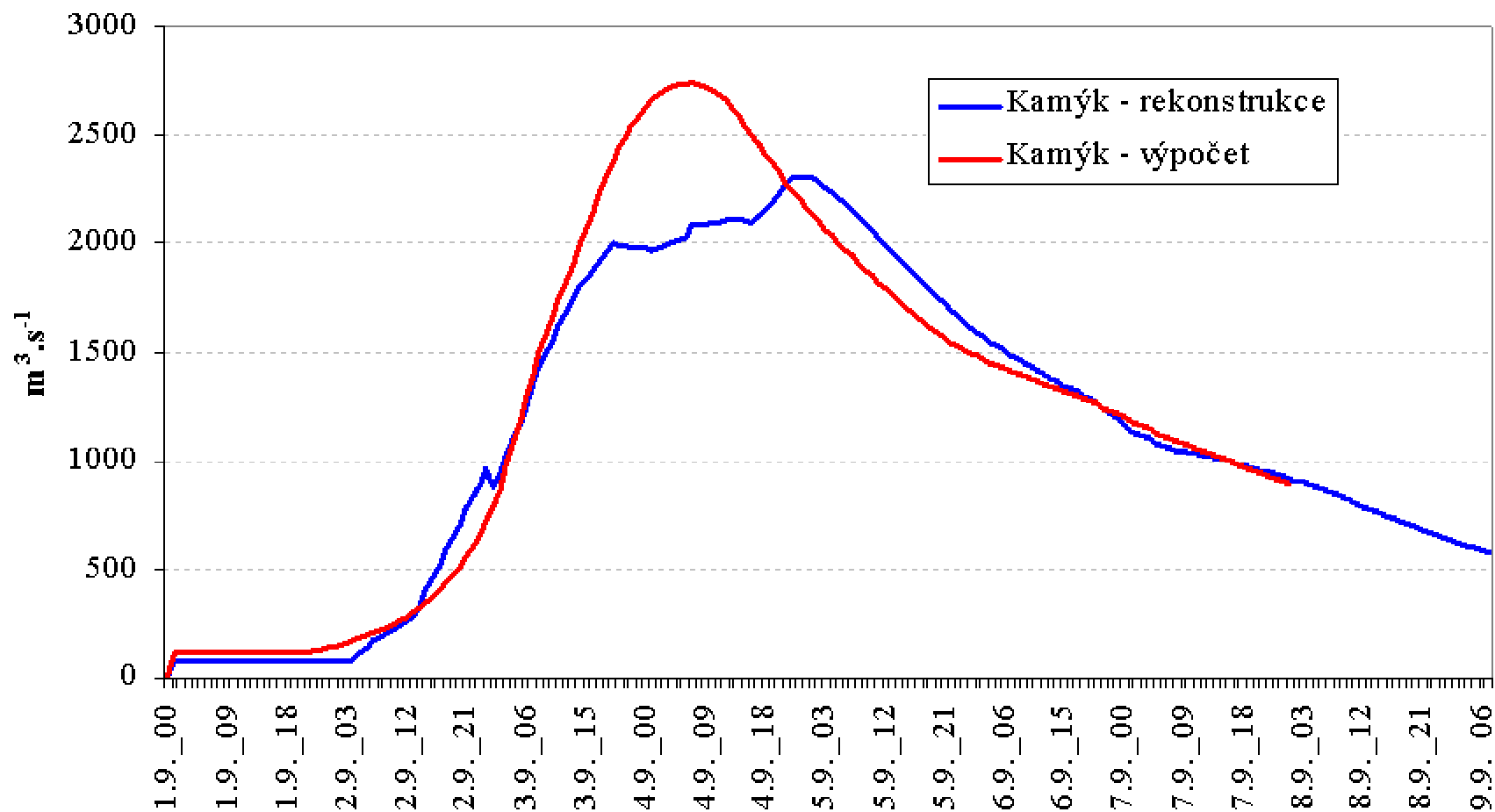
Floods - 1890 - calibration

- 2002



