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Bed stability as parameter describing the hydro-morphological balance of mountain river

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Presentation schedule:

- introduction

- methodology

- investigated objects

- bed stability

- influence of bed stability on the balance h-m
first attempt

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Ocena zrównoważonego stanu rzek i potoków górskich
w oparciu o naturalne warunki morfologiczne

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Introduction

Water policy of the European Union has set new requirements for the tasks of engineering and water management. Currently, one of the most important tasks of water management in accordance with the requirements of the Water Framework Directive of the European Union is to prevent the deterioration of water bodies and to achieve good status for all waters by the end of 2015.

For surface water "good status" is determined by the "good ecological status". In the case when the current biotic and physicochemical is good, according to the WFD hydromorphological assessment may be taken into account and reduce the overall rating by one step.

Authors stress that hydromorphological and physicochemical parameters as creating live conditions for the nature should be taken first into account.

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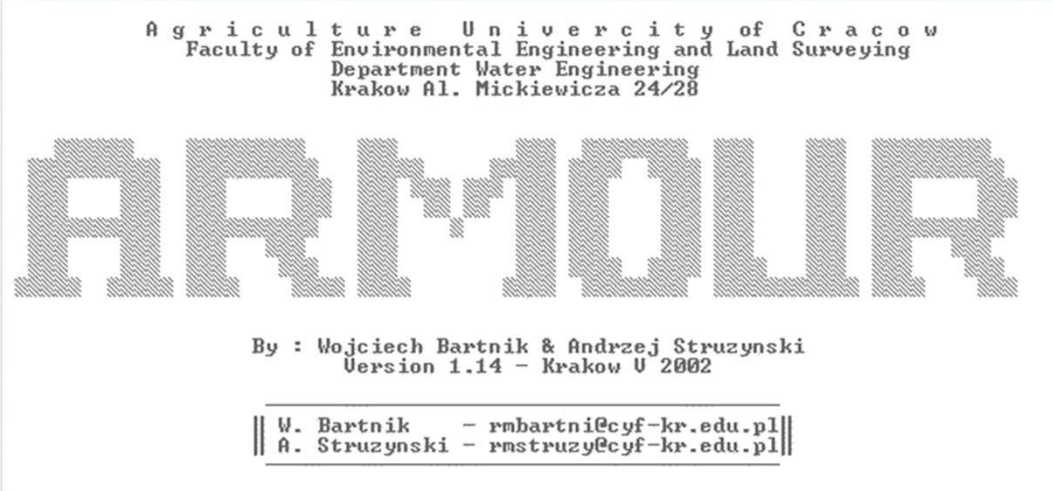
Methodology

- In situ measurements:
  - geodesy measurements
  - bedload

- hydrological data

- bed stability prognosis (ARMOUR)



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1. Ziarno kuliste

$\psi_p = 0.75$

2. Ziarno spłaszczone - elipsoidalne

$\psi_p = 0.60 \div 0.86$

3. Ziarno elipsoidalne wydłużone

$0.50 < \psi_p < 0.75$

4. Dysk

$0.65 < \psi_p < 0.74$

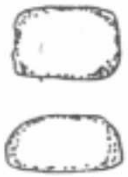
5. Dysk wydłużony

$\psi_p < 0.60$

6. Ziarno sześcienne

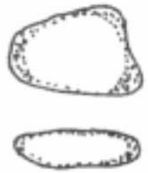
$\psi_p = 0.75$

7. Graniastosłuo



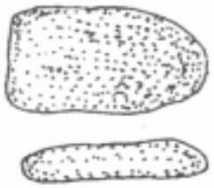
$0.6 \leq \psi_p < 0.75$

8. Płyta



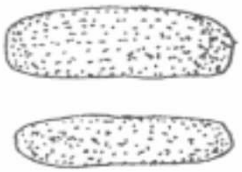
$\psi_p < 0.74$

9. Deska wydłużona



$\psi_p < 0.6$

10. Pręt



$\psi_p < 0.5$

$$d_i / d_m < 0,6 : \varepsilon_i = 0,039\delta^{0,26} / f_i = 1,786(d_i / d_m)^{0,95}$$

$$d_i / d_m > 0,6 : \varepsilon_i = 0,028\delta^{0,26} / f_i = (d_i / d_m)^{0,314}$$

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$$\tau_c = f_i g \Delta \rho_s d_i$$

$$\varepsilon = f_i / f_m = \left(d_i / d_m\right)^{-r}$$

$$f_i = \frac{f_{m1}}{1.786\left(\frac{d_i}{d_m}\right)^{0.947}}$$

$$f_i = \frac{f_{m2}}{\left(\frac{d_i}{d_m}\right)^{0.314}}$$

Wang [1977]

[Bartnik, 1992]

$f_{m1} = 0.039\ \delta^{0.26}$ for $d_i/d_m < 0.6$

$f_{m2} = 0.028\ \delta^{0.26}$ for $d_i/d_m > 0.6$

$$f_m = 0.0123\ e^{1.6\ SF}$$

Bartnik [1997]

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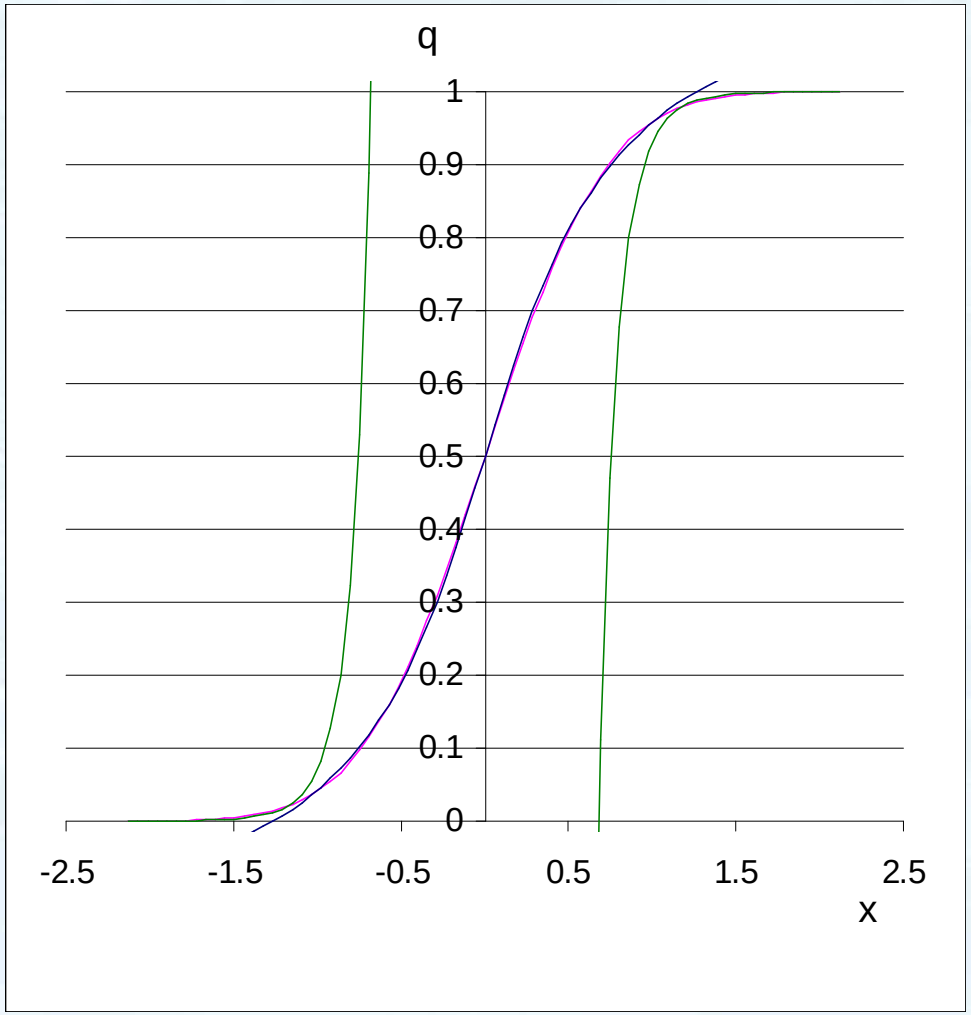
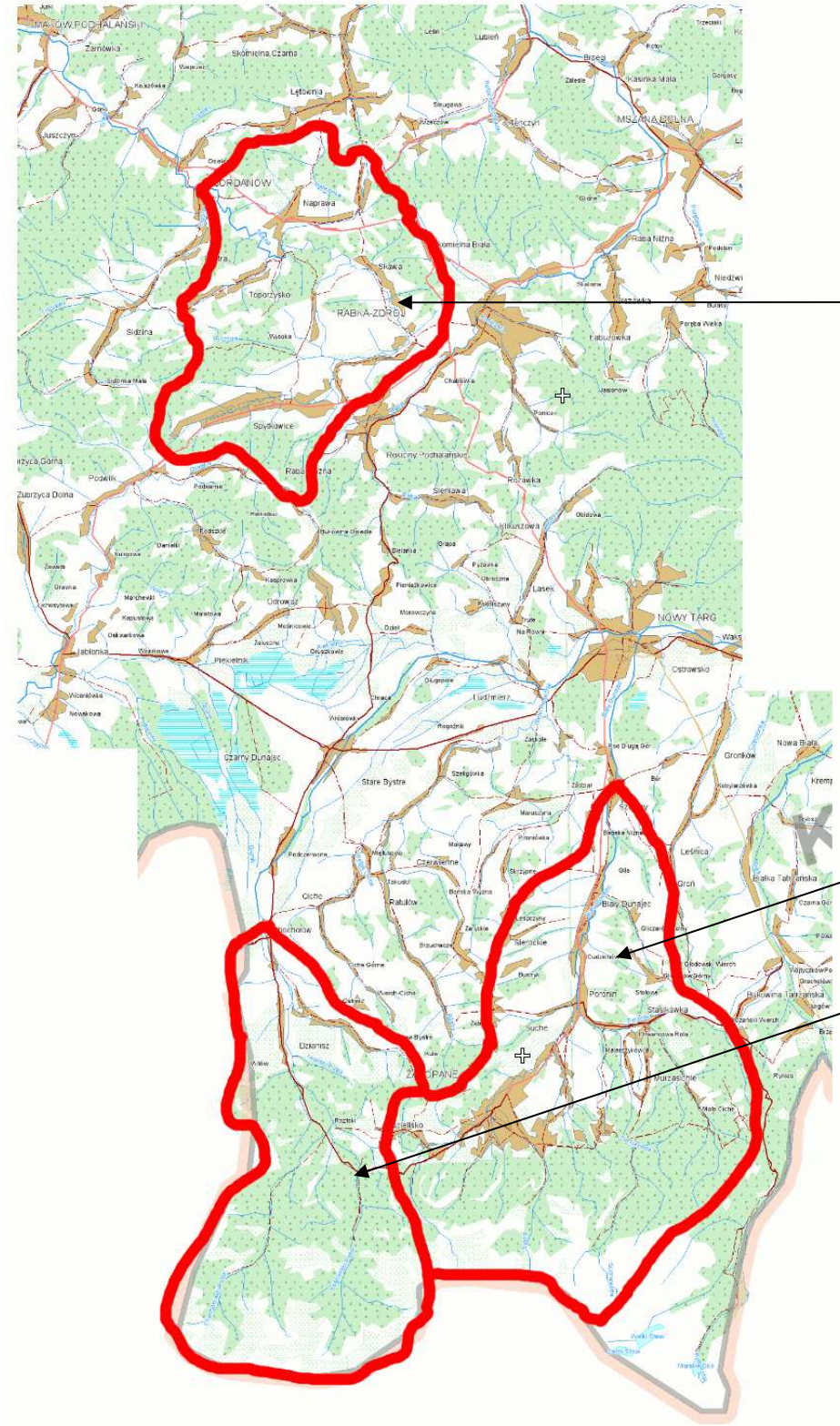
$$q = \phi_p\left(\tau_0 / \tau_c\right)$$

$$p_a(di) = \frac{\sum_{d\min}^{di} q(di)\Delta p_0(di)}{\sum_{d\min}^{d\max} q(di)\Delta p_0(di)}$$



