

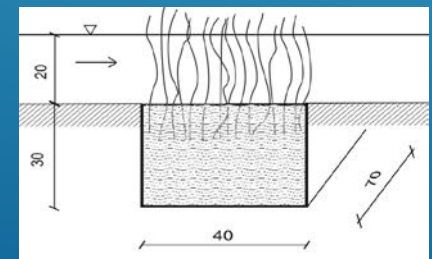
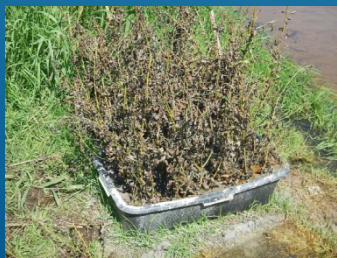
IMPACT OF RIVER RESTORATION ON HYDROMORPHOLOGICAL PROCESSES: THE FLINTA RIVER CASE STUDY

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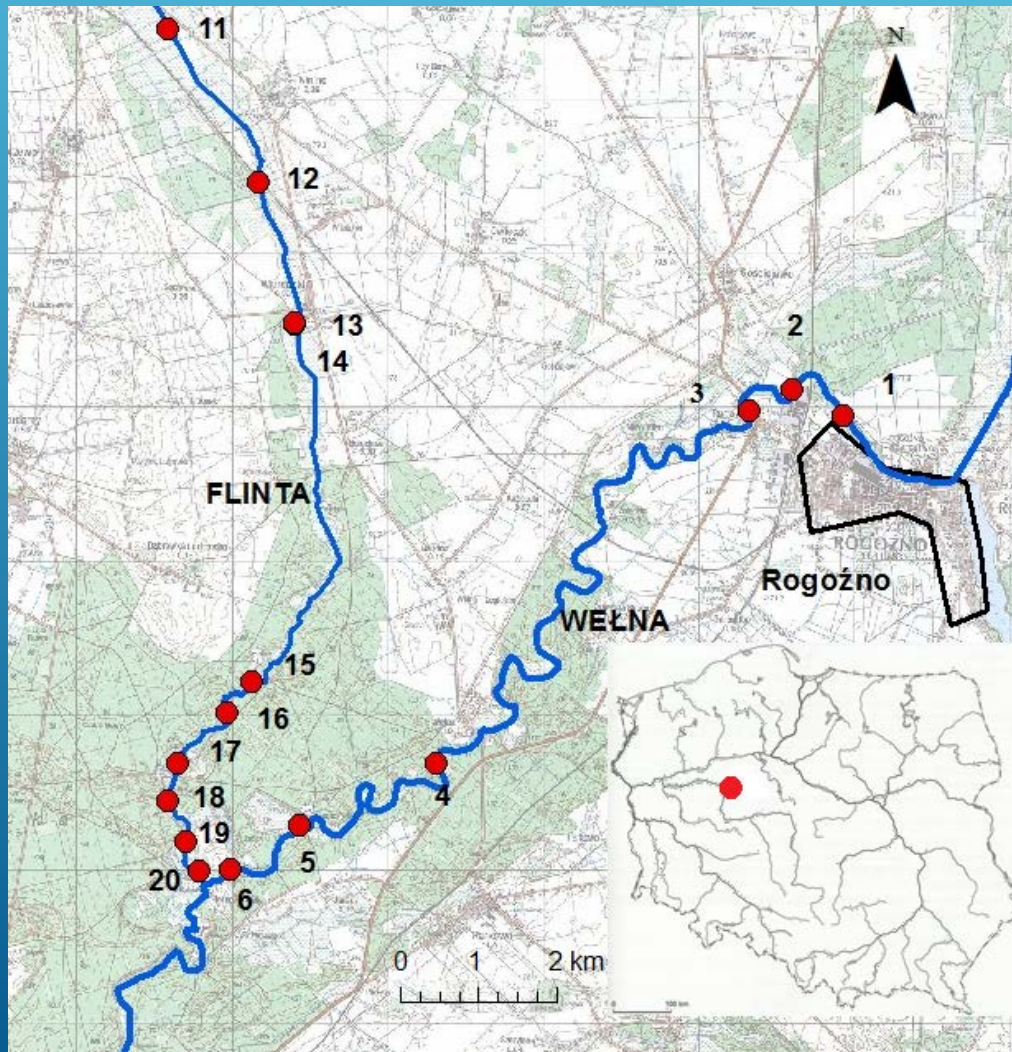
PRESENTATION

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 4. The river Flinta Restoration Programme
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WHERE WE ARE?



