E-Learning Tools

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SWARM
Training for WB teaching staff
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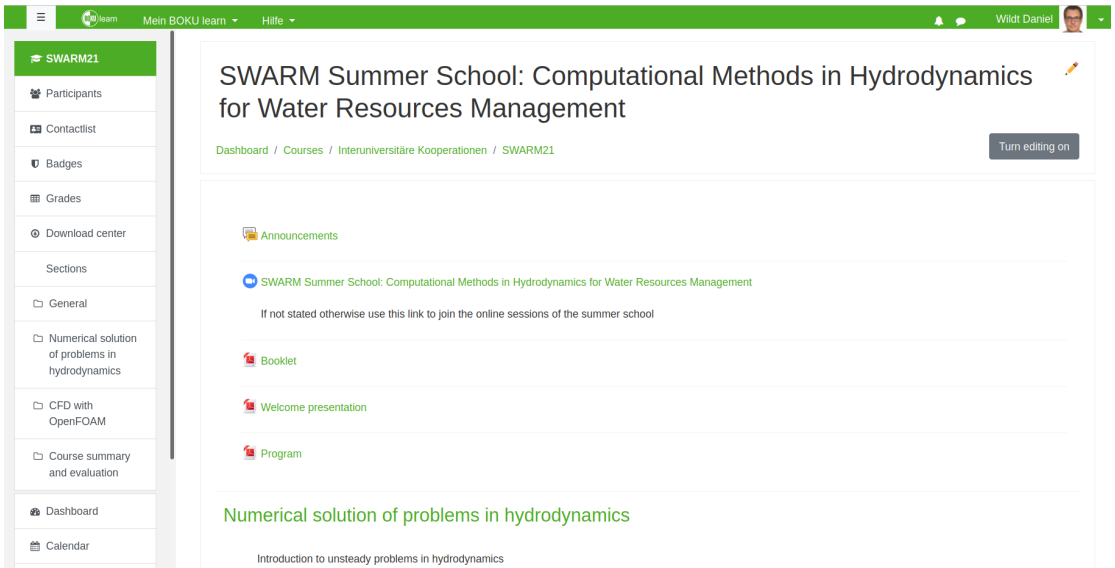
Outline I