Probabilistic interpretation of grain movement - Gessler

distribution drawn by Komura



Investigated objects:

upper Skawa

upper Biały Dunajec

upper Czarny Dunajec

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Biały Dunajec in Szaflary

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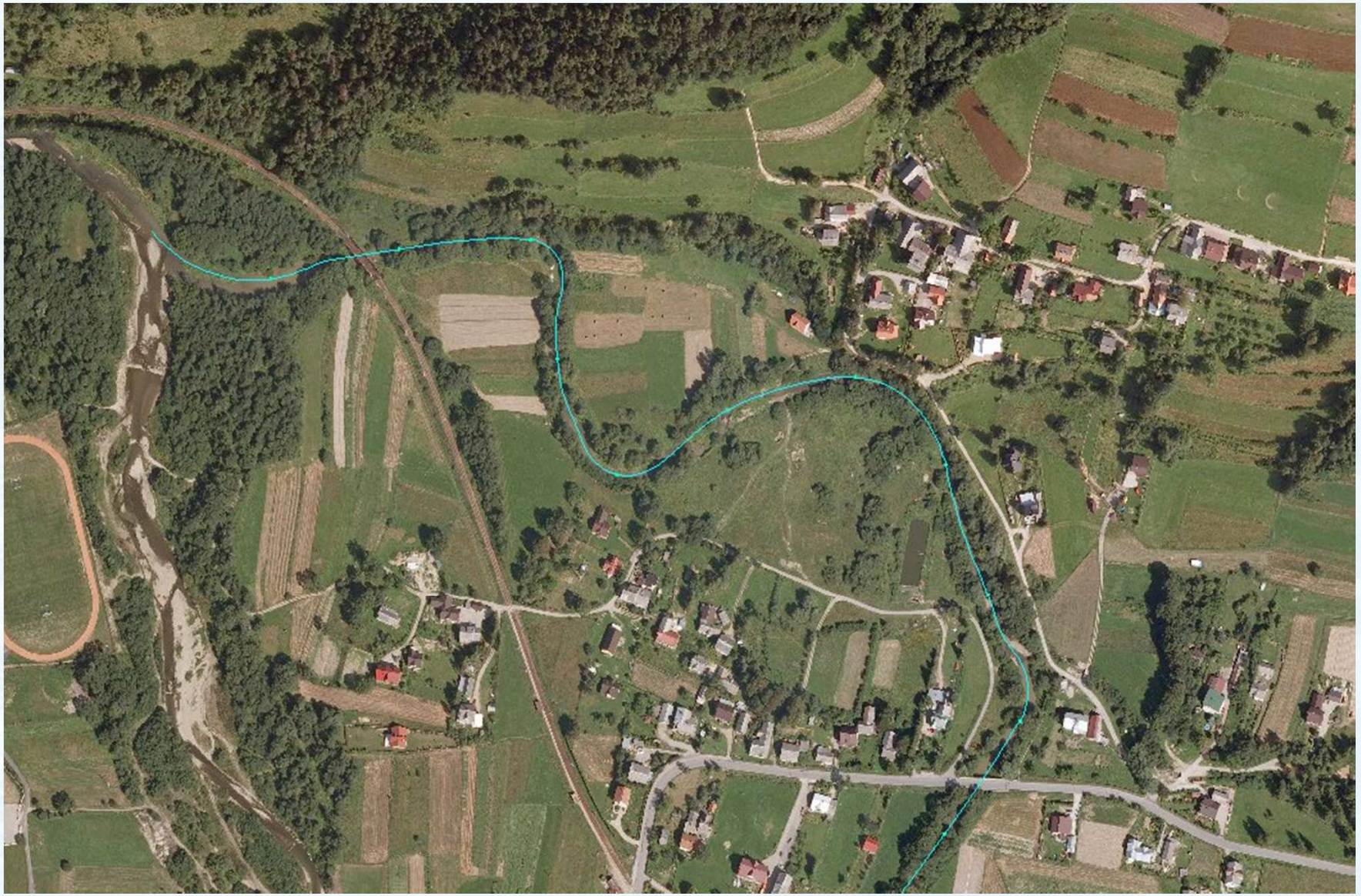
Czarny Dunajec in Chochołów

Bed stability as parameter describing the hydro-morphological balance of mountain river



Skawa in Bystra

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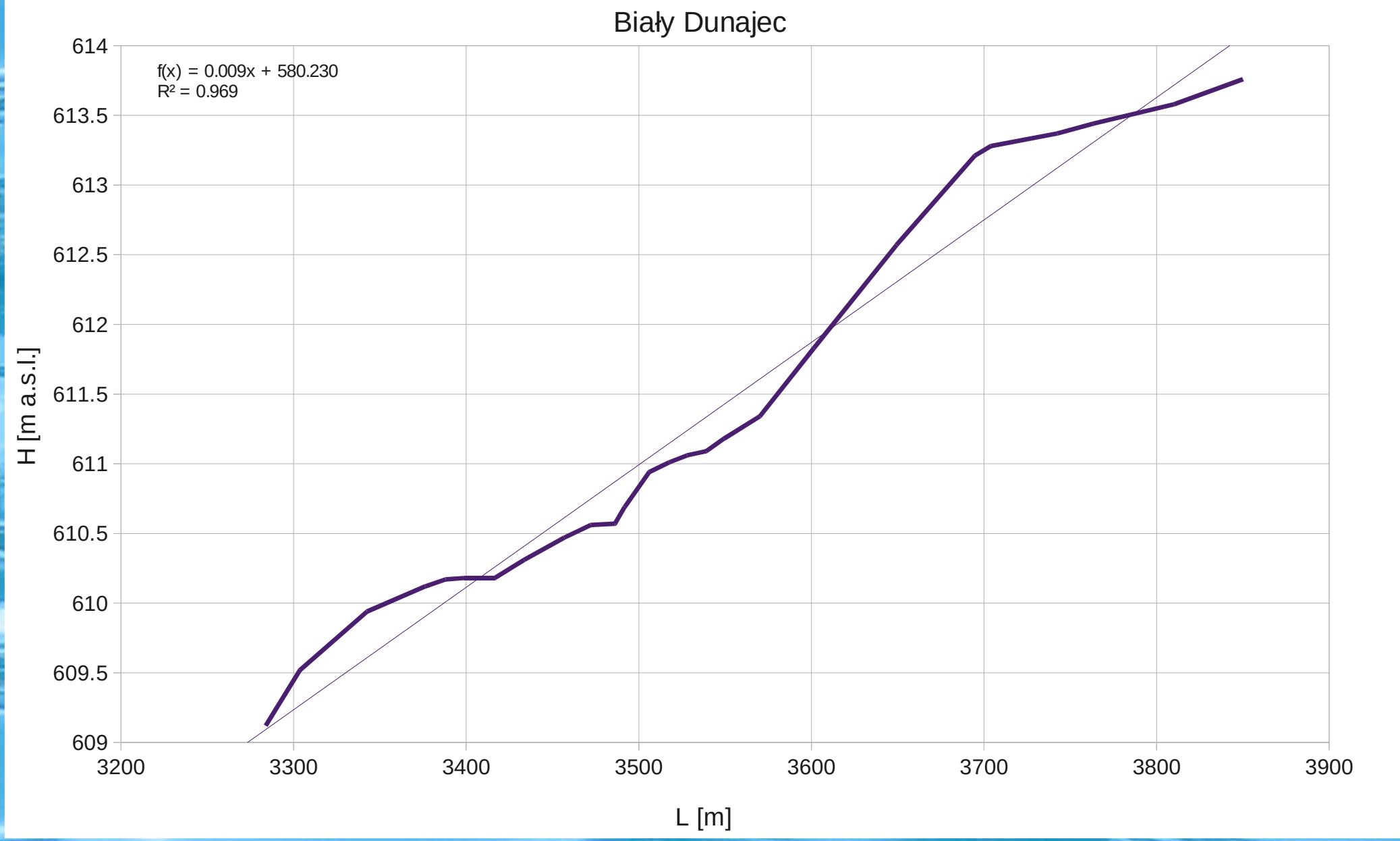

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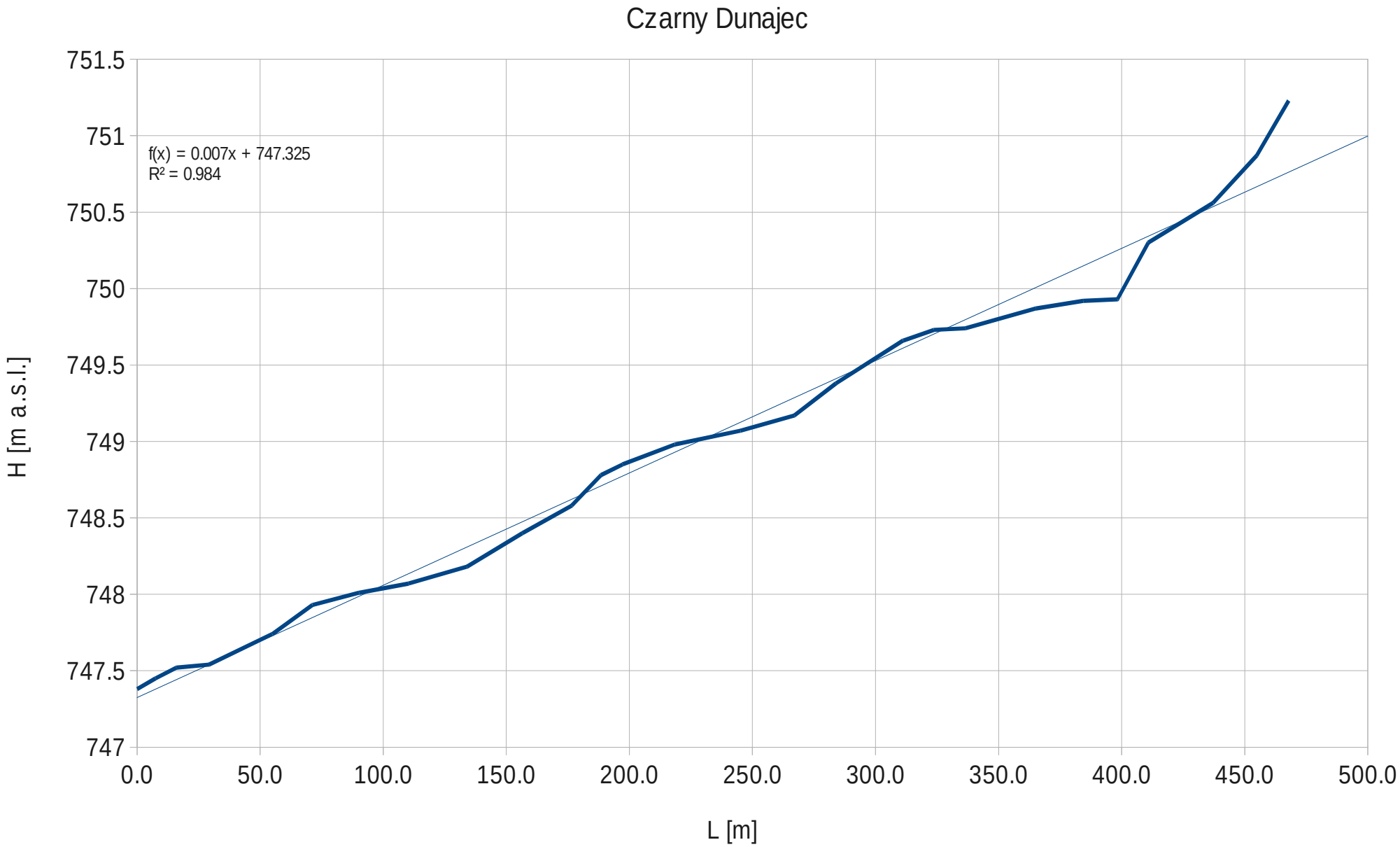

