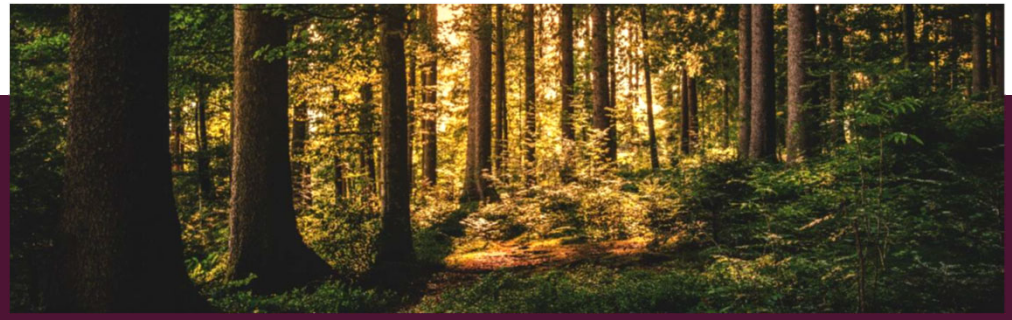
INVESTIGATION OF FRICTION COEFFICIENTS FOR THE 2D MODELING OF FOREST AREAS ALONG RIVERS

OST
Ostschweizer
Fachhochschule

BACHELOR THESIS IN CIVIL ENGINEERING

HYDRAULIC ENGINEERING



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BASEMENT User Meeting 2024

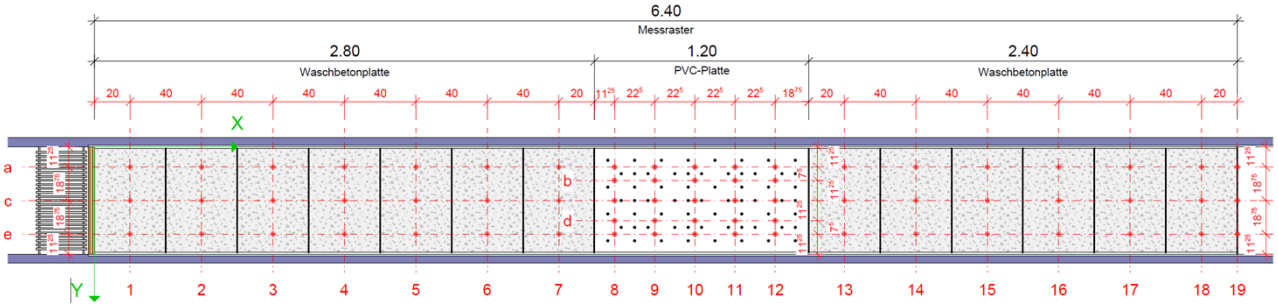
25.01.2024

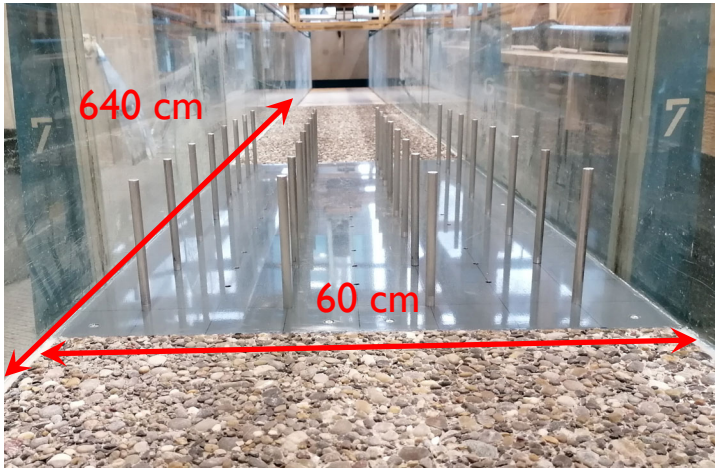
CONTENT

- Task and Objective of the Bachelor Thesis
- Procedure, results and Interpretation
- Summary
- Recommendation and Outlook

TASK AND OBJECTIVE OF THE BACHELOR THESIS

- Investigate the flow ressitance of forested areas in rivers
- Hybrid approach is required
  - Test channel at Ostschweizer Fachhochschule OST
  - 2D Modelling with BASEMENTv3
- Statement about the roughness of floodplains with forested areas