THE FLINTA CATCHMENT AREA WITH THE LOCATION OF THE MEASUREMENT POINTS



ENVIRONMENTAL CONDITIONS



- Special Protection Area "Nature 2000" (Puszcza Notecka – PLB300015)
- Special Area of Conservation (SAC), the Dolina Wełny (PLH300043)
- Protected Landscape Area (PLA) Puszcza Notecka,
- nature reserve Źródlika Flinty

METHODS OF HYDROMORPHOLOGICAL SURVEY OF THE RIVER FLINTA

The hydromorphological evaluation was conducted at the selected sites (Fig. 1) according to the River Habitat Survey (RHS) method. Two numerical metrics based on the RHS protocol were produced:

- the Habitat Modification Score (HMS), based on the extent and type of artificial features and modifications,
- the Habitat Quality Assessment (HQA), based on the extent and variety of natural features recorded.

SITES ON THE RIVER FLINTA SURVEYED HYDROMORPHOLOGICALLY

| No | Site name | Section characteristics |
|-----|---------------------|---|
| 11. | Ryczywół | Resectioned and deepened channel, resectioned and partly reinforced banks |
| 12. | Ninino | Resectioned and deepened channel, resectioned banks |
| 13. | Wiardunki 1 | Resectioned and deepened channel, resectioned and partly reinforced banks |
| 14. | Wiardunki 2 | Resectioned and deepened channel, resectioned banks |
| 15. | Smolarz 1 | Natural section |
| 16. | Smolarz 2 | Natural section |
| 17. | Piłka above weirs | Weirs, impoundments, partly reinforced banks |
| 18. | Piłka below weirs | Semi-natural section |
| 19. | Rożnowo above mouth | Receptioned banks |
| 20. | Rożnowo mouth | Receptioned banks |

HYDROMORPHOLOGICAL STATUS OF A RIVER

The combination of the two numerical RHS metrics (HMS and HQA) enables one to estimate the hydromorphological status of a river site in a five class system, where classes I, II, III, IV and V correspond to a very good, good, moderate, poor and bad hydromorphological status, respectively.

THE HYDROMORPHOLOGICAL CLASSIFICATION OF SITES SURVEYED ON THE RIVER FLINTA

| No | Site name | HQA | HMS | Hydromorphological status |
|-----|---------------------|-----|-----|---------------------------|
| 11. | Ryczywół | 28 | 43 | V |
| 12. | Ninino | 39 | 13 | III |
| 13. | Wiardunki 1 | 38 | 2 | II |
| 14. | Wiardunki 2 | 33 | 9 | III |
| 15. | Smolarz 1 | 71 | 0 | I |
| 16. | Smolarz 2 | 73 | 0 | I |
| 17. | Piłka above weirs | 53 | 9 | III |
| 18. | Piłka below weirs | 60 | 0 | I |
| 19. | Rożnowo above mouth | 36 | 11 | IV |
| 20. | Rożnowo mouth | 27 | 6 | IV |

THE RIVER FLINTA RESTORATION PROGRAMME

| No | Measures | Number of units | Unit |
|-----|----------------------------|-----------------|----------|
| 1. | Wooden deflector | 4 | Piece |
| 2. | Wood-stone deflector | 40 | Piece |
| 3. | Wooden weir | 7 | Piece |
| 4. | Willow faggots | 2 | Distance |
| 5. | Brushwood mattresses | 2 | Piece |
| 6. | Tree planting | 180 | Seedling |
| 7. | Spawning gravel insert | 4 | Surface |
| 8. | Fish bypass | 1 | Piece |
| 9. | Tree trunk | 14 | Piece |
| 10. | Wooden poles | 1 | Distance |
| 11. | Concrete weir removal | 1 | Piece |
| 12. | Rip-rap on willow mattress | 4 | Piece |
| 13. | Rip-rap on willow mattress | 13 | Piece |



THE PILOT PROJECT – PLANT BASKET HYDRAULIC STRUCTURES (PBHS)

