USING POINT CLOUDS FOR DETECTION OF CHANNEL BATHYMETRY BY REFRACTION CORRECTION

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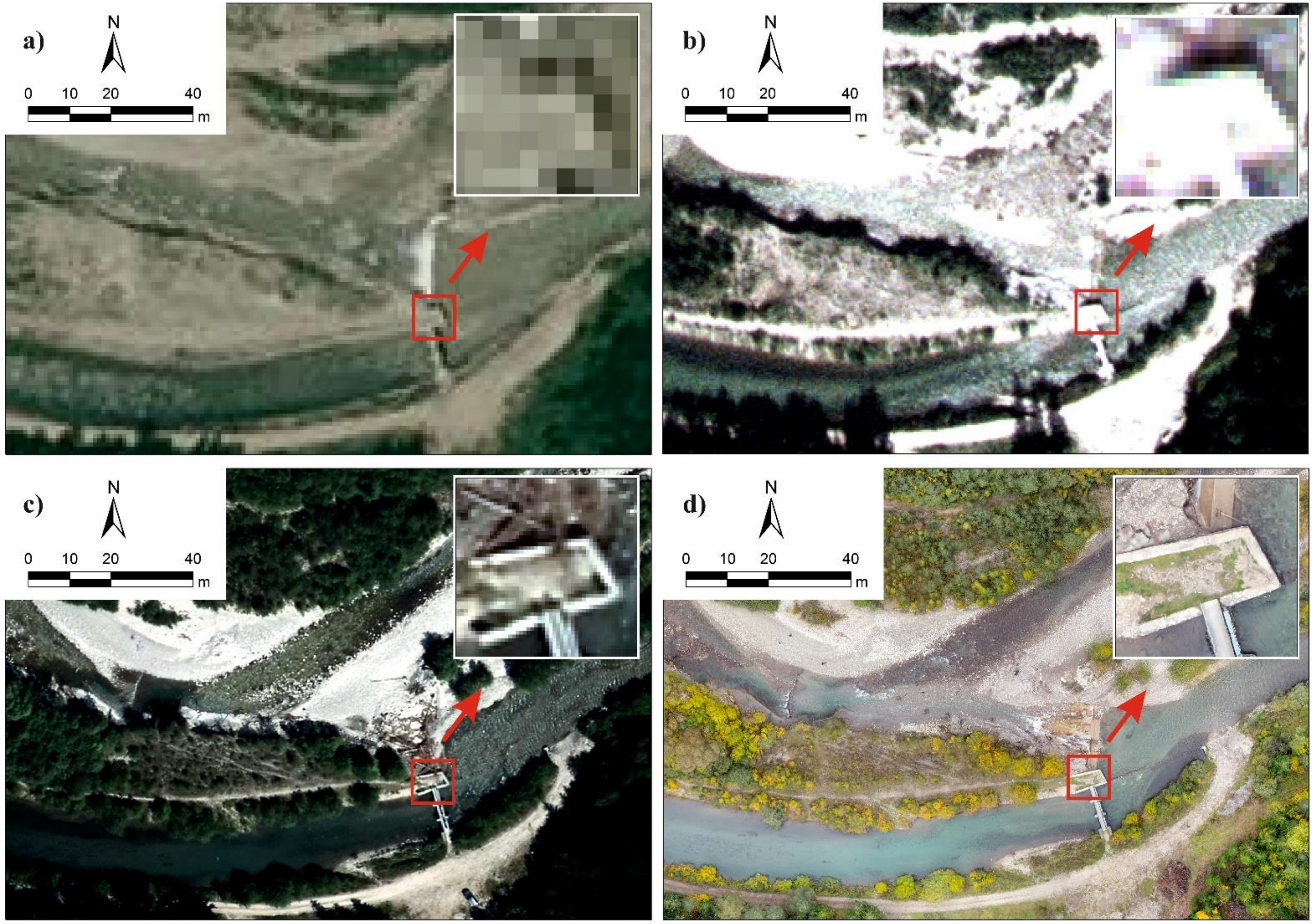
River channels are key elements for maintaining landscape