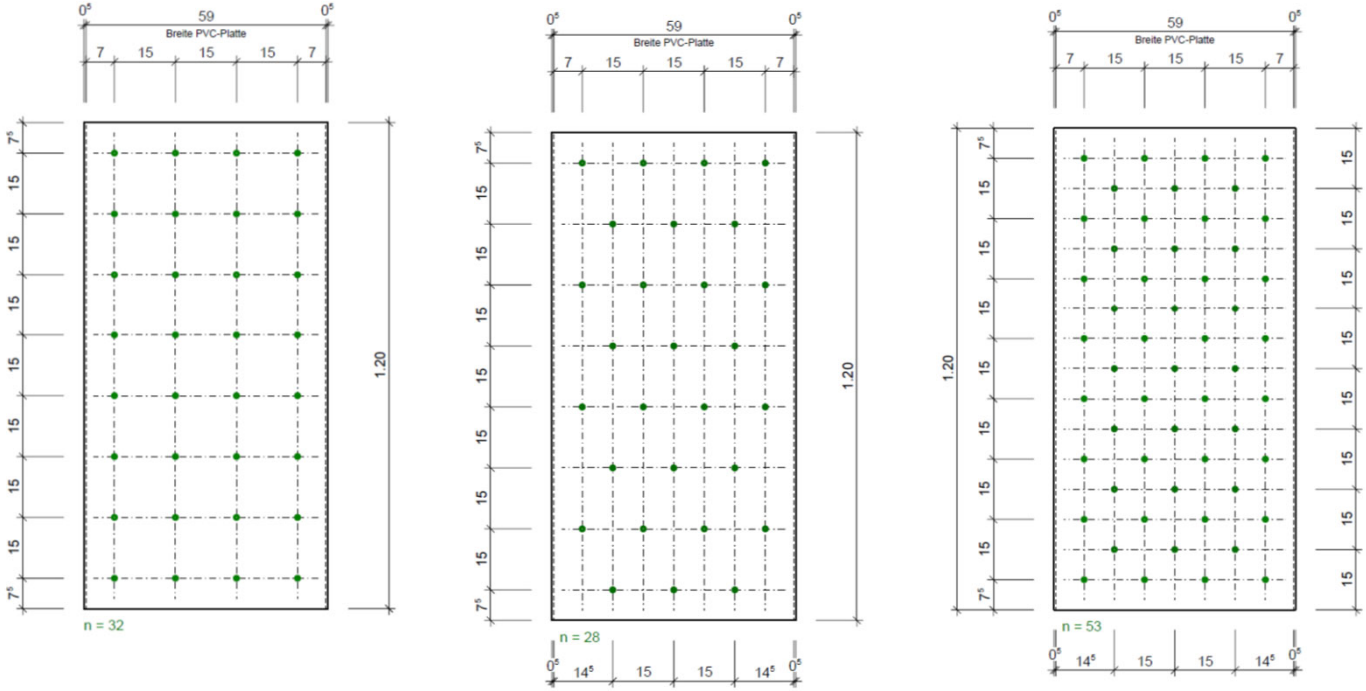


PROCEDURE

Experimental Setup

Test Arrangements

- Linear
- Offset
- Compacted

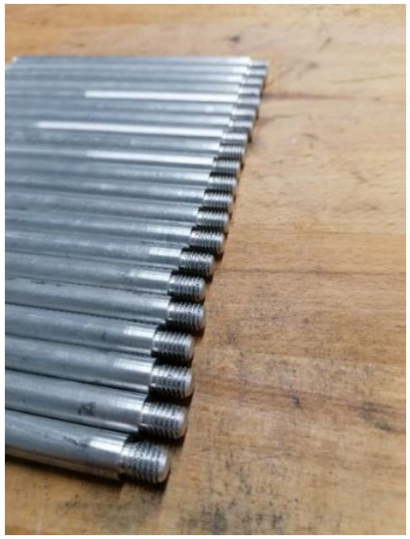


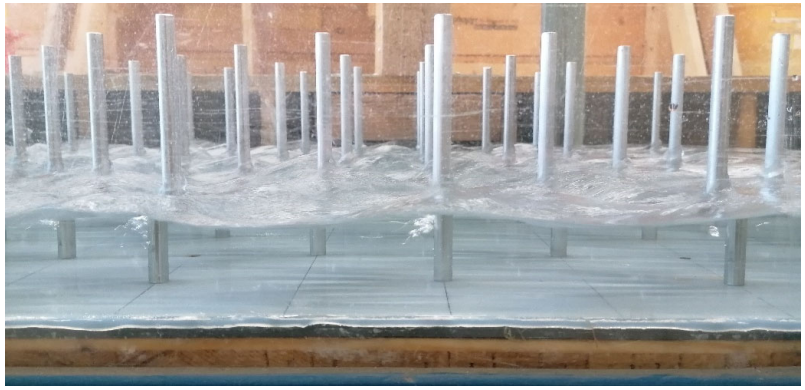
PROCEDURE

Aluminium Rods as Trees

Length 15 cm

Ø 1 cm

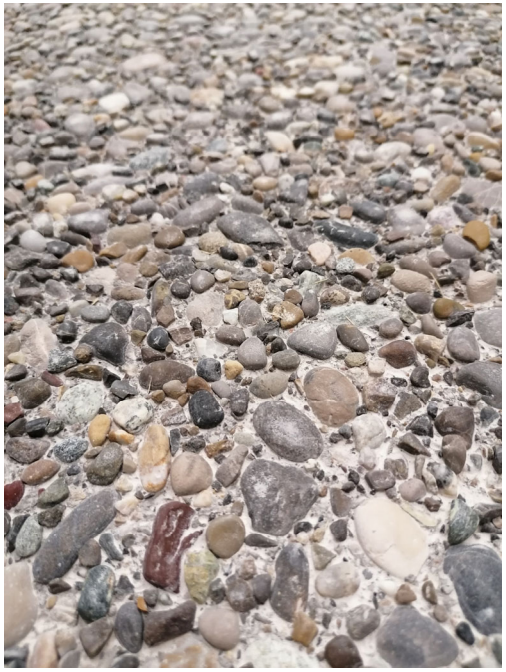




PROCEDURE

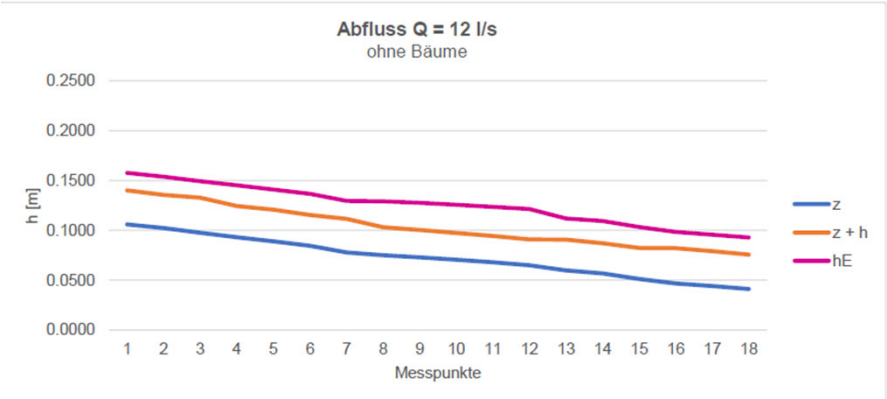
Exposed aggregate concrete slabs as Streambed

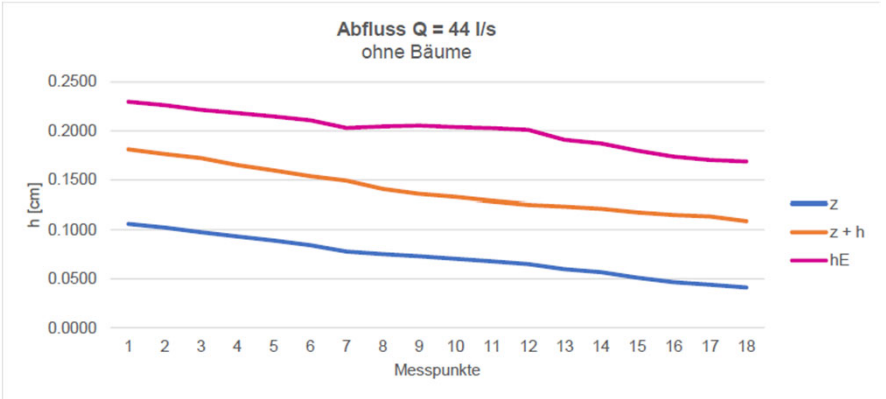
Length	40 cm
Width	60cm
Thickness	3.6 cm



PROCEDURE

Discharges without trees





Results Strickler-Values

Discharge [m^3/s]	$k_{average}$ (WBP1) [$m^{1/3}/s$]	$k_{average}$ (PVC) [$m^{1/3}/s$]	$k_{average}$ (WBP2) [$m^{1/3}/s$]
0.012	60.11	110.48	67.56
0.023	64.65	138.25	72.09
0.035	65.30	167.78	72.48
0.044	65.89	109.66	75.32

PROCEDURE

Conduct of Experiments

- Summary of the experiments

Discharge [m^3/s]	Slope Test Channel J_s [%]		Experimental Arrangement
0.012	Election	Nivellement	without Trees
0.023	1.000	1.125	linear
0.035	2.000	1.946	offset
0.044	3.000	3.025	compacted