Online courses
Digital teaching materials

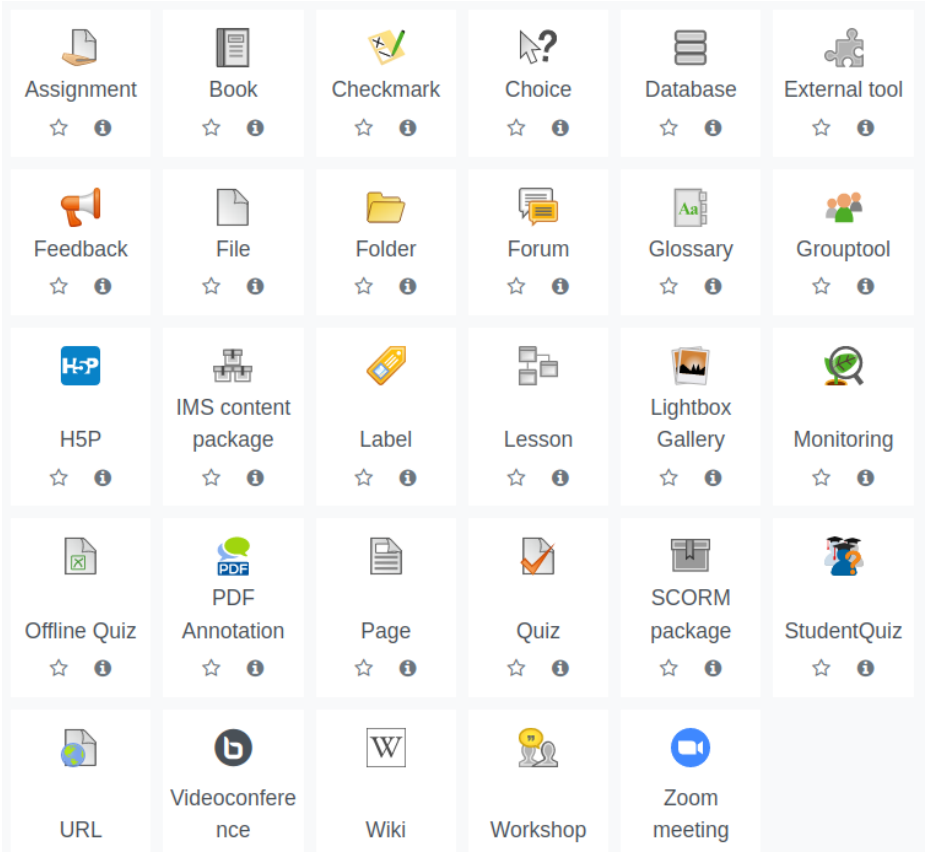


Visit example course at:
`https://learn.boku.ac.at/course/view.php?id=44340`

Online courses

Functionality of online courses:

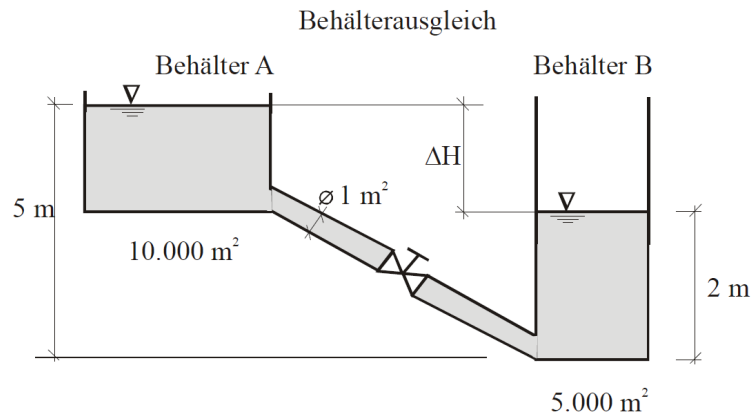
- provide course materials
- online exams, tests, etc.
- interact with students through forums
- foster interaction of students
- motivate mutual feedback



Digital teaching materials

Excel worksheets:

- basic mass and heat transport
- basic transient hydrodynamic processes
  - levelling of two tanks
  - retention
  - flood wave
- developed by MSc-students (Aubrunner, 2009; Maurer, 2010)
- available in the BOKUlearn course



	A	B	C	D	E
1	**Variable**	**Value**	**Unit**	Calculate	
2	Area A	10000	m²		
3	Area B	5000	m²		
4	Water surface elevation A	5	m		
5	Water surface elevation B	2	m		
6	Pipe diameter	1,1284	m		
7	Pipe length	1	m		
8	Roughness	1	mm		
9	Local losses ξ	2			
10	Precision of total time	10	s		
11	Initial interval	10	s		

Fig.: Maurer (2010)

Digital teaching materials

Input for mass transport modelling in an open channel

Number of discrete river sections	20			
Number of time steps	200			
Length of the river reach [km]	80			
Simulation time [h]	20			
Length of the discrete river sections [km]	4			
Time step duration [h]	0,1			
Flow velocity u_s in $A_{s\,[m/s]}$	2,4	Storing cross sectional area A_b [m²]	120	
Manning-Strickler roughness coefficient k_{st} [m/s$^{1/3}$]	35	Mass of added substance M [kg]	2	
Water depth h [m]	5	Exchange coefficient κ [-]	1	
Flow rate Q [m³]	1800	Dispersion coefficient α	1	
Effective cross sectional area A_s [m²]	750	Skewness G_t [-]	1	
Effective river width B_s [m]	75			

Imput by user

Calculated by the program

Calculate

Settings for output

		Anzahl
Length of discrete river sections [km]	4	20
Time steps [h]	0,5	40

	von	bis
Length of river reach [km]	0	80
Simulation time [km]	0	20

Visualize results

Information on the output:

The output provides an overview over the concentration distribution along the river reach at user defined time steps and points. Time steps and points along the river are independent of the calculation. Intermediate values are interpolated. Additionally a 3d-diagram is created.