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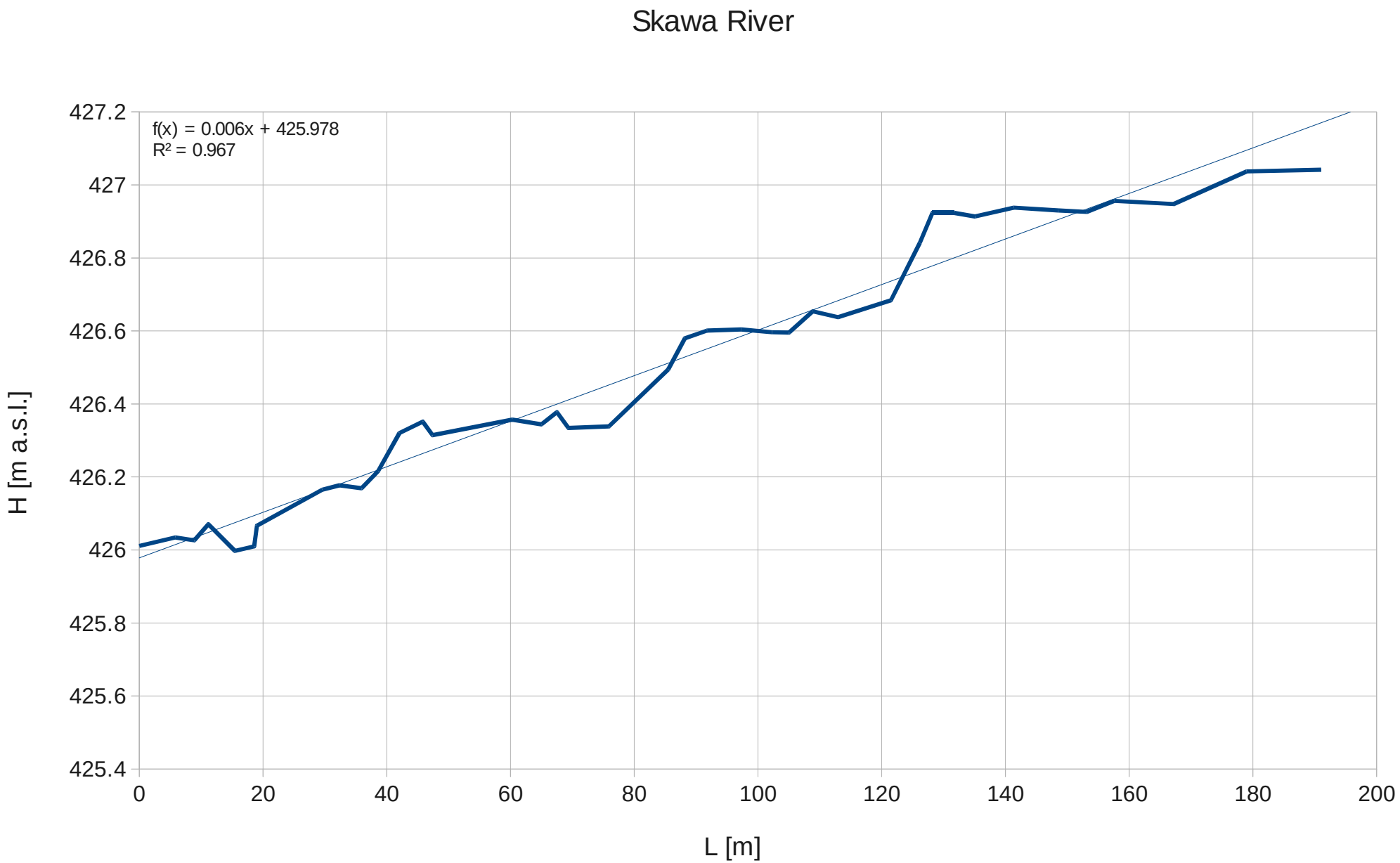


Bed stability as parameter describing the hydro-morphological balance of mountain river

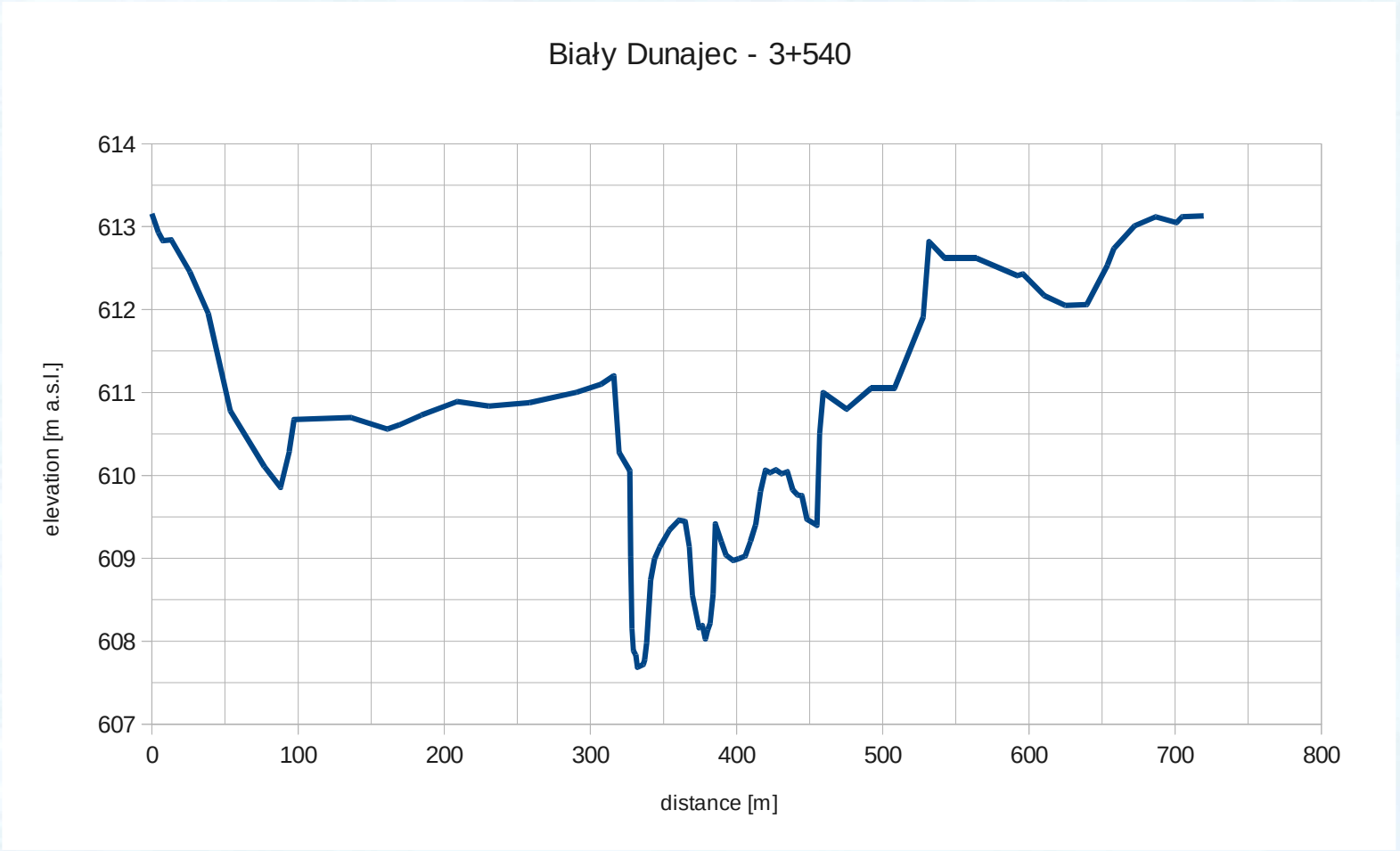
	I avg [-]	I pools [-]	I riffles [-]	L pools [m]	L riffles [m]	L r / L p
Biały Dunajec	0.008	0.004	0.012	99	60	0.61
Czarny Dunajec	0.008	0.004	0.015	276	192	0.70
Skawa	0.005	0.002	0.025	166	25	0.15

Bed stability as parameter describing the hydro-morphological balance of mountain river

Hydrological data	p%	1	2.5	5	10	25	50
B – Dunajec	Q [m3/s]	459	348	257	200	103	62
Cz – Dunajec	- / -	252	202	171	136	82	52
Skawa	- / -	425	345	276	211	165	67

	Biały Dunajec	Czarny Dunajec	Skawa
slope	0.008	0.008	0.005
n – low flow	0.030	0.030	0.035
n – high flow	0.028	0.030	0.040

Bed stability as parameter describing the hydro-morphological balance of mountain river