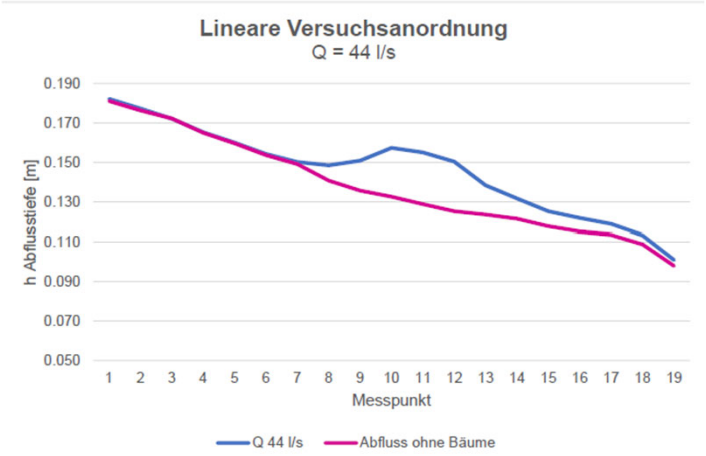
SOME IMPRESSIONS FROM THE HYDRAULIC ENGINEERING LABORATORY



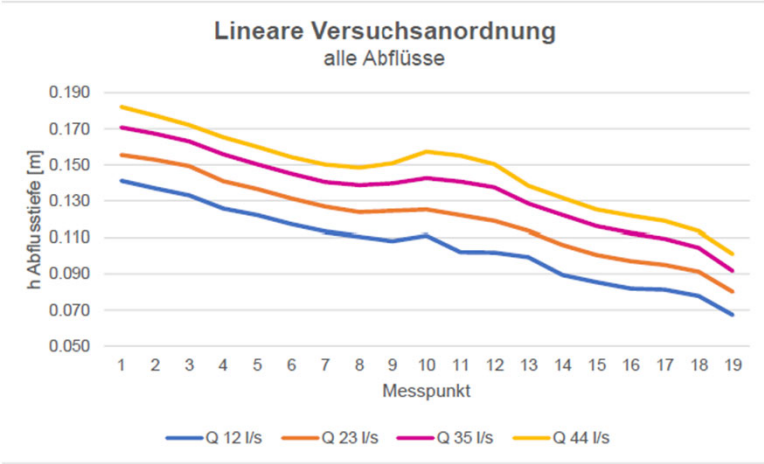

PROCEDURE

Experiments

- Linear test arrangement



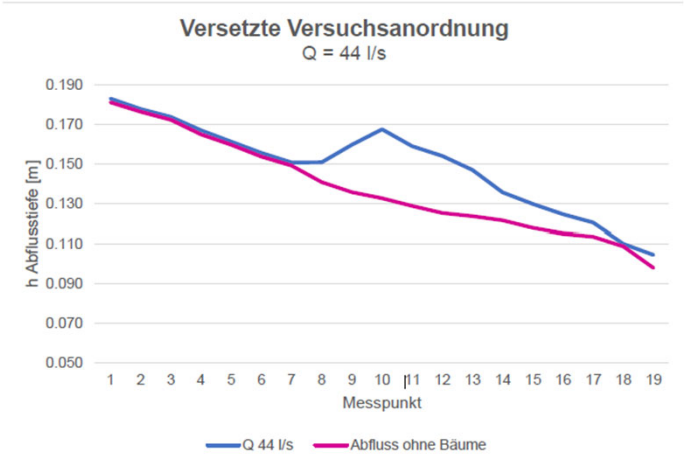
Summary of all discharges on the linear test arrangement



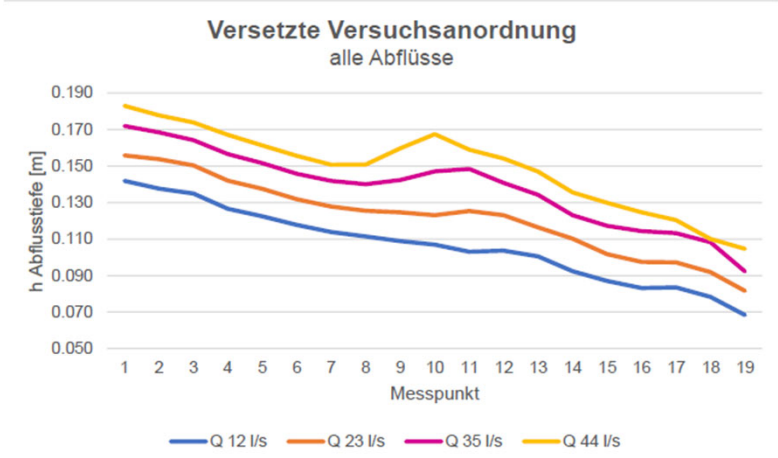
PROCEDURE

Experiments

- Offset test arrangement



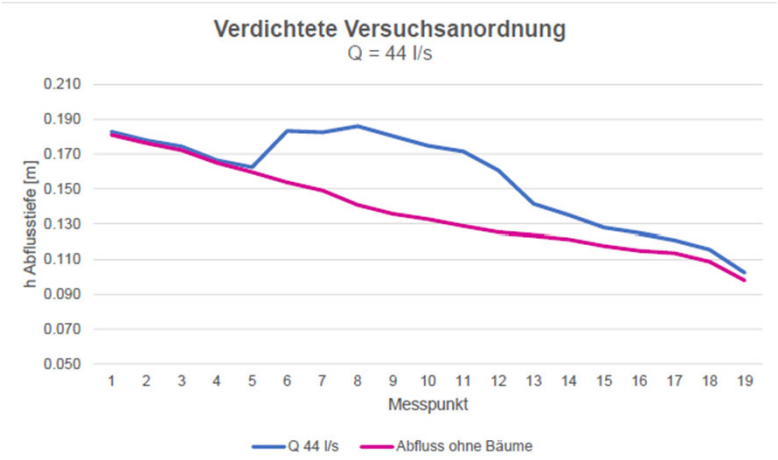
Summary of all discharges on the offset test arrangement