Fig.: Replica of the Rhine-warning model (Maurer (2010))

Digital teaching materials

Input for the calculation of a transition curve in a rectangular channel

Step size in km	0.001	
River width b in m	30	
Water level at reference point in m	2.5	
Discharge in m^3	525	
Manning-Strickler coefficient k_{St} in $m^{1/3}/s$	34	
Bed slope	0.01	
Elevation difference h_n-h_j at the end of transition cureve in cm (convergence criteria)	0.1	

	Input by user
	Calculated by the program

Norm flow depth in m	###
Critical depth in m	3.1487
###	
###	

Calculate

Fig.: Excel worksheet for the calculation of water surface elevation of non-uniform flow

Digital teaching materials

	A	B	C	D	E	F
1	**variable**		**unit**			
2	Riverwidth B1	60	m			
3	Riverwidth B2	72	m			
4	Riverwidth B3	120	m			
5	Chezy Coeffizient C	50	$m^{1/2}/s$			
6						
7						
8						
9						
10						
11	ALPHA	150	m^2/s			
12						
13	Initial Depth HA	5	m			
14	Initial Depth HB	5	m			
15						
16						
17						
18						
19	Steps of computation N1	20				
20	Steps of computation N2	20				
21	Steps of computation N3	20				
22						
23						
24	Discharge Q3	750	m^3/s			
25	Riverlength RL1	15000	m			
26	Riverlength RL2	25000	m			
27	Riverlength RL3	10000	m			
28	Slope S1	5,00E-04				
29	Slope S2	3,00E-04				
30	Slope S3	5,00E-04				
31	IMAX (Turns of Iterations)	100				
32						

Calculate

Fig.: Excel worksheet for the calculation of a backwater curve in a braided river

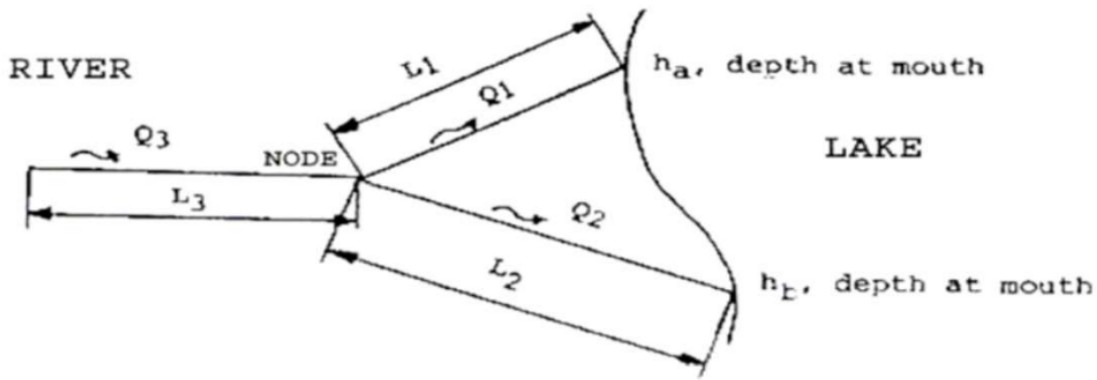
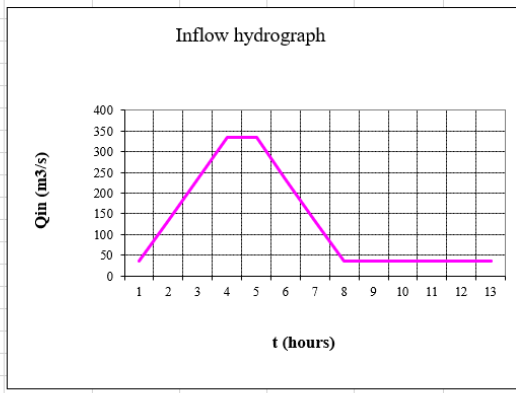