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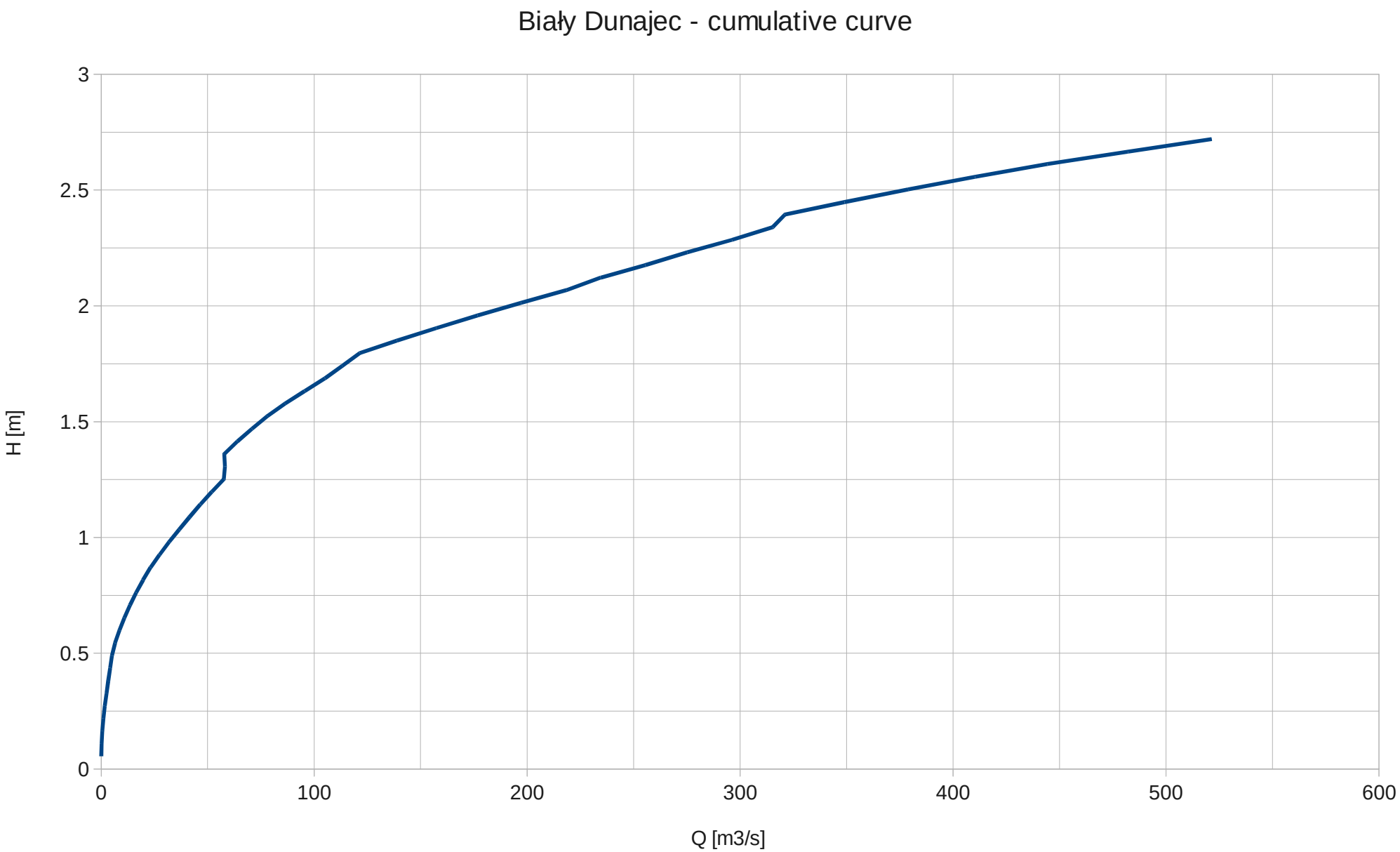

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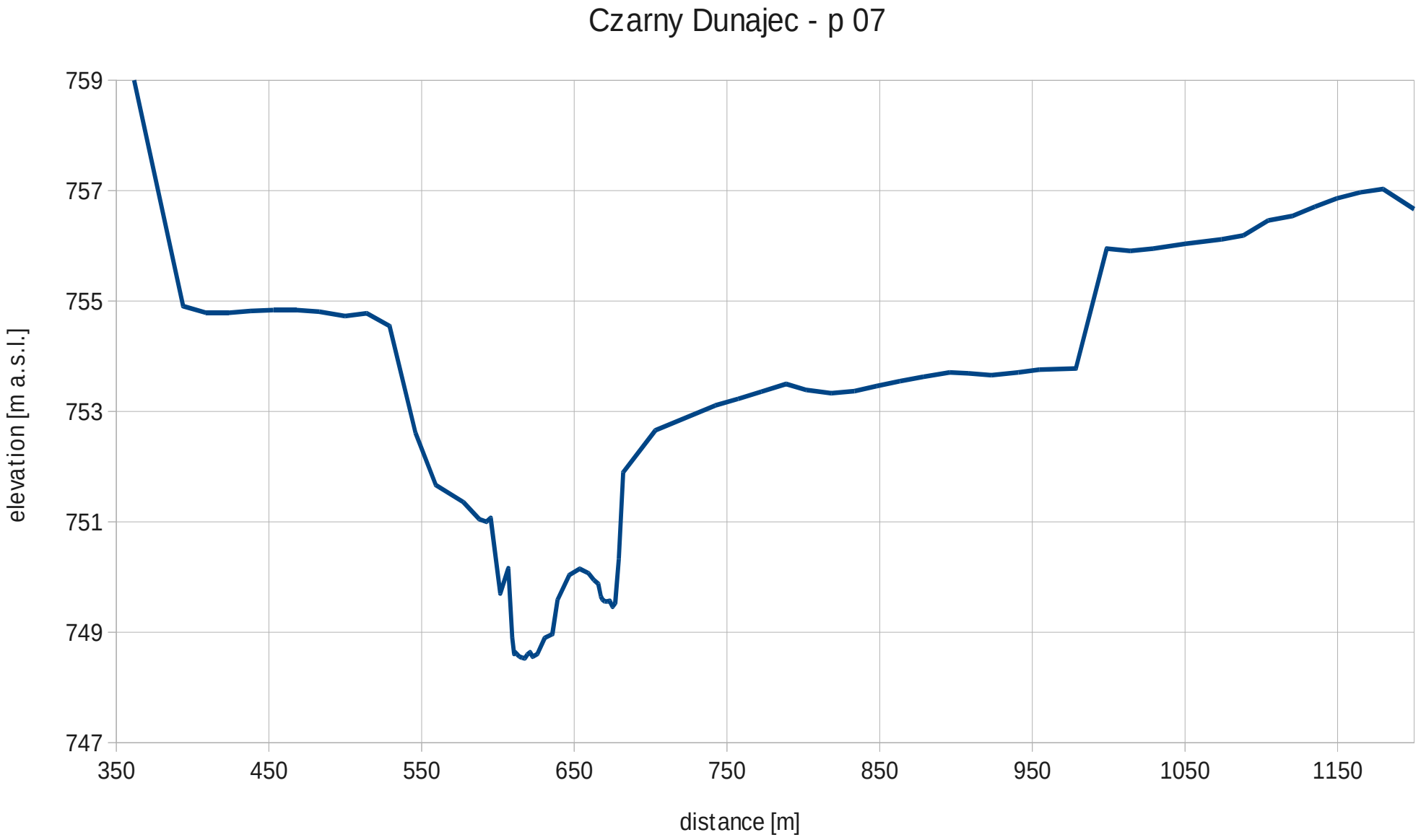
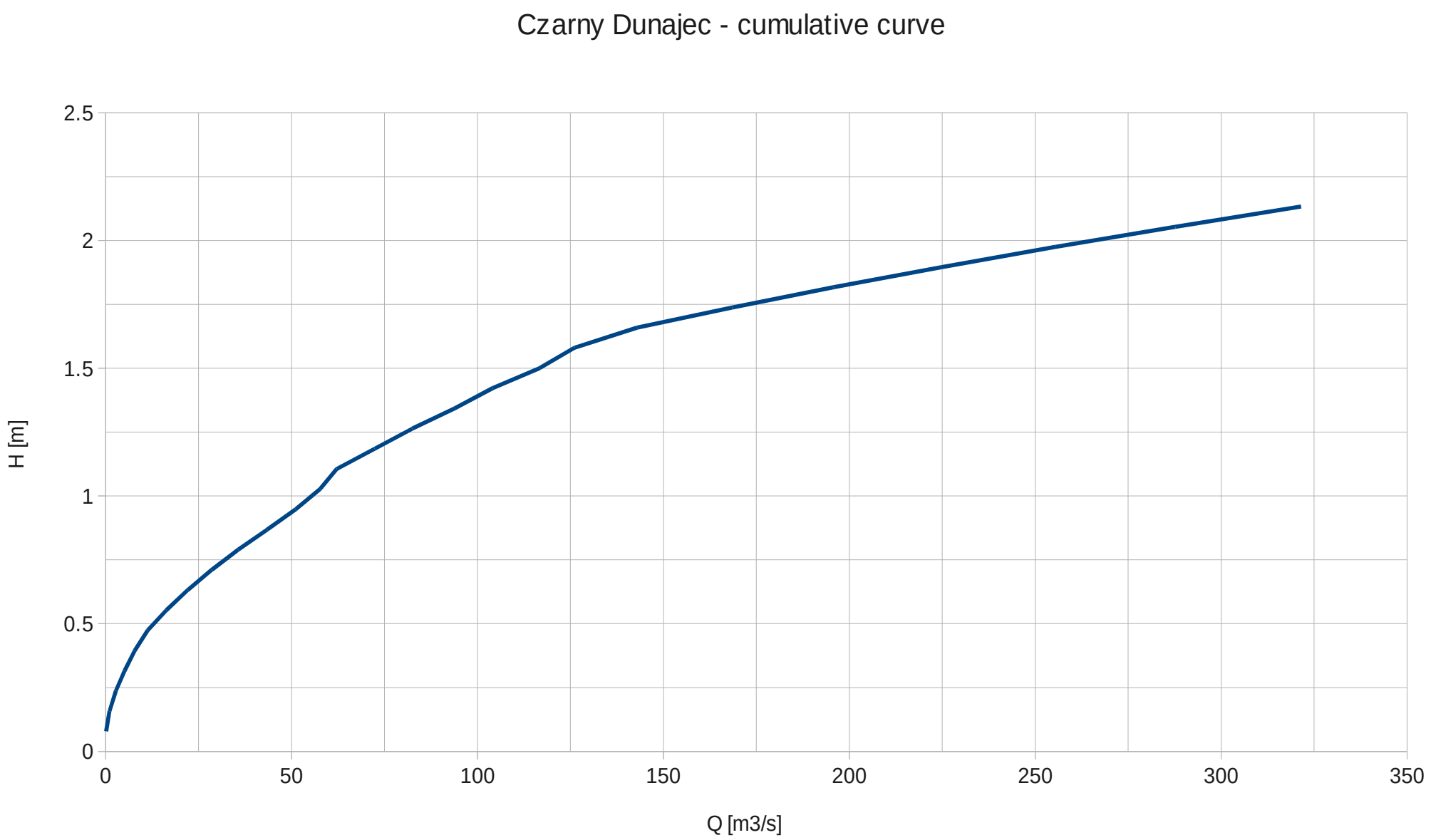


7.74


Czarny Dunajec - cumulative curve
H [m]
2.5
2
1.5
1
0.5
0
0
50
100
150
200
250
300
350
Q [m3/s]