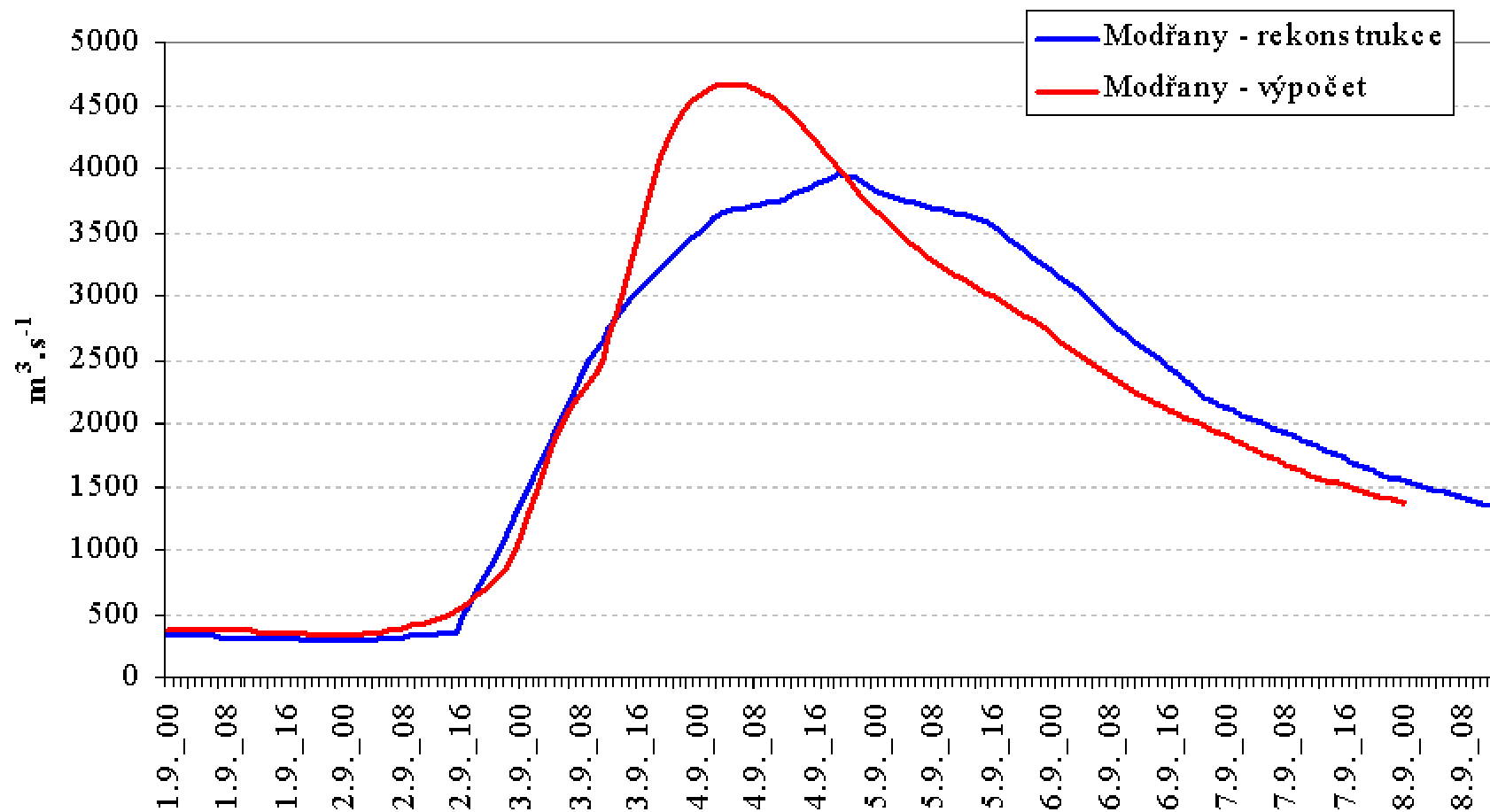
# Results – Kamýk profile for 1890 flood