Fig.: Scheme of the situation

Digital teaching materials

	t	Qzu	h_A^n	h_B^n	Qout	Q_{AB}	h_A^{n+1}	h_B^{n+1}
	[h]	[m³/s]	[m]	[m]	[m³/s]	[m³/s]	[m]	[m]
3	0	35	2,00	4,50	35,36	0,00	2,00	4,50
4	1	135	2,00	4,50	35,32	0,00	2,36	4,50
5	2	235	2,36	4,50	45,25	0,00	3,04	4,50
6	3	335	3,04	4,50	66,28	0,00	4,01	4,50
7	4	335	4,01	4,50	100,00	0,00	4,85	4,50
8	5	235	4,85	4,50	100,00	21,72	5,26	4,66
9	6	135	5,26	4,66	100,00	28,40	5,29	4,86
10	7	35	5,29	4,86	100,00	23,79	4,97	5,03
11	8	35	4,97	5,03	100,00	-9,39	4,77	4,96
12	9	35	4,77	4,96	100,00	-16,27	4,59	4,85
13	10	35	4,59	4,85	100,00	-18,50	4,42	4,71
14	11	35	4,42	4,71	100,00	-19,70	4,26	4,57
15	12	35	4,26	4,57	100,00	-20,40	4,10	4,50
16	13	35	4,10	4,50	100,00	0,00	3,87	4,50
17	14	35	3,87	4,50	94,99	0,00	3,65	4,50
18	15	35	3,65	4,50	87,14	0,00	3,46	4,50
19	16	35	3,46	4,50	80,51	0,00	3,30	4,50
20	17	35	3,30	4,50	74,86	0,00	3,15	4,50
21	18	35	3,15	4,50	70,03	0,00	3,03	4,50
22	19	35	3,03	4,50	65,87	0,00	2,92	4,50
23	20	35	2,92	4,50	62,28	0,00	2,82	4,50
24	21	35	2,82	4,50	59,16	0,00	2,73	4,50
25	22	35	2,73	4,50	56,44	0,00	2,65	4,50
26	23	35	2,65	4,50	54,07	0,00	2,59	4,50
27	24	35	2,59	4,50	51,98	0,00	2,52	4,50
28	25	35	2,52	4,50	50,15	0,00	2,47	4,50
29	26	35	2,47	4,50	48,54	0,00	2,42	4,50
30	27	35	2,42	4,50	47,11	0,00	2,38	4,50
31	28	35	2,38	4,50	45,84	0,00	2,34	4,50
32	29	35	2,34	4,50	44,72	0,00	2,30	4,50
33	30	35	2,30	4,50	43,72	0,00	2,27	4,50
34	31	35	2,27	4,50	42,83	0,00	2,24	4,50
35	32	35	2,24	4,50	42,03	0,00	2,22	4,50
36	33	35	2,22	4,50	41,32	0,00	2,20	4,50
37	34	35	2,20	4,50	40,69	0,00	2,18	4,50



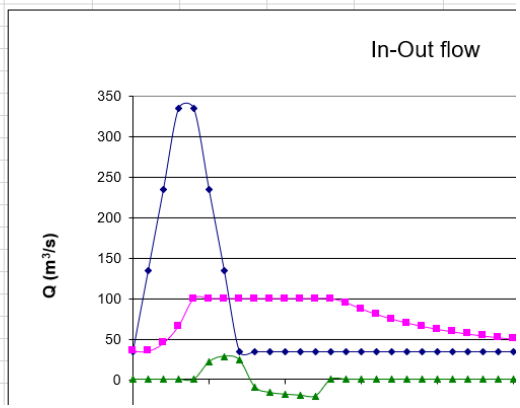
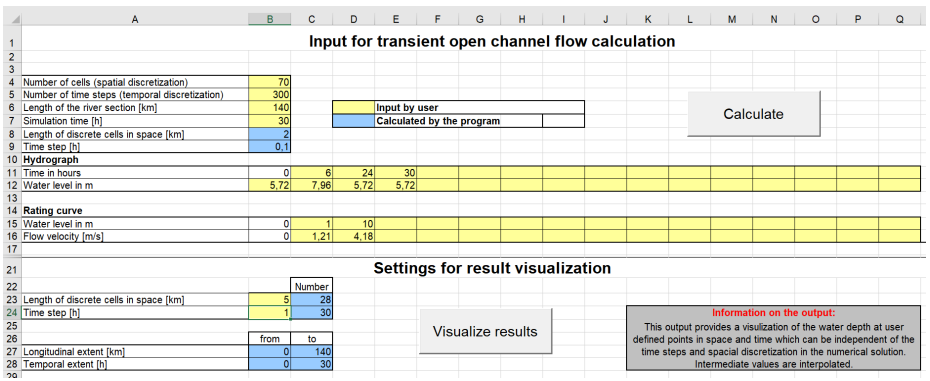