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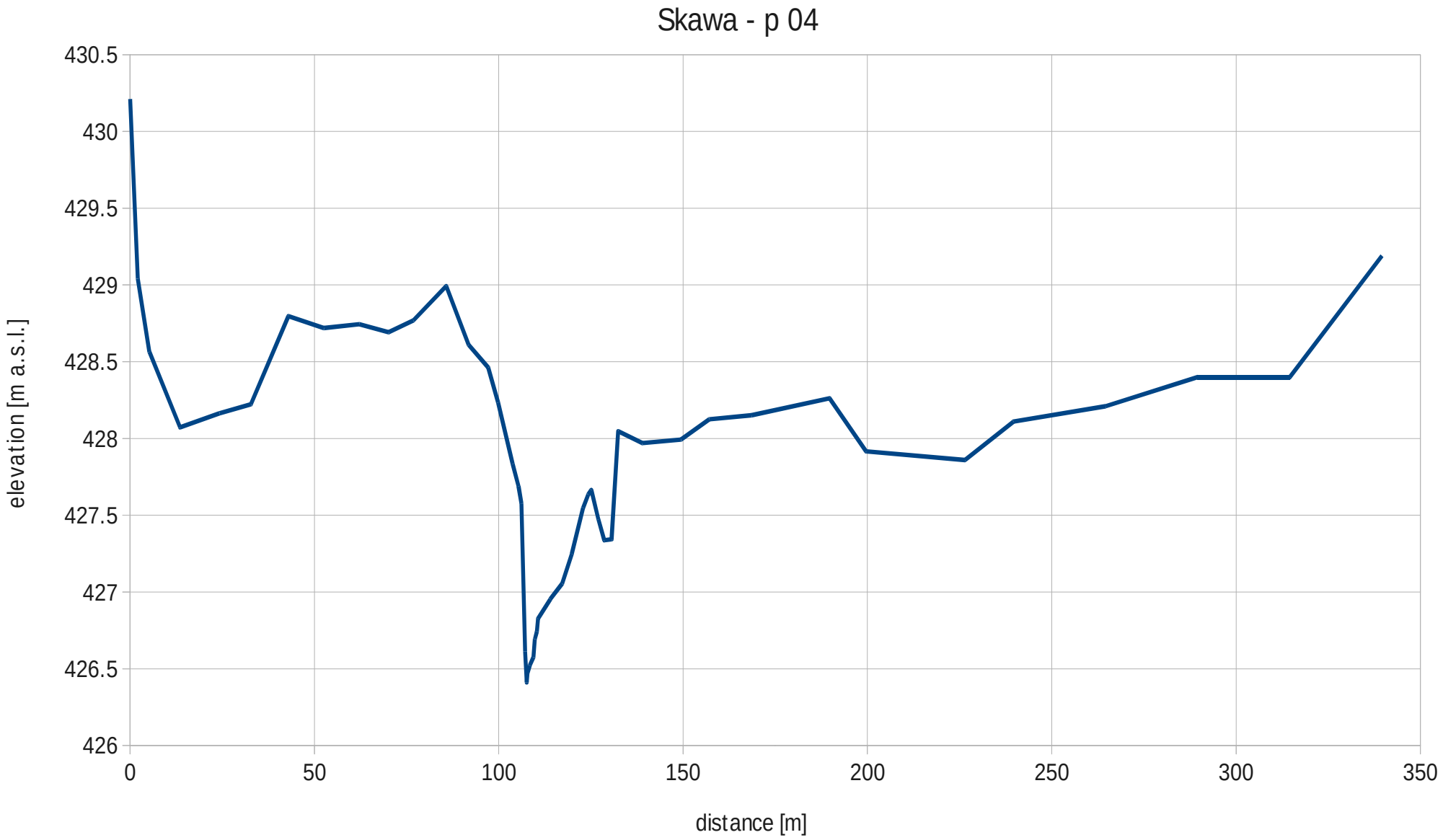

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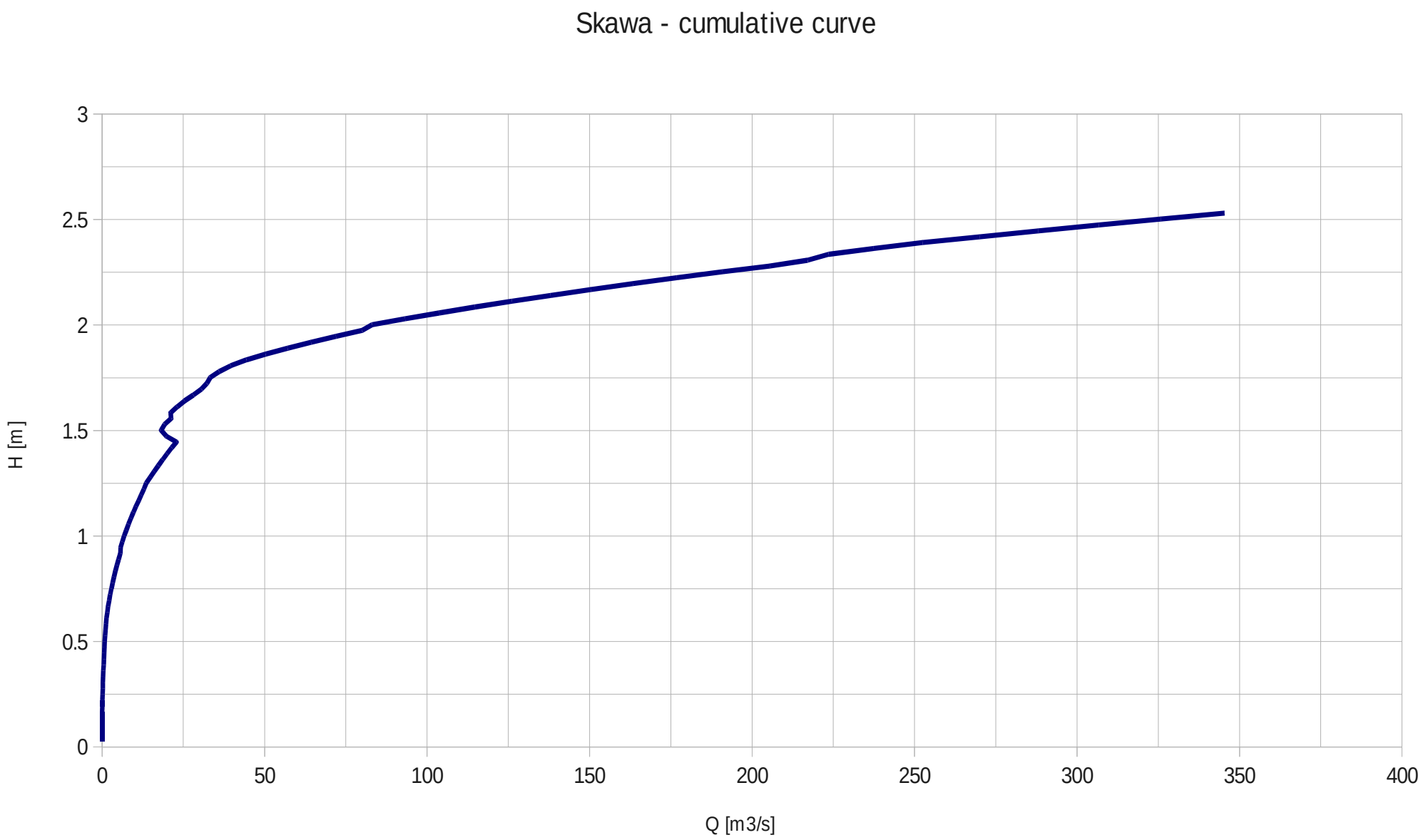

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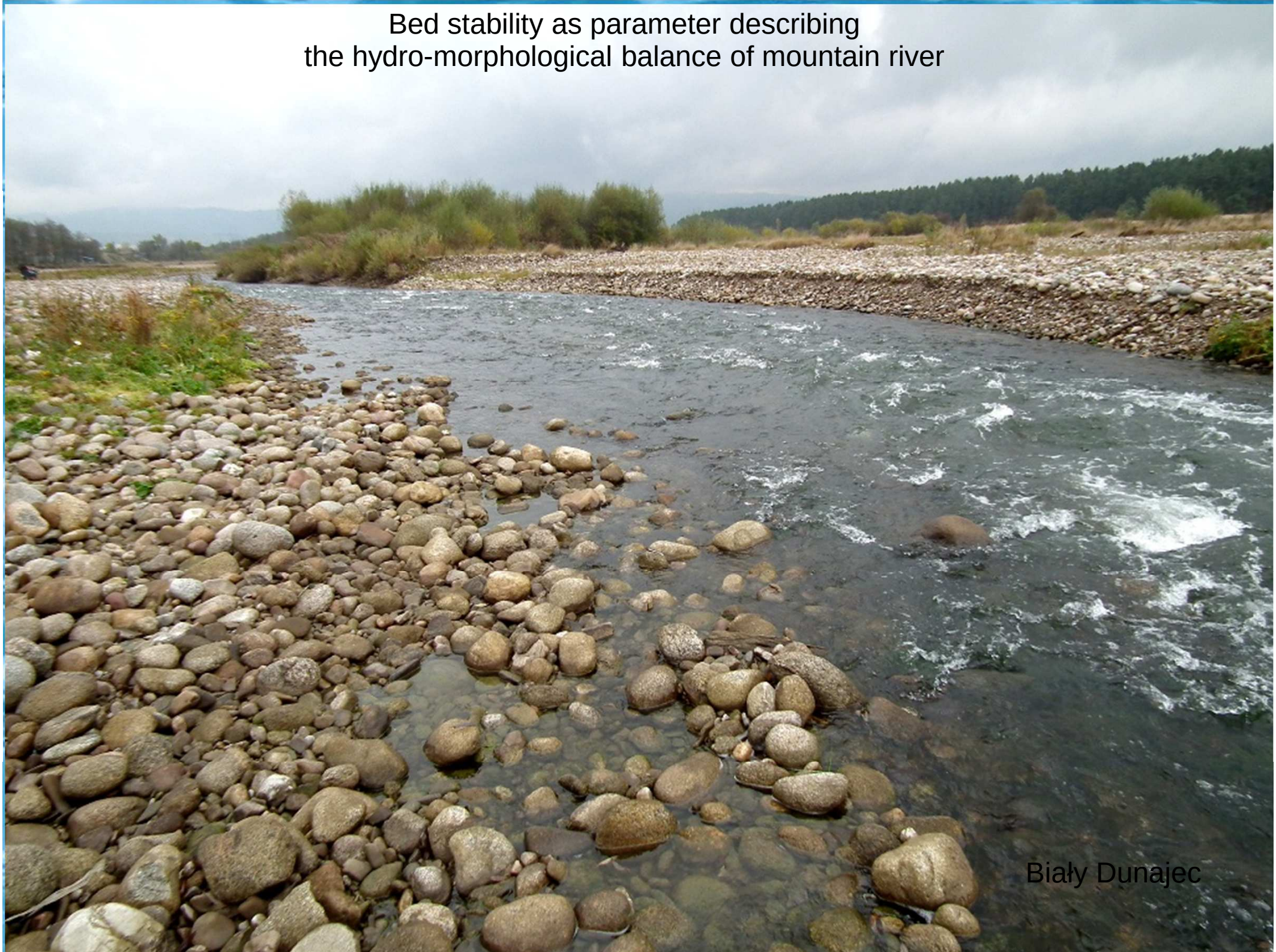