We need to know where what is: objects detection



UAV (UAS) at IG SAS

GEOGRAFICKÝ ČASOPIS / GEOGRAPHICAL JOURNAL 65 (2013) 3, 269-285

NÍZKONÁKLADOVÉ MIKRO-UAV TECHNOLÓGIE

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VYUŽITIE
A MA

BEZPILOTNÉ SYSTÉMY

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REGULAR PAPER

WILEY AREA

Monitoring of avulsion channel evolution and river morphology changes using UAV photogrammetry: Case study of the gravel bed Ondava River in Outer Western Carpathians

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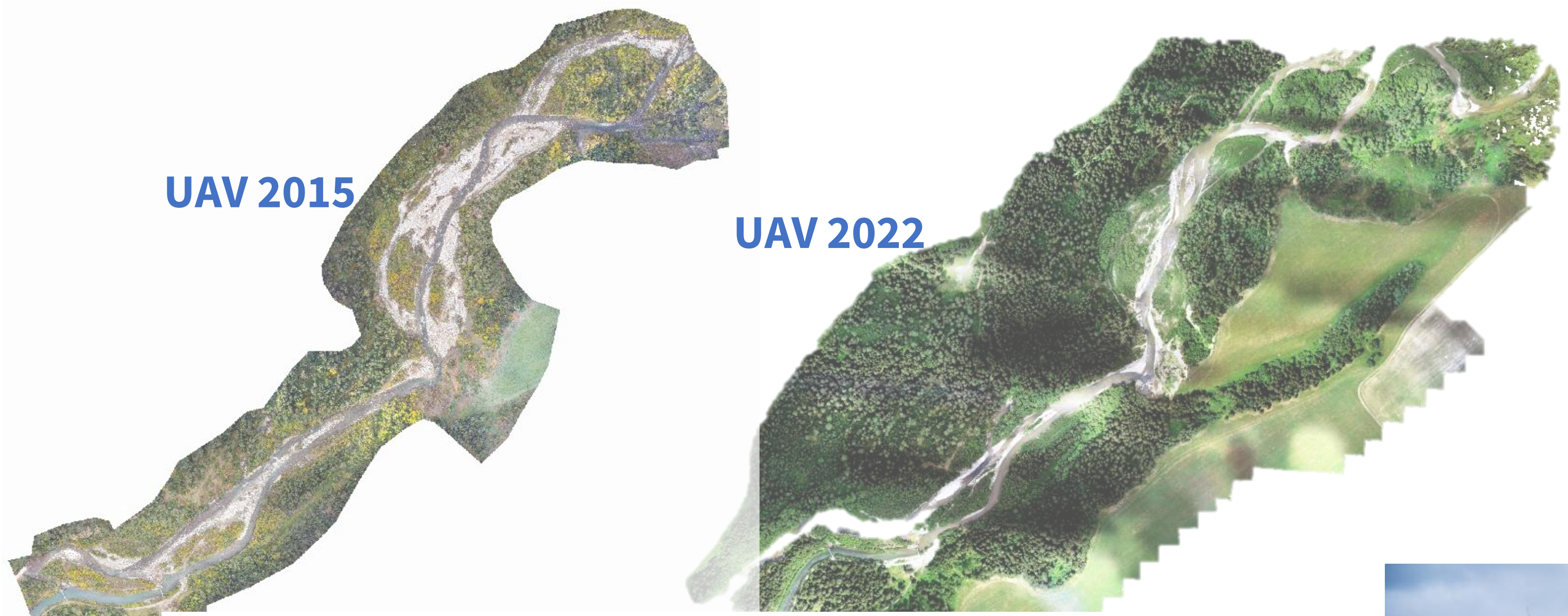
braided and wandering Belá River



Tab. 2. Basic parameters of UAV flights

Year	Date	No. images	Camera	AGL [m]	GSD [cm/px]	No. GCP	No. CP
2015	22 Oct.	1866	SONY NEX 6 (16–50 mm)	80, 50, 20	2.38	20	18
2022	30 June	2333	FC6310 (8.8mm)	112, 70	3.07	14	22