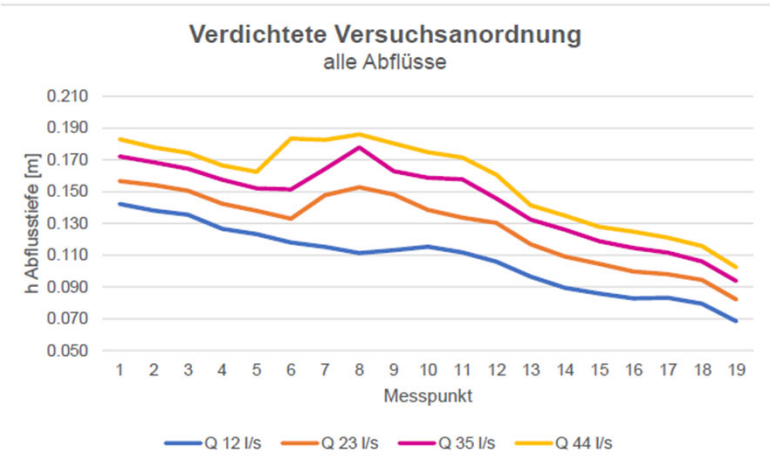
PROCEDURE

Experiments

- Compacted test arrangement



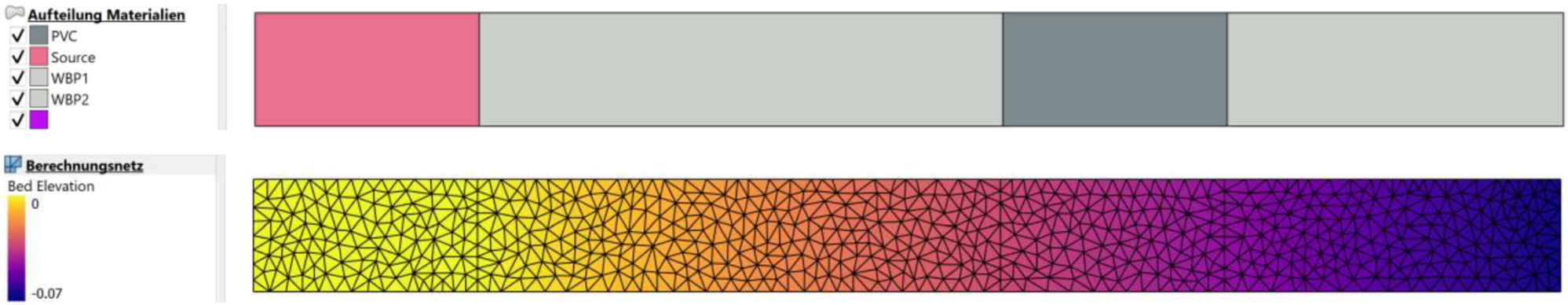
Summary of all discharges on the compacted test arrangement



PROCEDURE

2D-Modelling

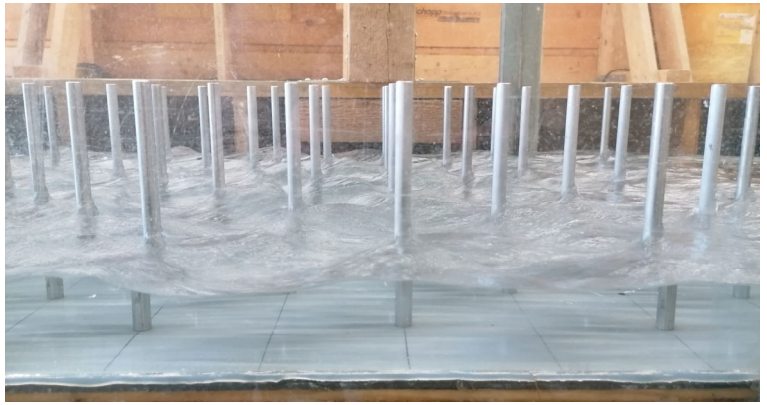
- Elements = 1300, A_{El} = 30 cm^2 , $Edge_{length}$ = 8 cm



PROCEDURE

Determination of the roughness coefficients of forest areas

- Modelling without trees – results from the measurement with experimental arrangements
- Adjust the roughness coefficient of the region PVC
- specify a roughness coefficient for an entire forested area