Plant basket hydraulic structures (PBHS): preparation phase in the field

THE PILOT PROJECT – PLANT BASKET HYDRAULIC STRUCTURES (PBHS)

a)



b)



a) location of the study site on the river Flinta near Rożnowo,

b) the river bed and the sediment traps on 25.09.2013,

c)



d)



c) the sediment traps with plant debris on 25.09.2013,

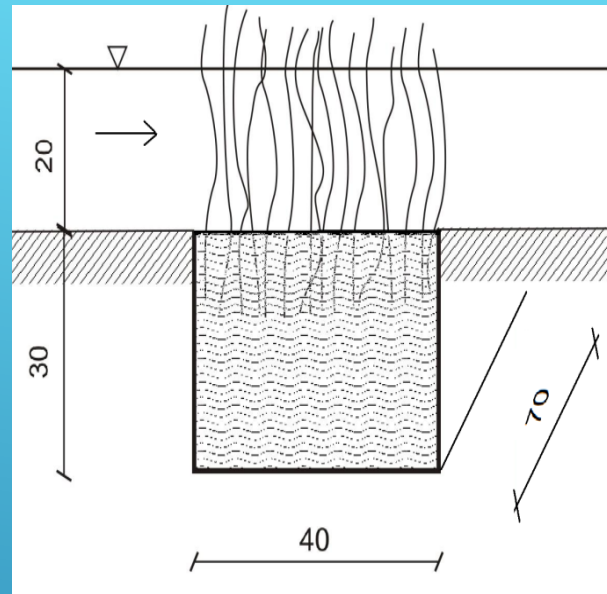
d) the sediment traps with plant debris and plants growing on it on 2.10.2014.

THE PILOT PROJECT – PLANT BASKET HYDRAULIC STRUCTURES (PBHS)



PLANT BASKET HYDRAULIC STRUCTURES (PBHS)

a)



b)



Dimensions and
sketch of PBHS

Plant basket hydraulic structures (PBHS): a) just constructed at the river bank, b) just immersed in

INVESTIGATED (PBHS) AND THE MEASURING POINTS ALONG THE FLINTA IN THE CASE STUDY RESEARCH REACH

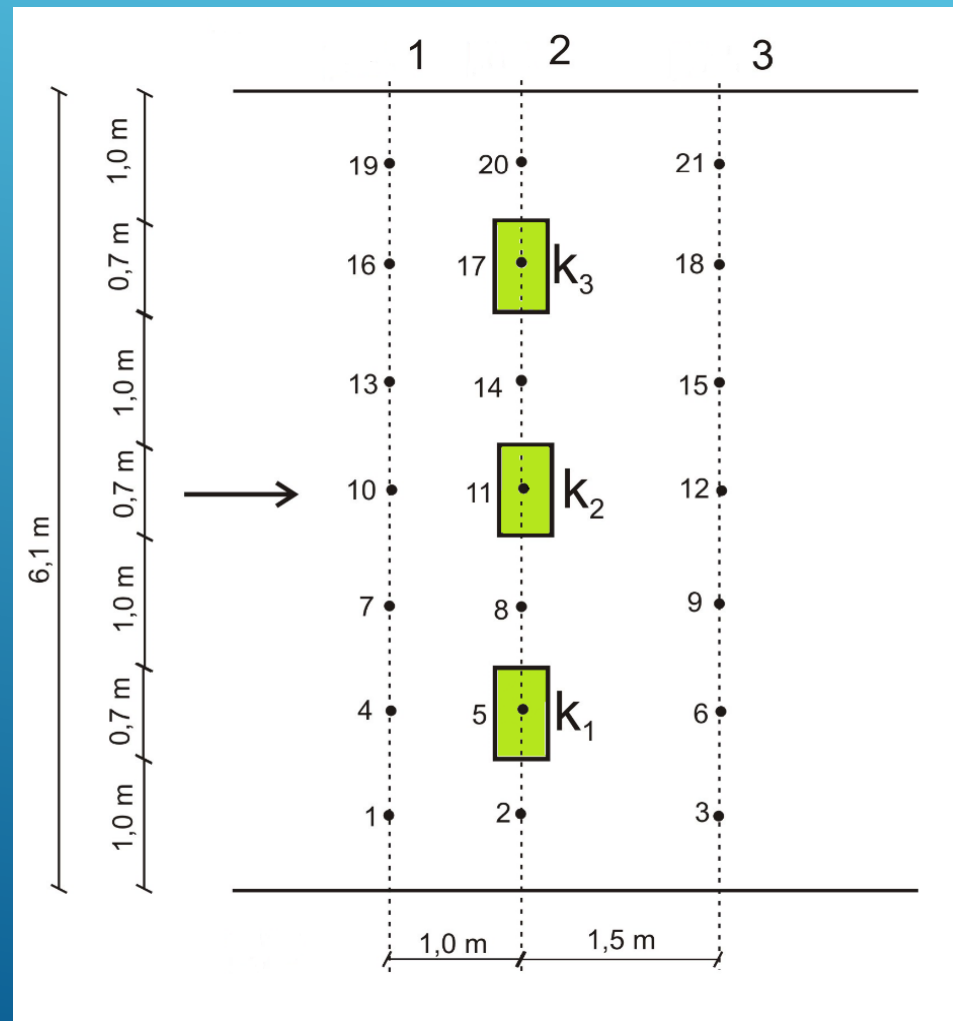


Table.1. Results of hydrodynamical measurements in the Flinta river (2 August 2013).