Fig.: Excel-worksheet for retention calculations

Digital teaching materials



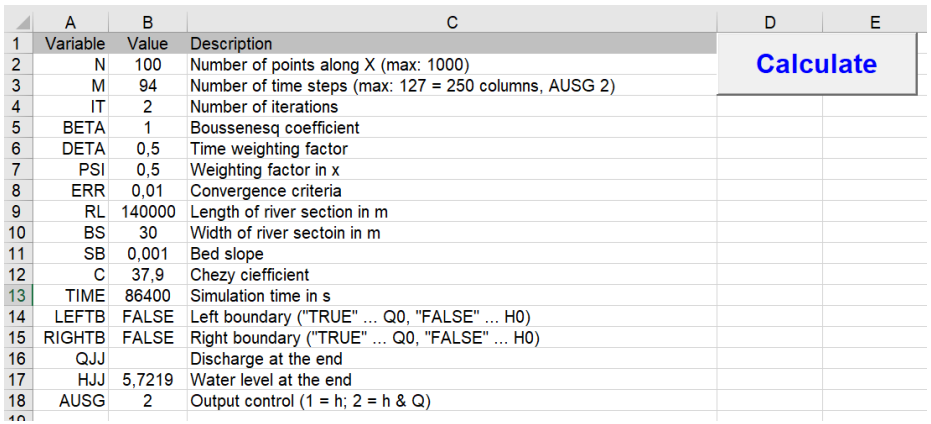
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Input for transient open channel flow calculation																
2																	
3																	
4	Number of cells (spatial discretization)	70															
5	Number of time steps (temporal discretization)	300															
6	Length of the river section [km]	140			Input by user												
7	Simulation time [h]	30			Calculated by the program												
8	Length of discrete cells in space [km]	2															
9	Time step [h]	0,1															
10	**Hydrograph**																
11	Time in hours	0	6	24	30												
12	Water level in m	5,72	7,96	5,72	5,72												
13																	
14	**Rating curve**																
15	Water level in m	0	1	10													
16	Flow velocity [m/s]	0	1,21	4,18													
17																	
21	Settings for result visualization																
22			Number														
23	Length of discrete cells in space [km]	5	28														
24	Time step [h]	1	30														
25																	
26		from	to														
27	Longitudinal extent [km]	0	140														
28	Temporal extent [h]	0	30														

Calculate

Visualize results

Information on the output:
This output provides a visulization of the water depth at user defined points in space and time which can be independent of the time steps and spacial discretization in the numerical solution. Intermediate values are interpolated.

Fig.: Excel worksheet for the calculation of a flood wave using an explicit scheme



	A	B	C	D	E
1	Variable	Value	Description		
2	N	100	Number of points along X (max: 1000)	Calculate	
3	M	94	Number of time steps (max: 127 = 250 columns, AUSG 2)		
4	IT	2	Number of iterations		
5	BETA	1	Boussenesq coefficient		
6	DETA	0,5	Time weighting factor		
7	PSI	0,5	Weighting factor in x		
8	ERR	0,01	Convergence criteria		
9	RL	140000	Length of river section in m		
10	BS	30	Width of river sectoin in m		
11	SB	0,001	Bed slope		
12	C	37,9	Chezy ciefficient		
13	TIME	86400	Simulation time in s		
14	LEFTB	FALSE	Left boundary ("TRUE" ... Q0, "FALSE" ... H0)		
15	RIGHTB	FALSE	Right boundary ("TRUE" ... Q0, "FALSE" ... H0)		
16	QJJ		Discharge at the end		
17	HJJ	5,7219	Water level at the end		
18	AUSG	2	Output control (1 = h; 2 = h & Q)		

Fig.: Excel worksheet for the calculation of a flood wave using an implicit scheme

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References I

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