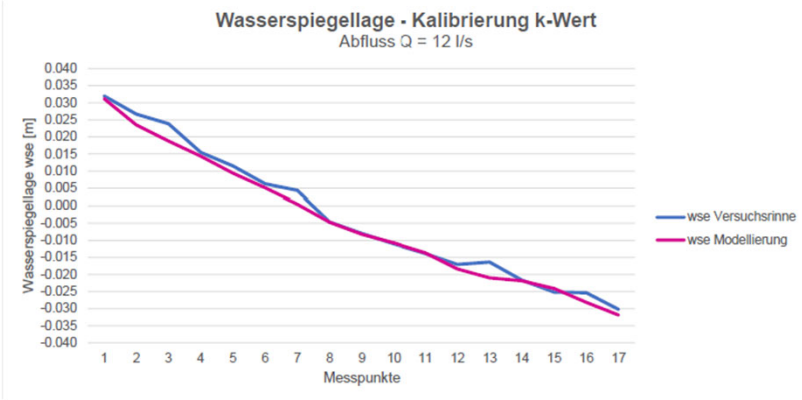


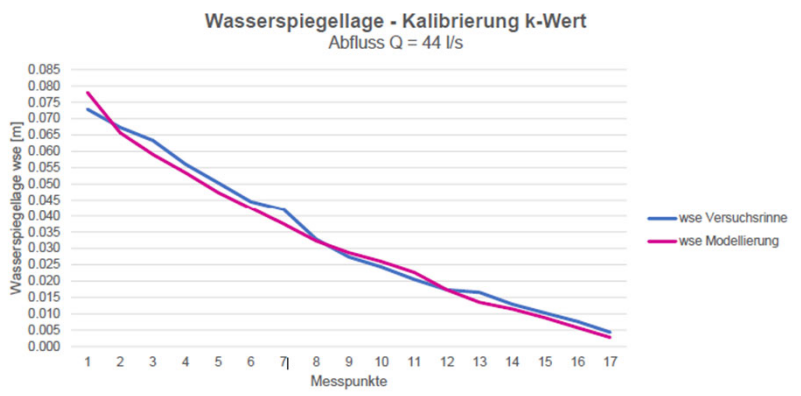
PROCEDURE

2D-Modelling

- Calibration of the calculated roughness coefficients without trees leads to following values:

k_{st} = 66 $m^{1/3}/s$	k_{st} = 110 $m^{1/3}/s$	k_{st} = 56 $m^{1/3}/s$

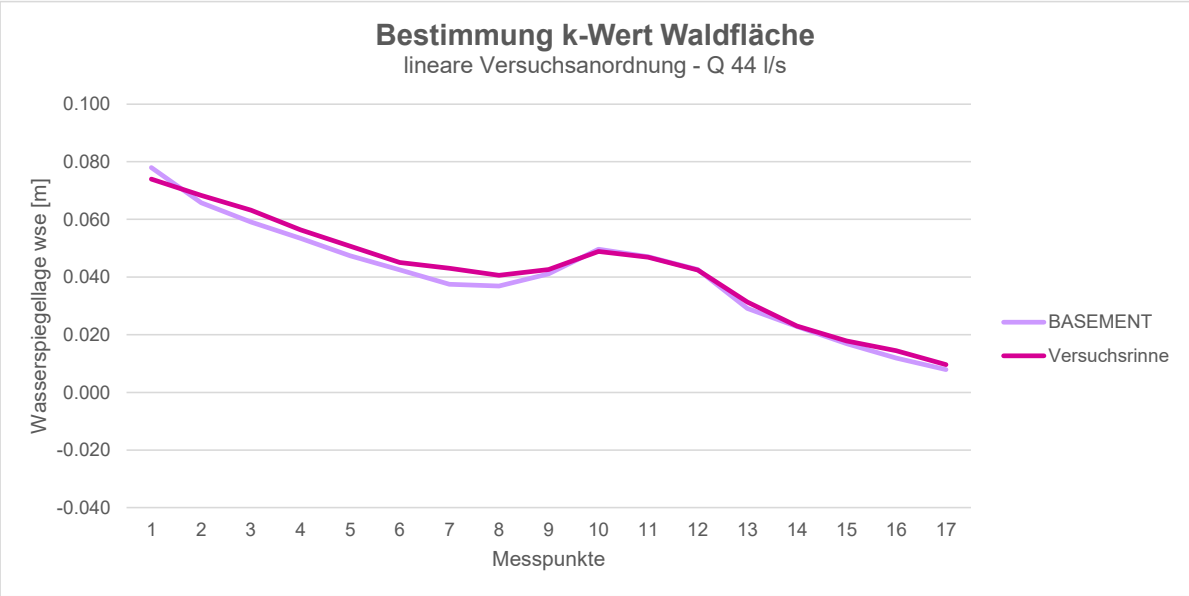




PROCEDURE

Determination of the roughness coefficients of forest areas

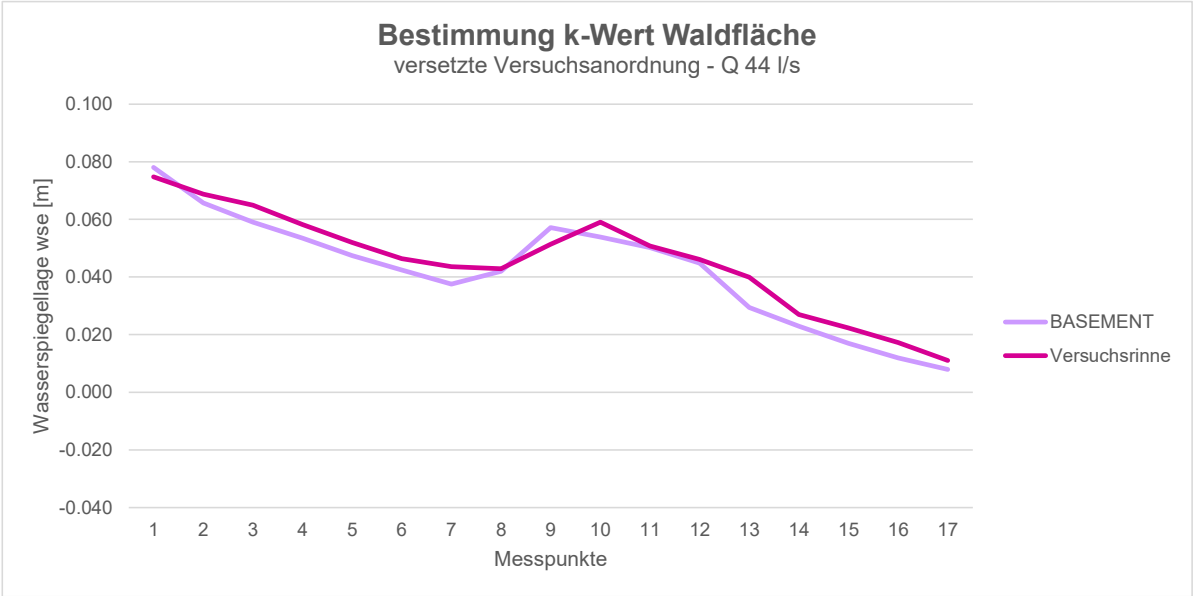
- Linear Test Arrangement
  - k-value 39 $m^{1/3}/s$