| Point | H | V_{\min} | V_{\max} | V_{av} | V^* | τ | Re | Re* | Fr | Fr* |
|-------|------|------------|------------|----------|-------|--------|-------|-----|-------|-------|
| 1 | 0,22 | 0,260 | 0,450 | 0,411 | 0,008 | 0,061 | 57666 | 2 | 0,280 | 0,005 |
| 4 | 0,18 | 0,398 | 0,550 | 0,480 | 0,007 | 0,051 | 55102 | 2 | 0,361 | 0,005 |
| 10 | 0,19 | 0,363 | 0,530 | 0,437 | 0,005 | 0,027 | 52953 | 1 | 0,320 | 0,004 |
| 16 | 0,21 | 0,328 | 0,440 | 0,420 | 0,004 | 0,013 | 56250 | 1 | 0,293 | 0,003 |
| 19 | 0,28 | 0,356 | 0,510 | 0,473 | 0,009 | 0,088 | 84464 | 4 | 0,285 | 0,005 |

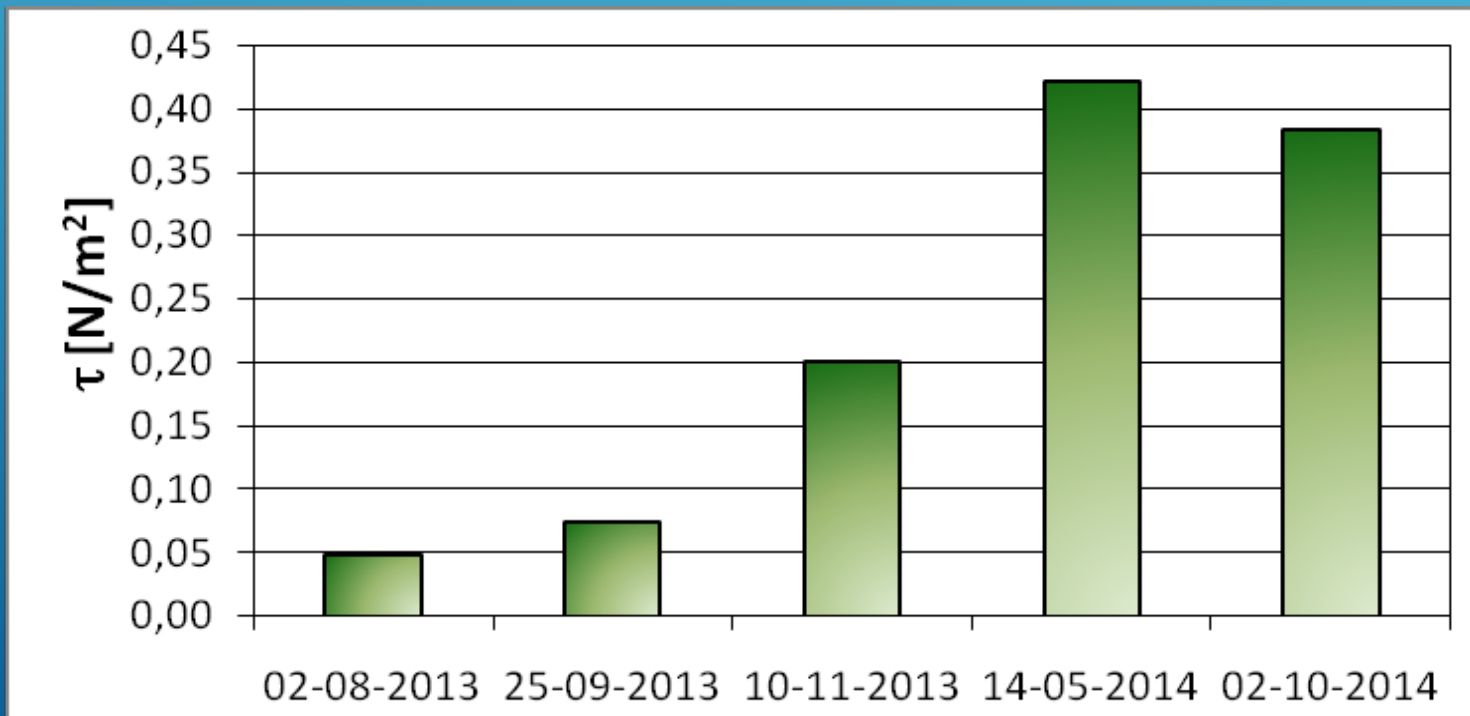
Table.2. Results of hydrodynamical measurements in the Flinta river (25 September 2013).