Biały Dunajec

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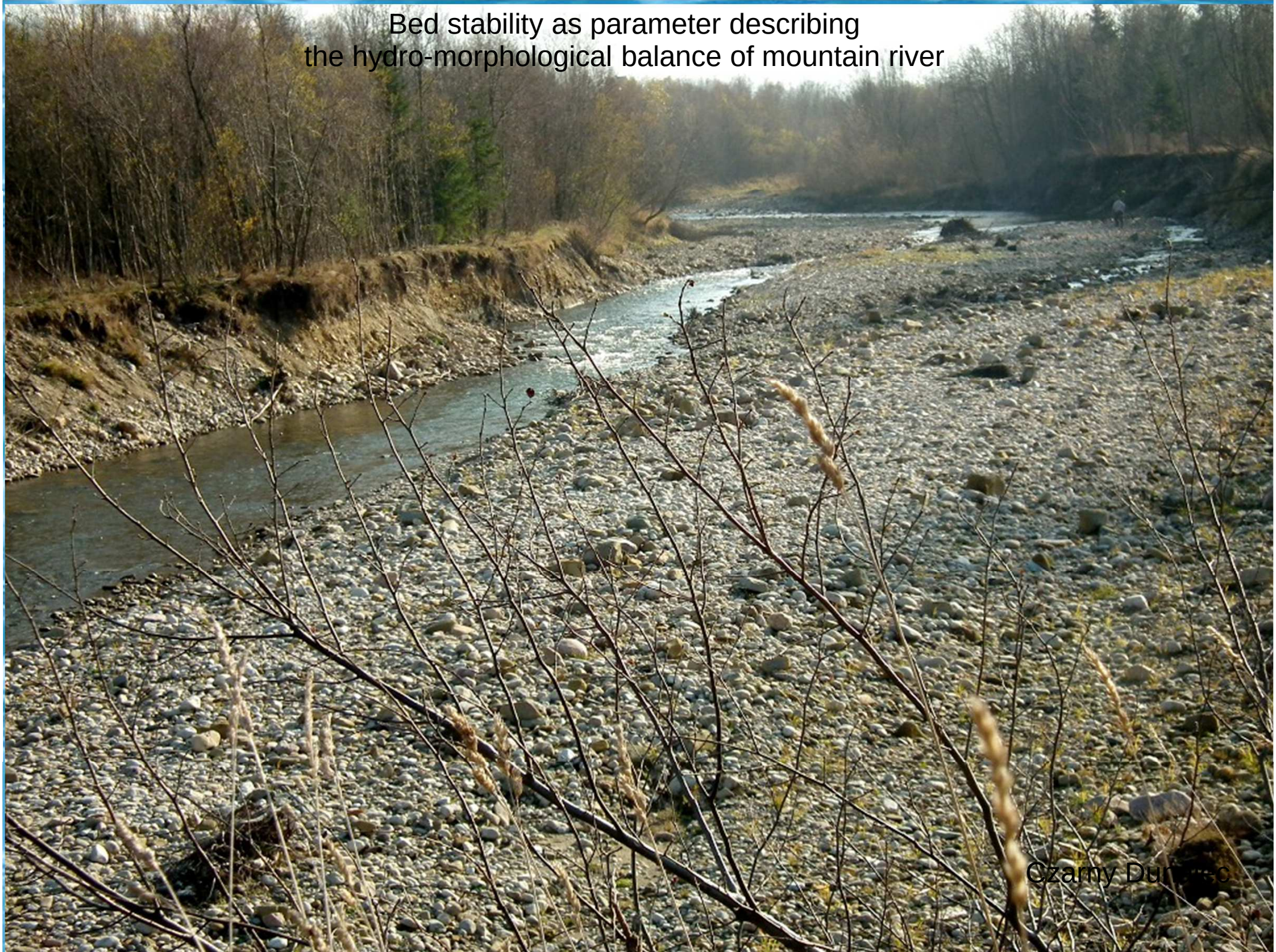

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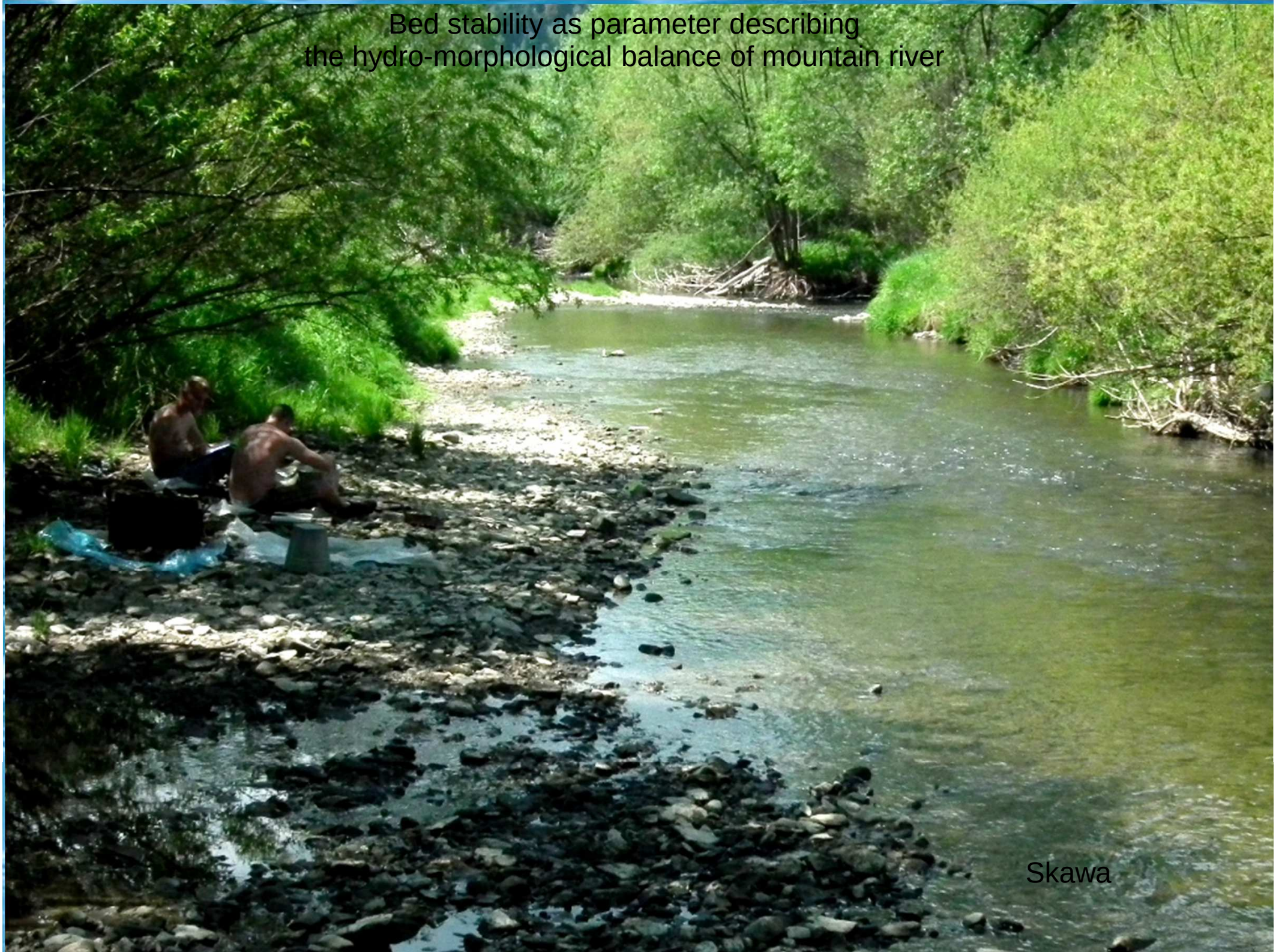

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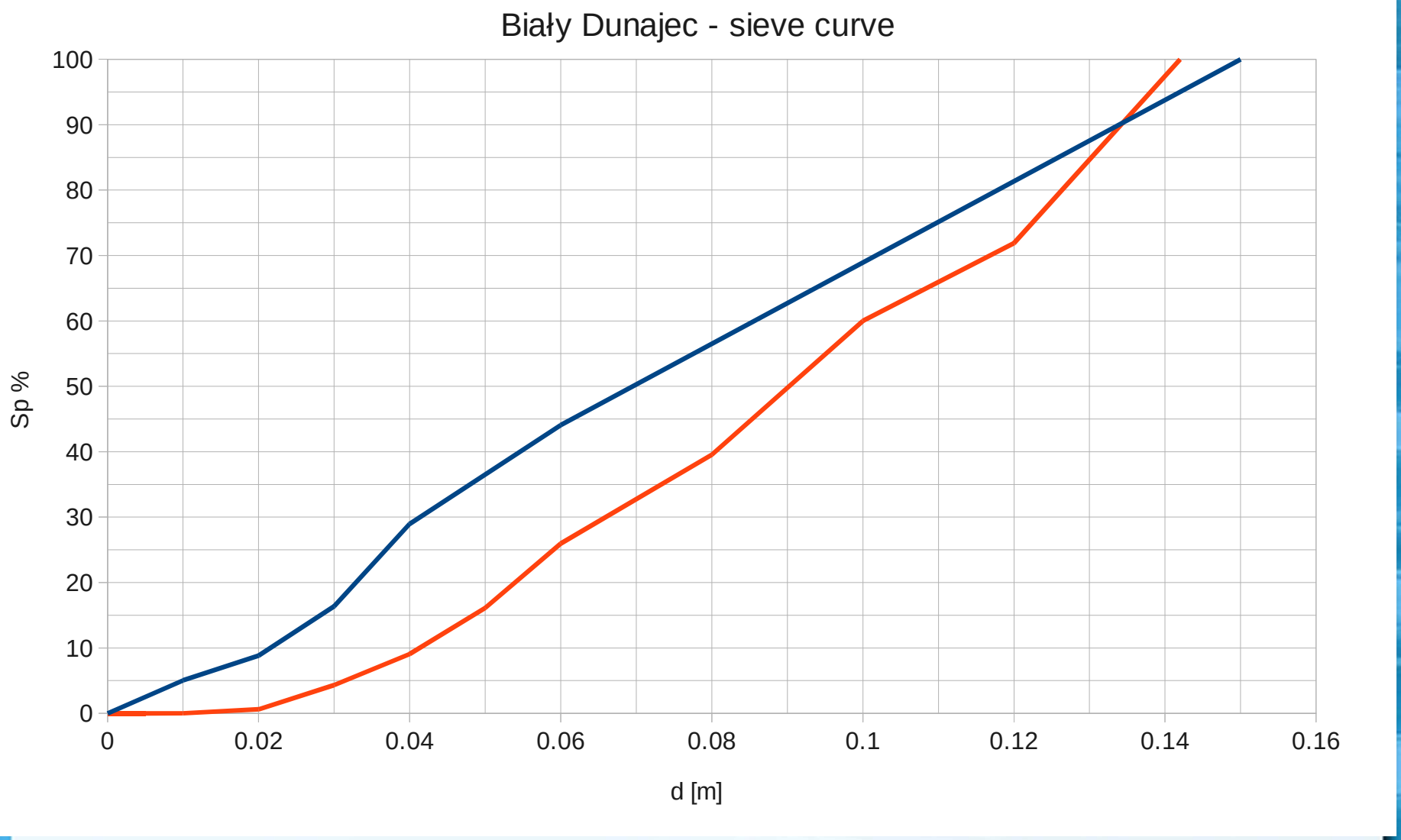