PROCEDURE

Determination of the roughness coefficients of forest areas

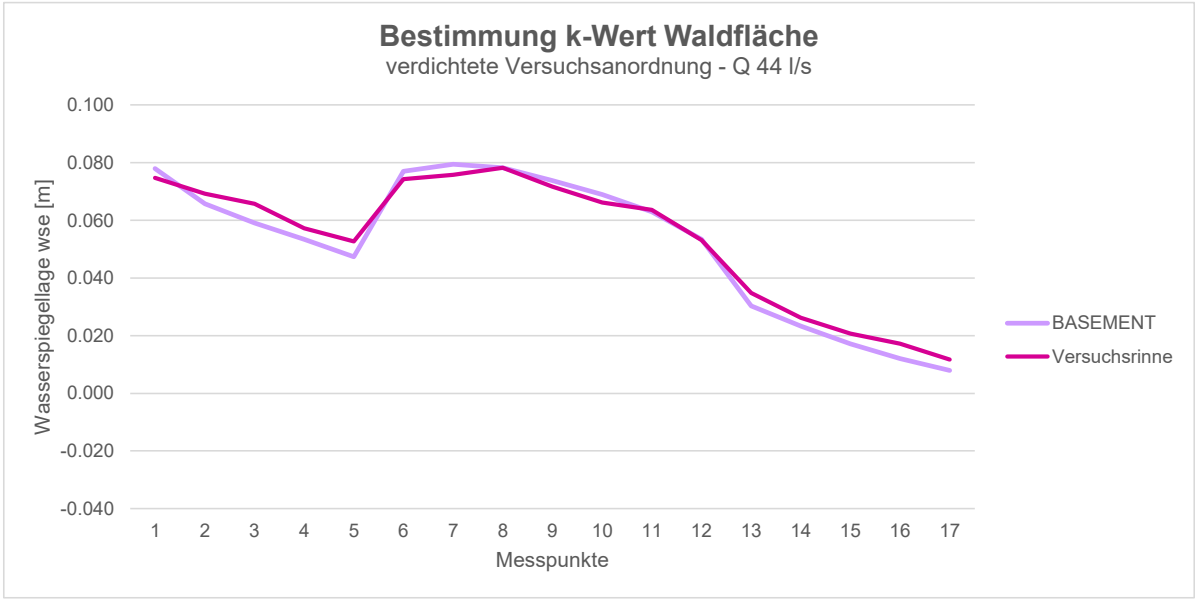
- Offset Test Arrangement
  - k-value 35 $m^{1/3}/s$



PROCEDURE

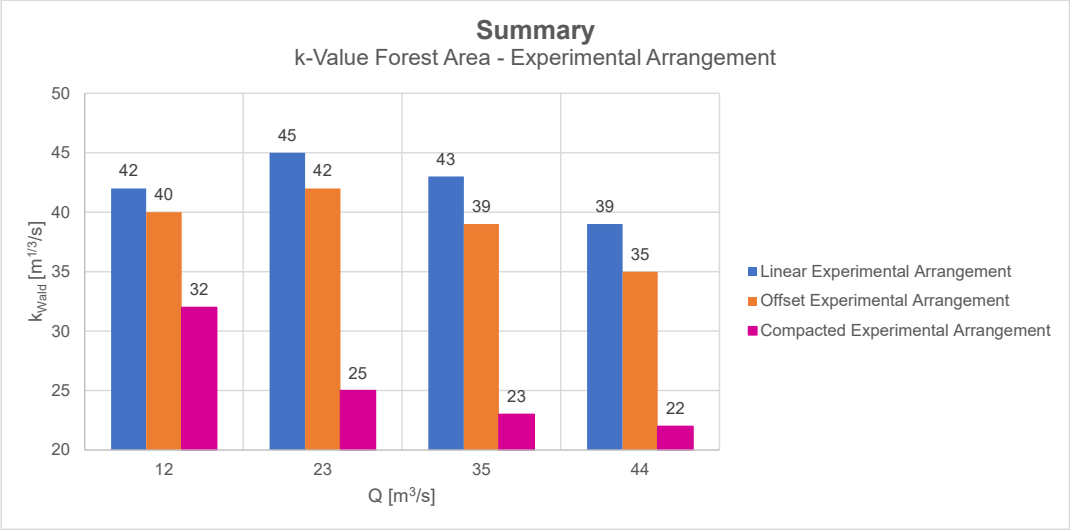
Determination of the roughness coefficients of forest areas