| Point | H | V_{\min} | V_{\max} | V_{av} | V^* | τ | Re | Re* | Fr | Fr* |
|-------|------|------------|------------|----------|-------|--------|-------|-----|-------|-------|
| 4 | 0,23 | 0,191 | 0,403 | 0,359 | 0,001 | 0,001 | 52659 | 0,3 | 0,239 | 0,001 |
| 5 | 0,31 | 0,140 | 0,199 | 0,171 | 0,004 | 0,016 | 33807 | 0* | 0,098 | 0,002 |
| 6 | 0,18 | 0,201 | 0,295 | 0,226 | 0,008 | 0,064 | 25944 | 3 | 0,170 | 0,006 |
| 7 | 0,16 | 0,370 | 0,517 | 0,477 | 0,010 | 0,091 | 48673 | 3 | 0,381 | 0,008 |
| 10 | 0,24 | 0,142 | 0,507 | 0,431 | 0,011 | 0,128 | 65969 | 3 | 0,281 | 0,007 |

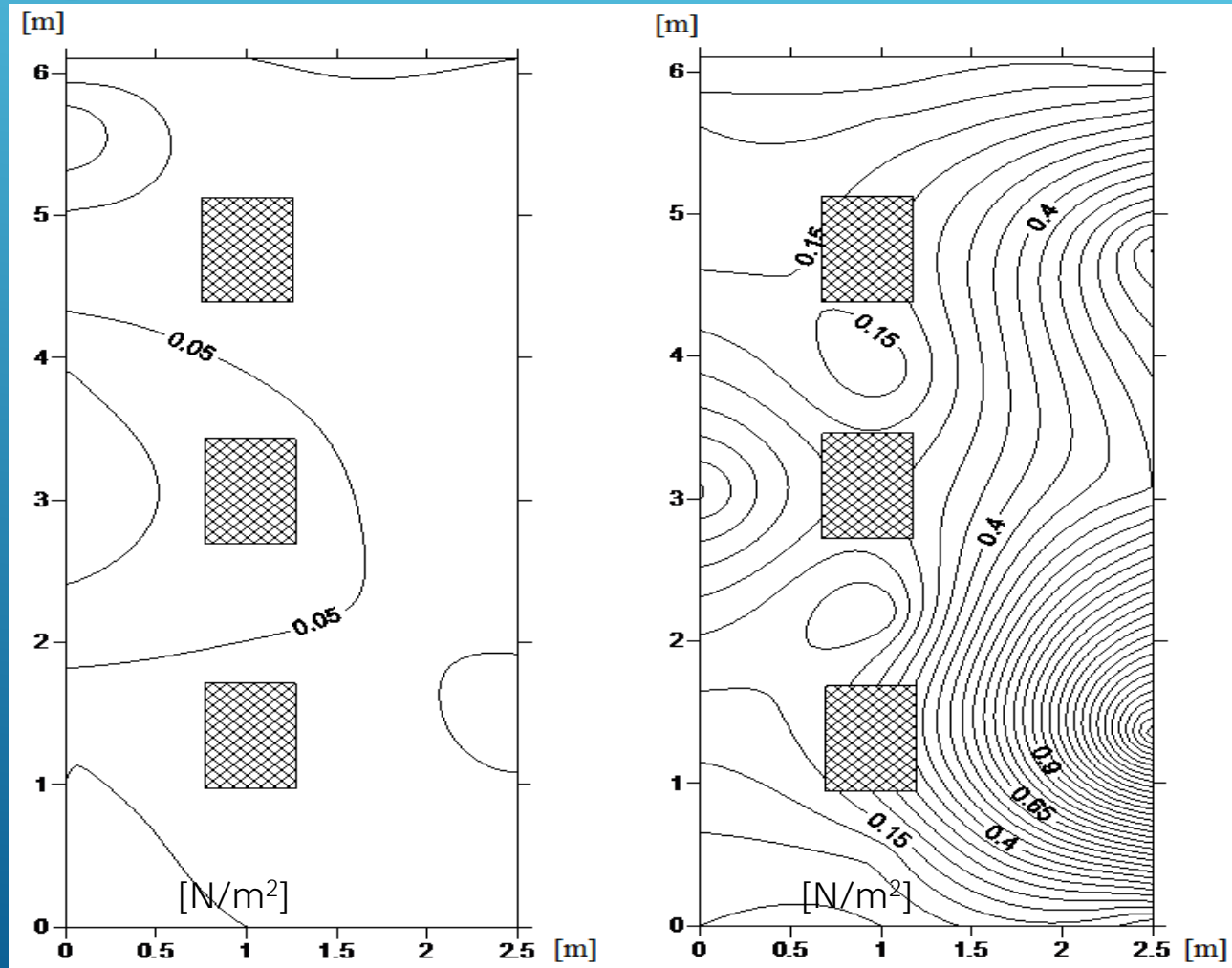
Table.4. Results of hydrodynamical measurements in the Flinta river (02 October 2014).