Validation

Discharge: 3,2 (m^3/s)

field sampling 2015: 184 bodov

field sampling 2022: 204 bodov

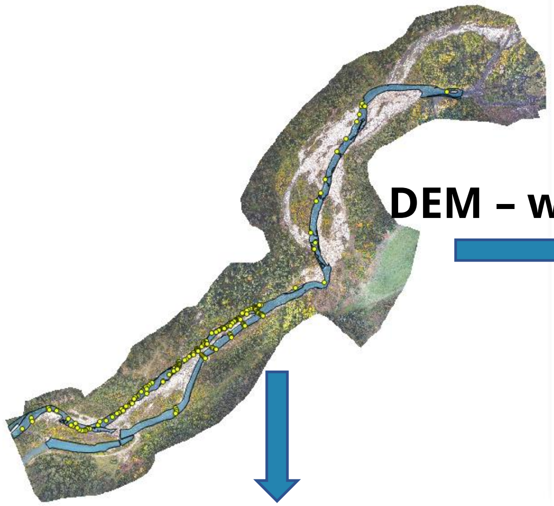
70% model

30% validation

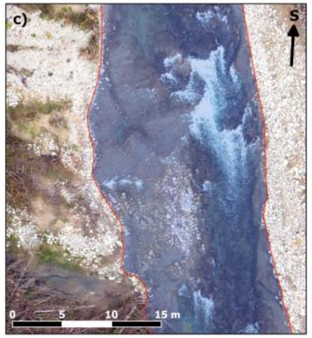
Model design:

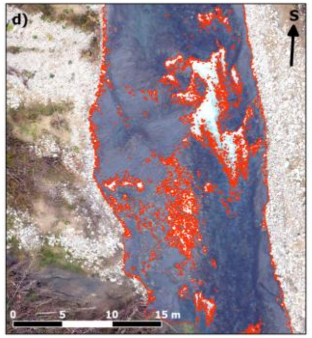
1) RGB images + field sampling
   - simple linear regression
   - multiple linear regression
2) SfM approach

UAV data processing



DEM – wet channel





PyBathySfM python script

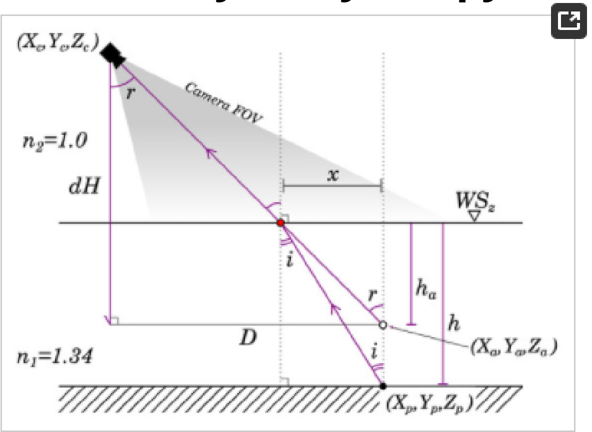
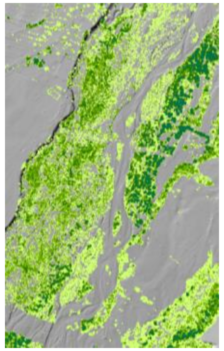


Figure 4. Diagram illustrating through water refraction geometry. Illustrating an off-nadir field of view (FOV) from the camera location (X_c, Y_c, Z_c) down to the water surface (WS_z). Point (X_a, Y_a, Z_a) is at the apparent depth (h_a) and represents the uncorrected SfM point cloud elevations. Point (X_p, Y_p, Z_p) is the "true" position as the "true" depth (h) that the refraction correction is solving. D is the point camera distance, dH is the elevation difference, r is the angle of refraction, i is the angle of incidence, x is the point/water interface distance, n_1 and n_2 are the refractive indicies of air and water. From [28], used with permission.