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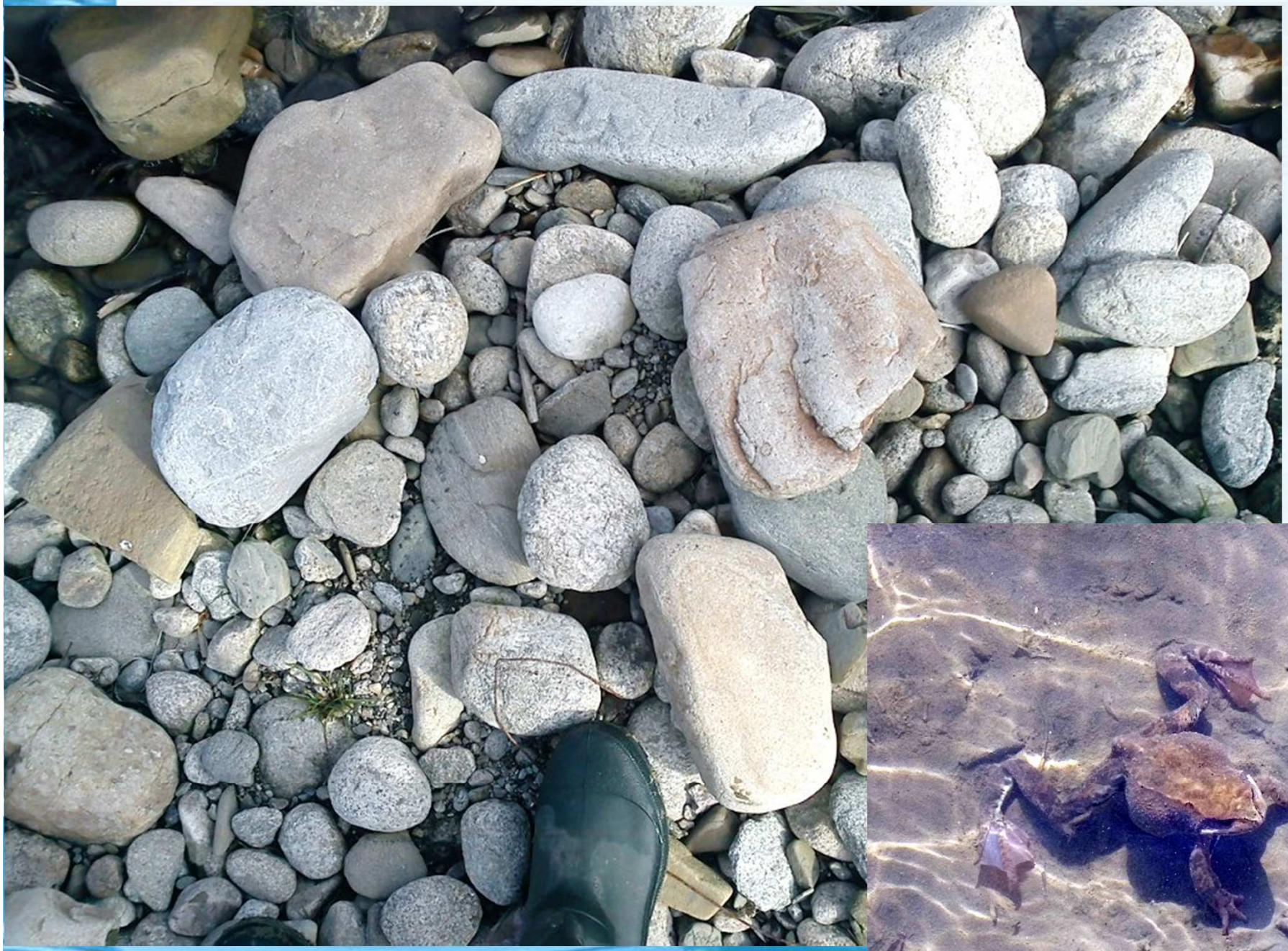

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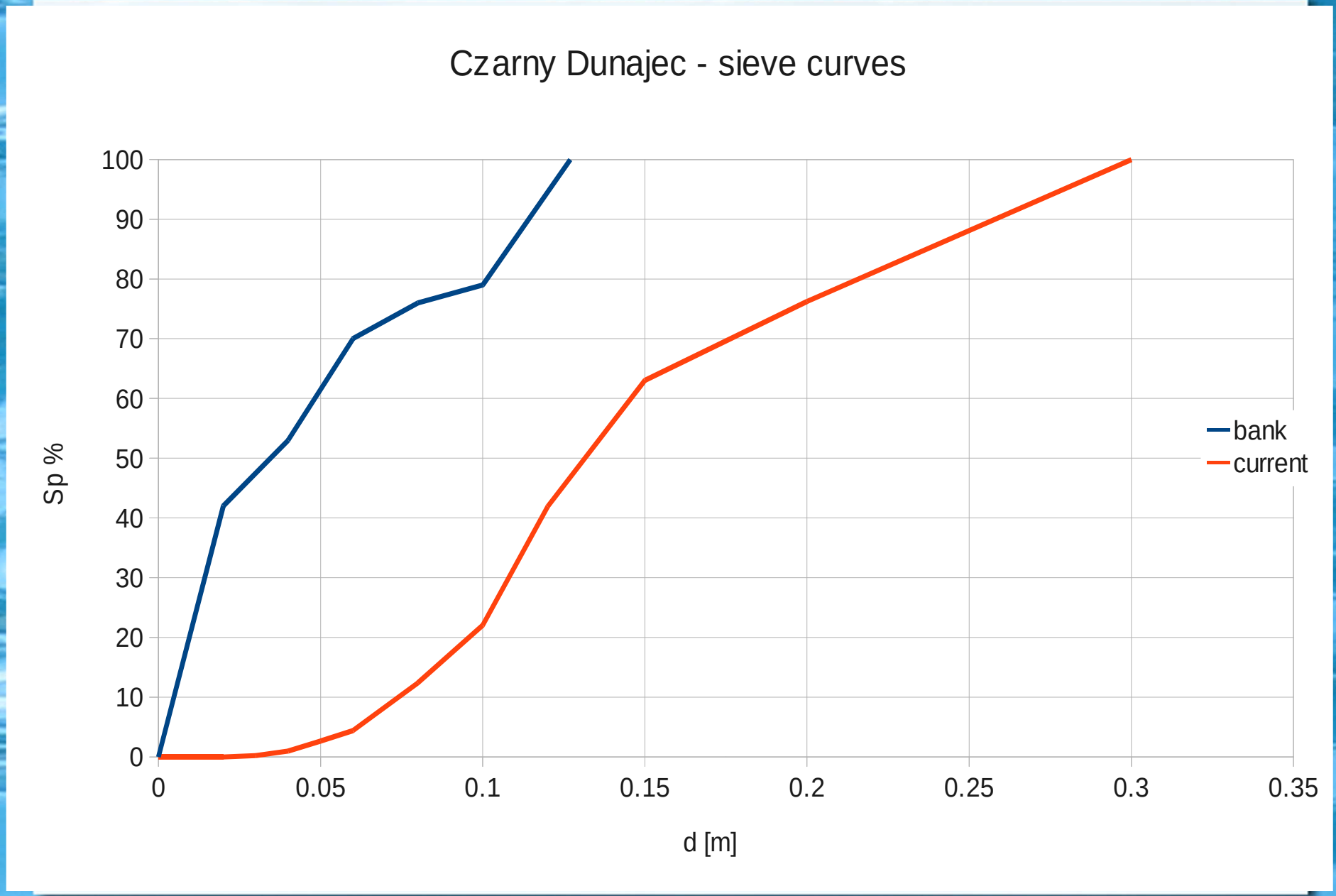

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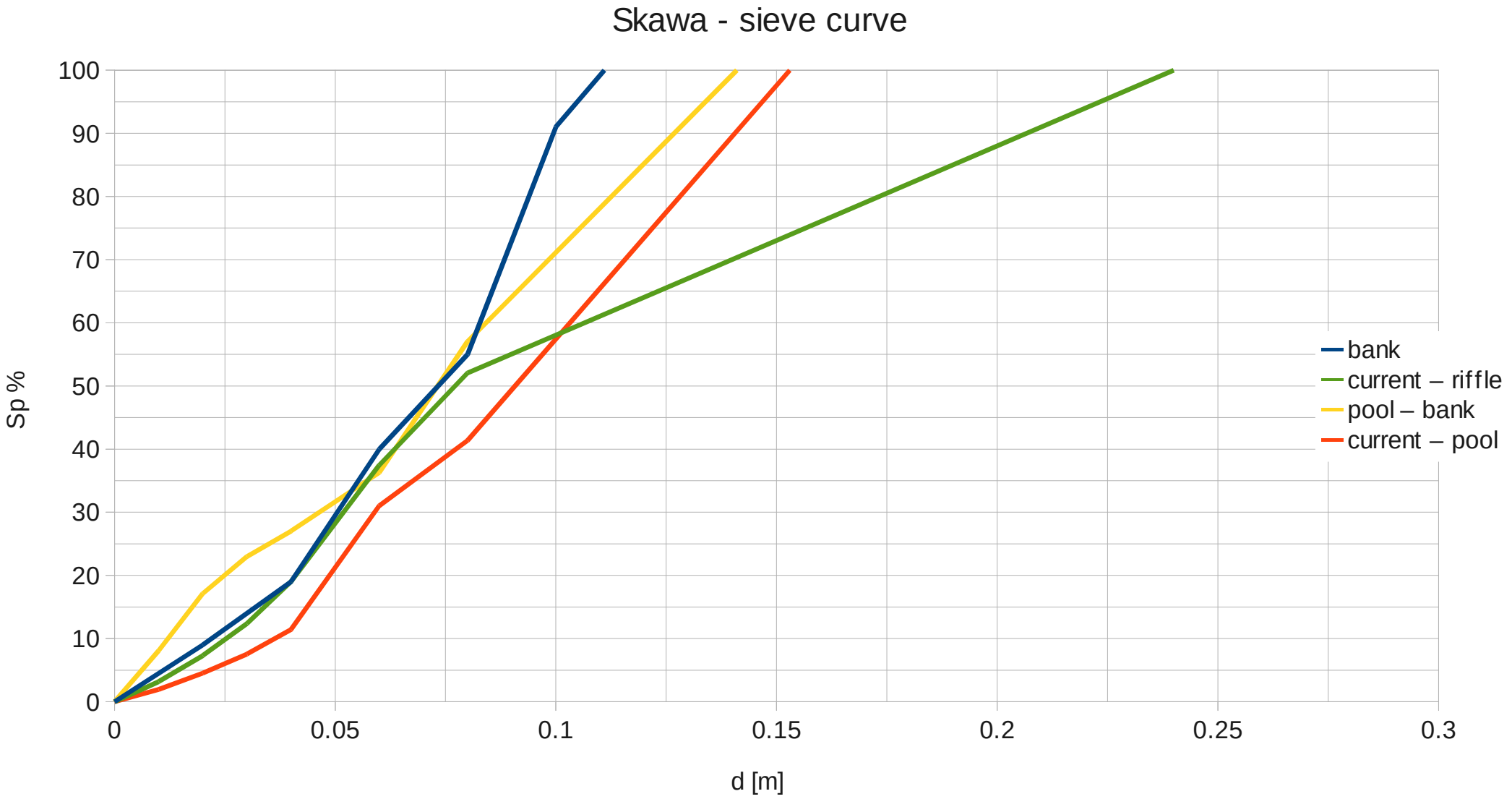

Bed stability as parameter describing the hydro-morphological balance of mountain river

H min		H bankfull	H terrace 1	h bankfull	h terrace 1	2/3 bankfull
607.69	Biały Dunajec	609.5	611	1.81	3.31	1.21
748.53	Czarny Dunajec	751	753.5	2.47	4.97	1.65
426.41	Skawa	427.6	428.2	1.19	1.79	0.79

h (Q%)	1	5	10	25	50
[m]	2.7	2.45	2.05	1.8	1.5
- / -	1.95	1.75	1.5	1.25	0.92
- / -	2.65	2.4	2.3	2.2	1.9