- Compacted Test Arrangement
  - k-value 22 $m^{1/3}/s$



RESULTS

Summary of the determined values

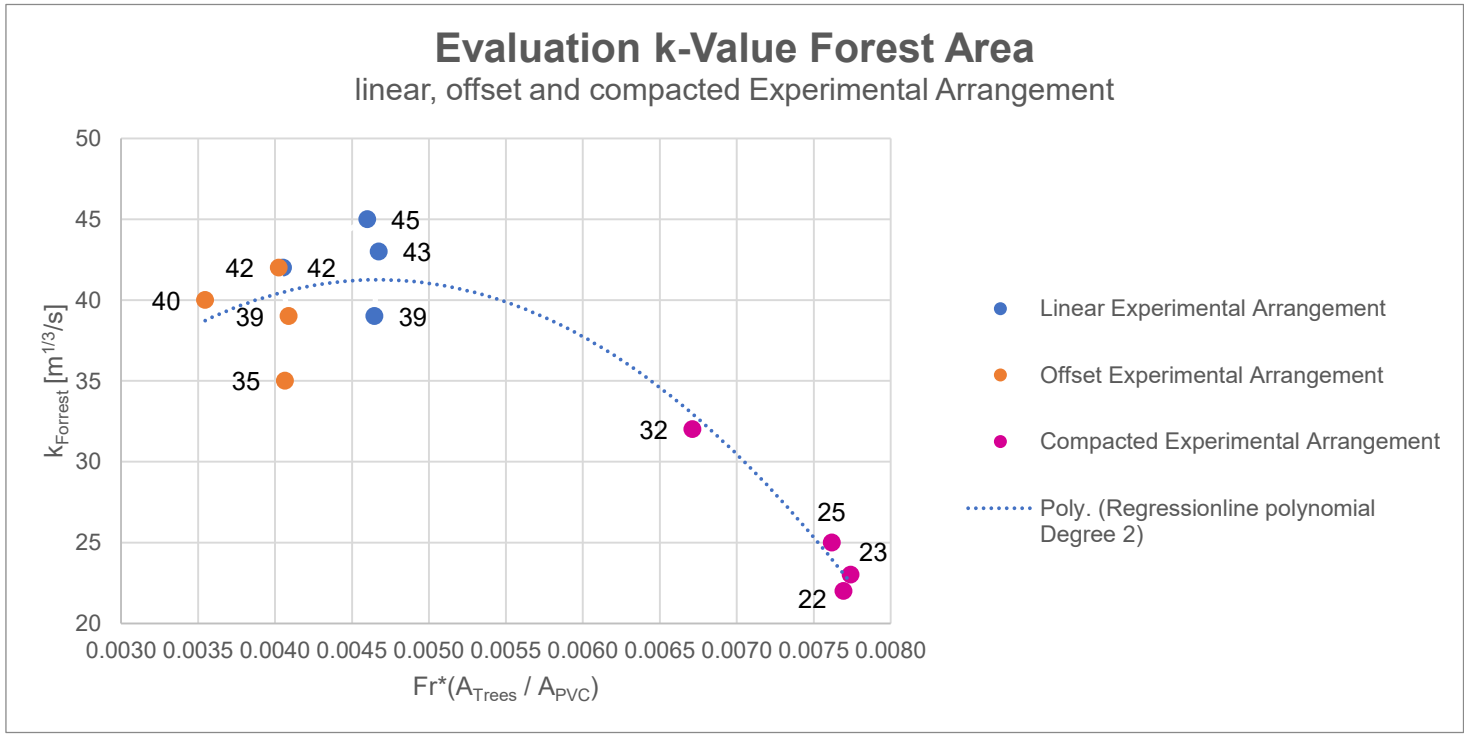


Linear Experimental Arrangement			
Discharge [l/s]	k-Wert [$m^{1/3}/s$]		
	WBP1	Forested Area	WBP2
12	66	42	56
23	66	45	56
35	66	43	56
44	66	39	56

Offset Experimental Arrangement			
Discharge [l/s]	k-Wert [$m^{1/3}/s$]		
	WBP1	Forested Area	WBP2
12	66	40	56
23	66	42	56
35	66	39	56
44	66	35	56

Compacted Experimental Arrangement			
Discharge [l/s]	k-Wert [$m^{1/3}/s$]		
	WBP1	Forested Area	WBP2
12	66	32	56
23	66	25	56
35	66	23	56
44	66	22	56

INTERPRETATION



CONCLUSION

- The preliminary results shows that the roughness depends mainly on the density of the trees
- The arrangement of trees has also an influence on the roughness
- The approach flow condition (Fr) plays minor role
- More experiments with lower slopes hast to be investigated
- Scale effect should be also considered

END OF THE PRESENTATION

THANK YOU FOR LISTENING!