| Point | H | V_{\min} | V_{\max} | V_{av} | V^* | τ | Re | Re* | Fr | Fr* |
|-------|------|------------|------------|----------|-------|--------|--------|-----|-------|-------|
| 2 | 0,20 | 0,398 | 0,460 | 0,433 | 0,008 | 0,067 | 55230 | 0 | 0,309 | 0,006 |
| 4 | 0,15 | 0,410 | 0,517 | 0,455 | 0,011 | 0,120 | 43527 | 3 | 0,375 | 0,009 |
| 6 | 0,23 | 0,280 | 0,586 | 0,484 | 0,041 | 1,699 | 70995 | 30 | 0,322 | 0,027 |
| 8 | 0,18 | 0,309 | 0,370 | 0,347 | 0,010 | 0,095 | 39834 | 0 | 0,261 | 0,008 |
| 10 | 0,26 | 0,478 | 0,622 | 0,575 | 0,022 | 0,465 | 95344 | 6 | 0,360 | 0,014 |
| 12 | 0,07 | 0,38 | 0,541 | 0,462 | 0,023 | 0,551 | 20625 | 17 | 0,558 | 0,028 |
| 14 | 0,45 | 0,500 | 0,675 | 0,543 | 0,010 | 0,102 | 155835 | 0 | 0,258 | 0,005 |
| 16 | 0,37 | 0,537 | 0,639 | 0,553 | 0,012 | 0,136 | 130491 | 3 | 0,290 | 0,006 |
| 18 | 0,13 | 0,067 | 0,186 | 0,124 | 0,027 | 0,755 | 10281 | 20 | 0,110 | 0,024 |
| 19 | 0,30 | 0,408 | 0,478 | 0,429 | 0,01 | 0,102 | 82079 | 3 | 0,250 | 0,006 |
| 20 | 0,18 | 0,137 | 0,232 | 0,169 | 0,011 | 0,116 | 19401 | 0 | 0,127 | 0,008 |

AVERAGE SHEAR STRESS BEFORE AND AFTER THE INSTALLATION OF PBHS OVER THE TIME UNDER STUDY



DISTRIBUTION OF STRESS OVER THE REACH WITH INSTALLED PBHS SHORTLY AFTER THE INSTALLATION OF BASKETS AND ONE YEAR INTO THE RESEARCH



DISCUSSION AND CONCLUSIONS

- Plant baskets hydraulic structures (PBHS) change the hydrodynamic conditions and lead to sediment accumulation and formation of river backwaters downstream and upstream the obstacle.
- PBHS cause plant debris accumulation, which influences the hydrodynamic flow conditions.
- The installation of PBHS on the river bed alters the flow conditions. Shear stress is an example of an affected hydraulic parameter – its value before the vegetative sediment traps increased significantly from $\tau = 0.027 \text{ N} \cdot \text{m}^{-2}$ (2.08.2013) to $\tau = 0.465 \text{ N} \cdot \text{m}^{-2}$ (2.10.2014)
- The highest shear stress was observed after one year of study (on October 2nd, 2014) upstream of the PBHS K1: $\tau = 1.699 \text{ N} \cdot \text{m}^{-2}$. In contrast, the smallest shear stress was measured between PBHS K1 and the right riverbank: $\tau = 0.067 \text{ N} \cdot \text{m}^{-2}$.

THANKS FOR YOUR ATTENTION



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