září 1890 - neustálené proudění

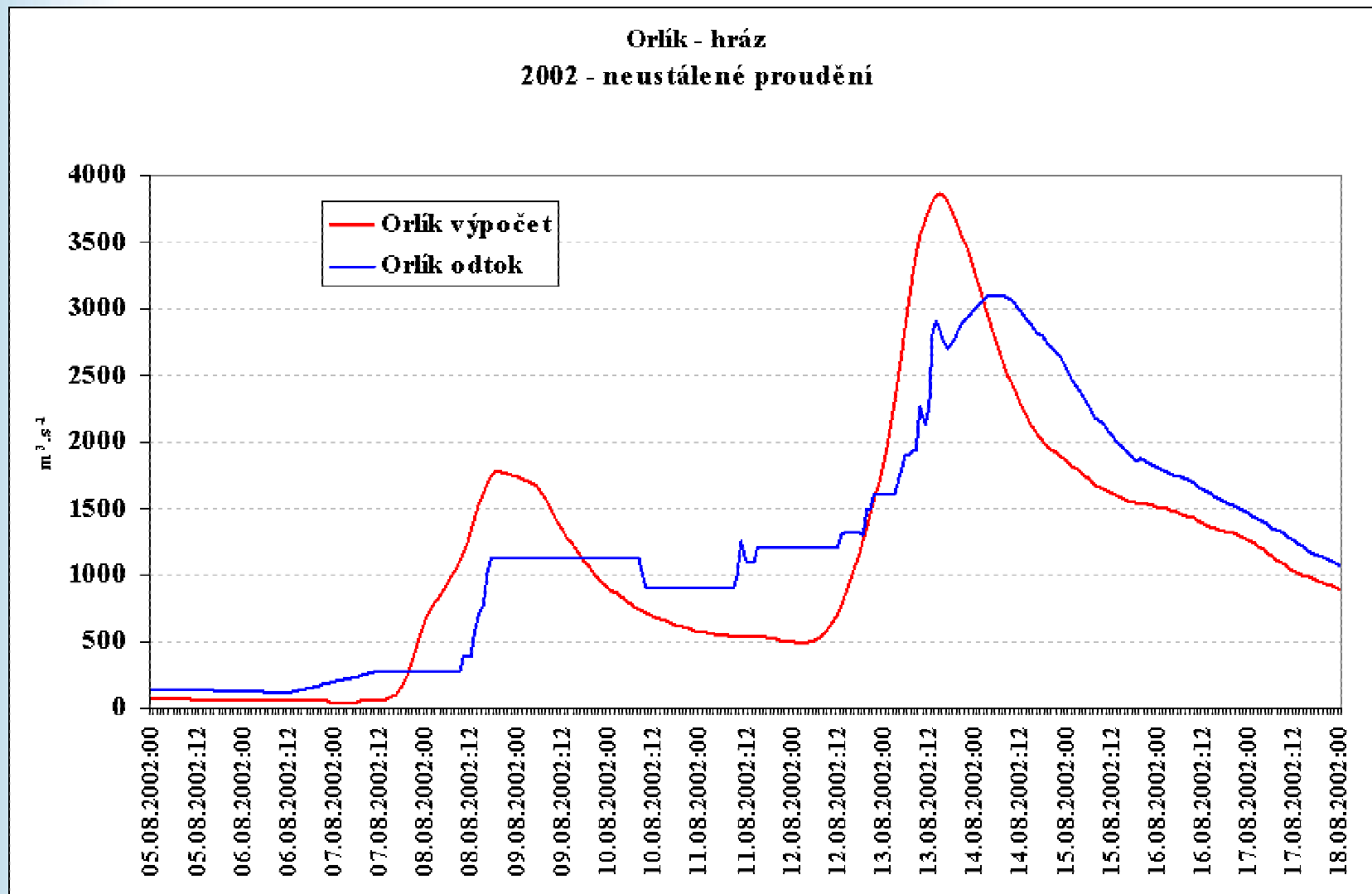


# Results – Prague profile for 1890 flood

září 1890 - neustálené proudění

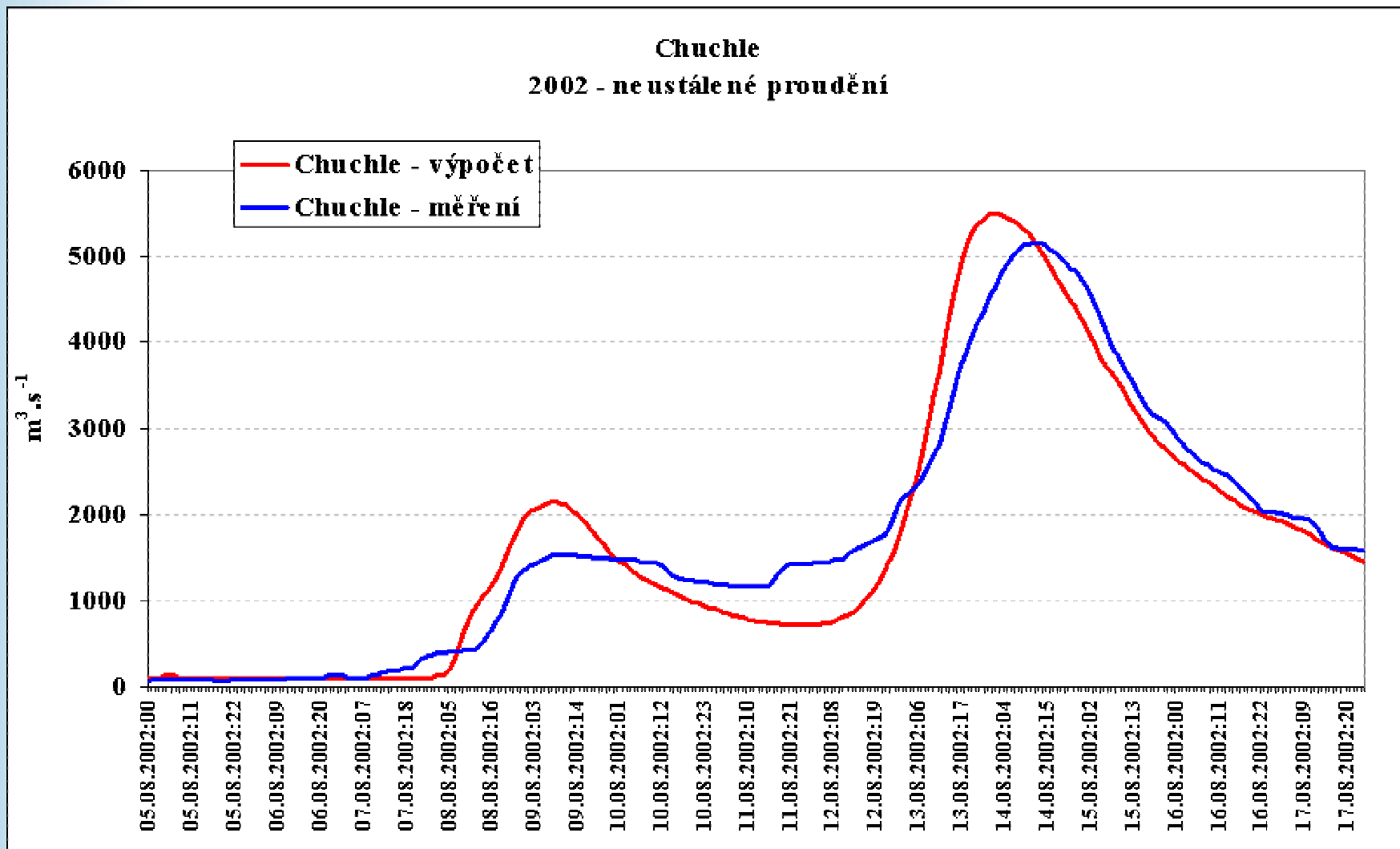


# Results – Orlík profile for 2002 flood





# Results – Prague profile for 2002 flood



## Zero variant results

- approximation only
- insufficient geometric data
- Berounka – Vltava confluence
- no reservoirs – results similar to 2002

## Conclusion

- complete evaluation of effect of Vltava reservoirs was made
- different initial conditions and operations – small effect only

# Thank You for Your Attention

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