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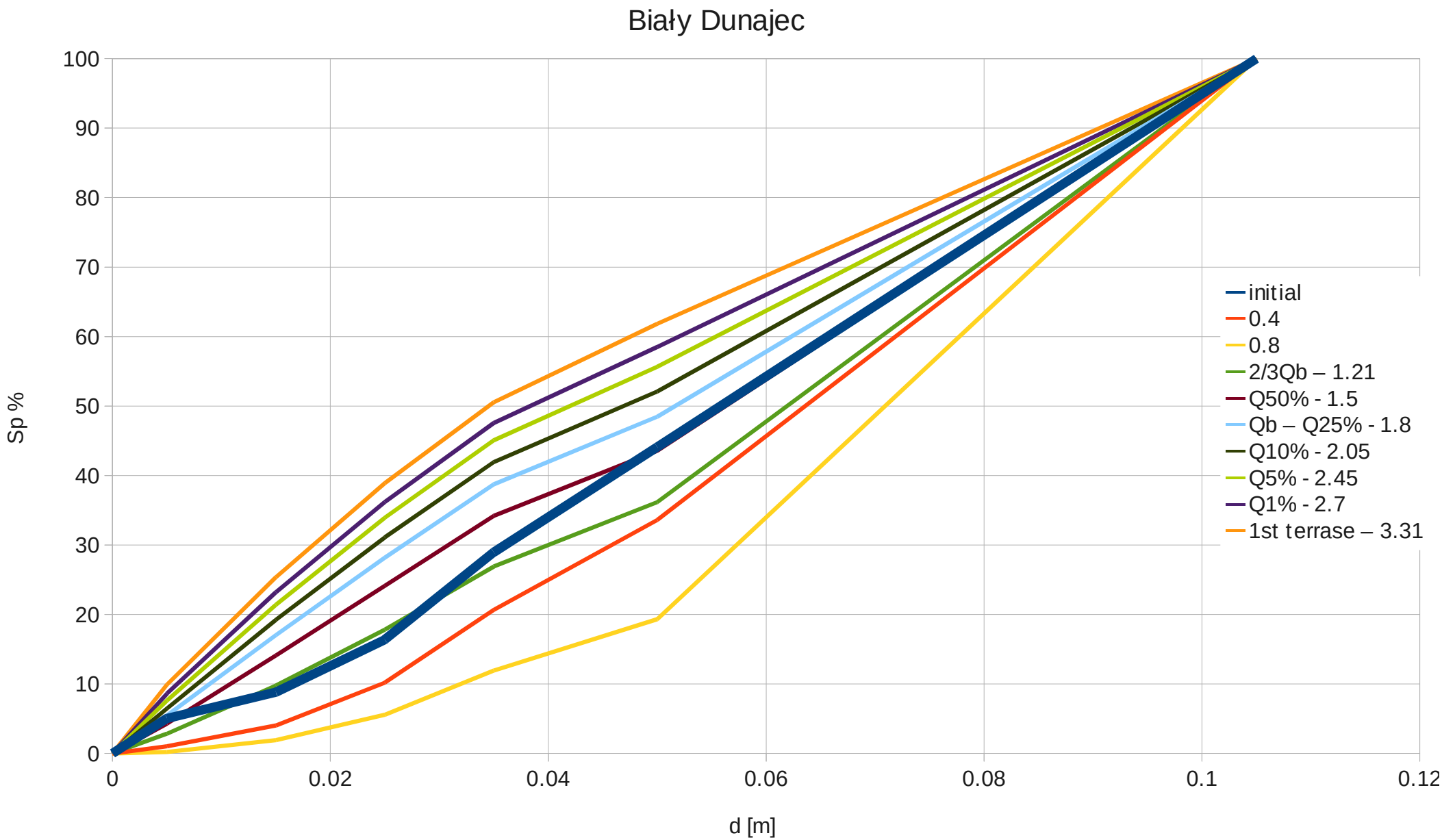

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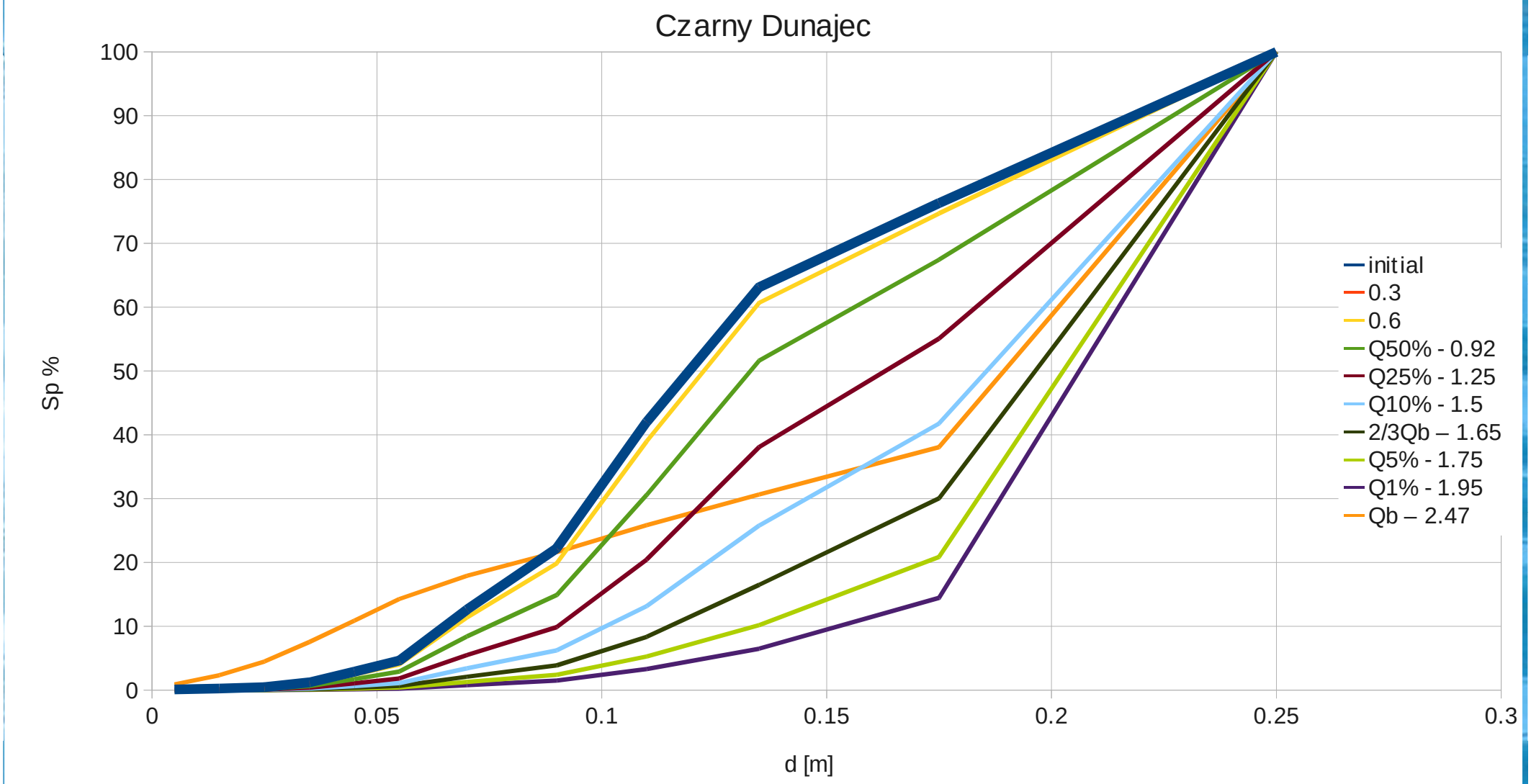

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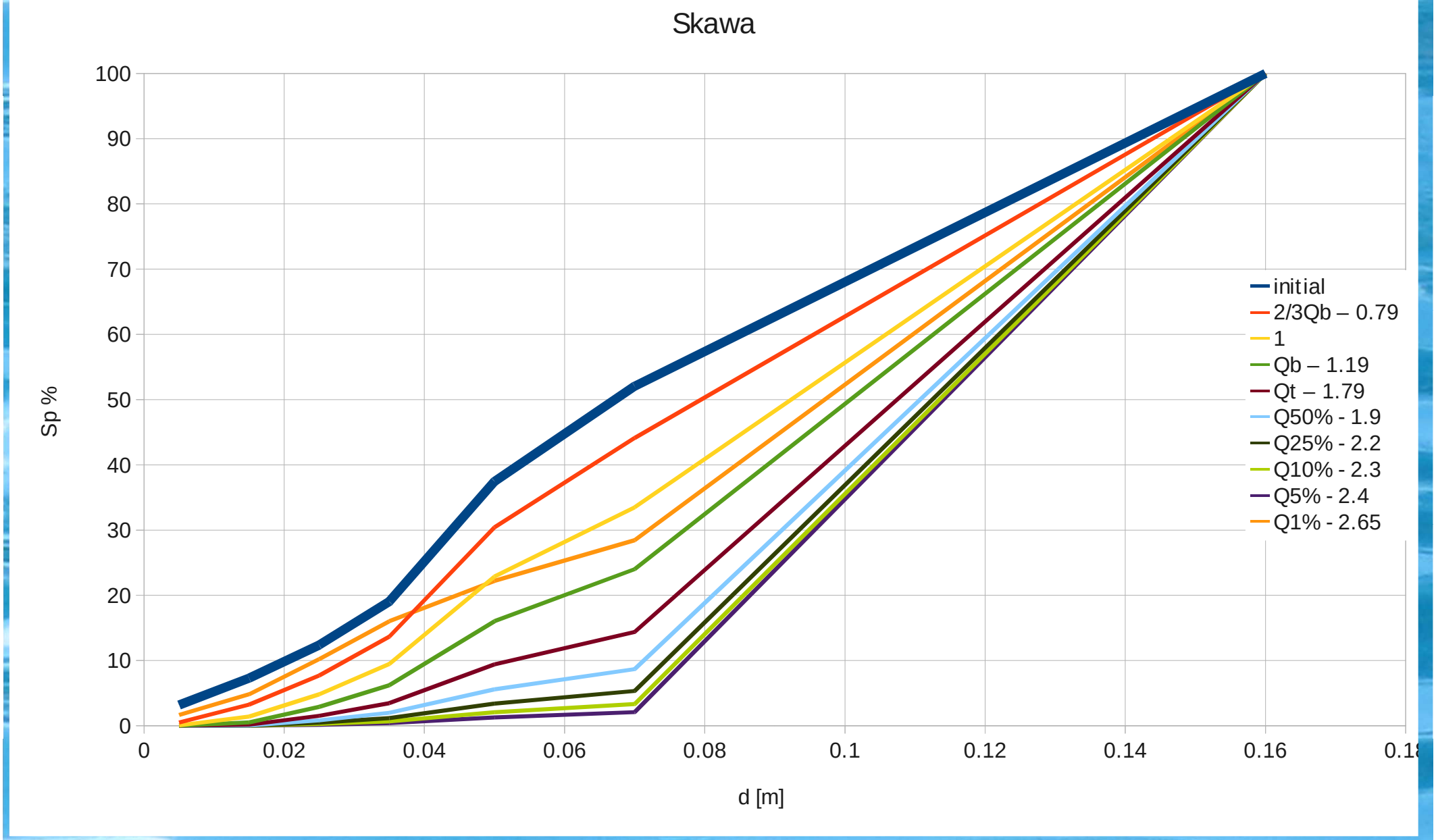

Bed stability as parameter describing the hydro-morphological balance of mountain river

Conclusions:

channel capacity:
- Biały Dunajec – bankfull discharge is equal to Q50%,
- Czarny Dunajec – bankfull discharge is equal to Q5%, 2/3Qb = Q25%.
- Skawa – Q50% - floods terrace

- Biały Dunajec - bed cover is moved for discharge smaller then Q50%
- Czarny Dunajec and Skawa – very stable bed surface layer – Q1%

In Szaflary the Biały Dunajec seems to be morphologically active.
Bed erosion processes appear.

Czarny Dunajec in Chochołów is cut into bottom of the bed.
The bank erosion predominates.

Skawa River has very stable bed. Erosion processes are found occasionally
Bed is armored. River often floods it's valley.

Thank You