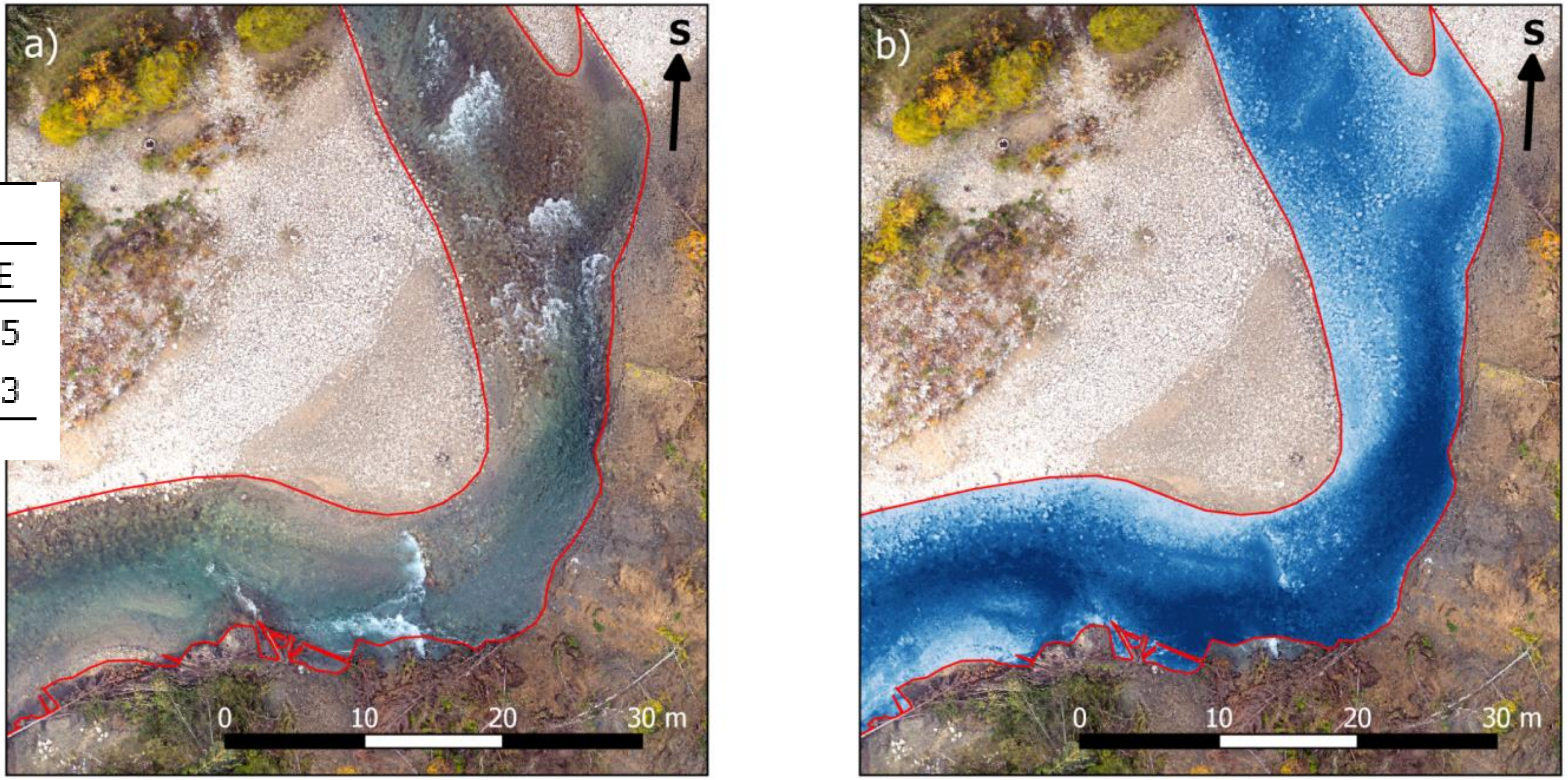
DEM - dry channel



Combined DEM

Channel bathymetry

Year	n	Depth error			
		ME	SDE	MAE	RMSE
2015	154	-0.0164	0.1289	0.1018	0.1295
2022	200	-0.0045	0.1115	0.0861	0.1113



Application

Application

$$\delta u = \sqrt{(\delta z_{post})^2 + (\delta z_{pre})^2}$$

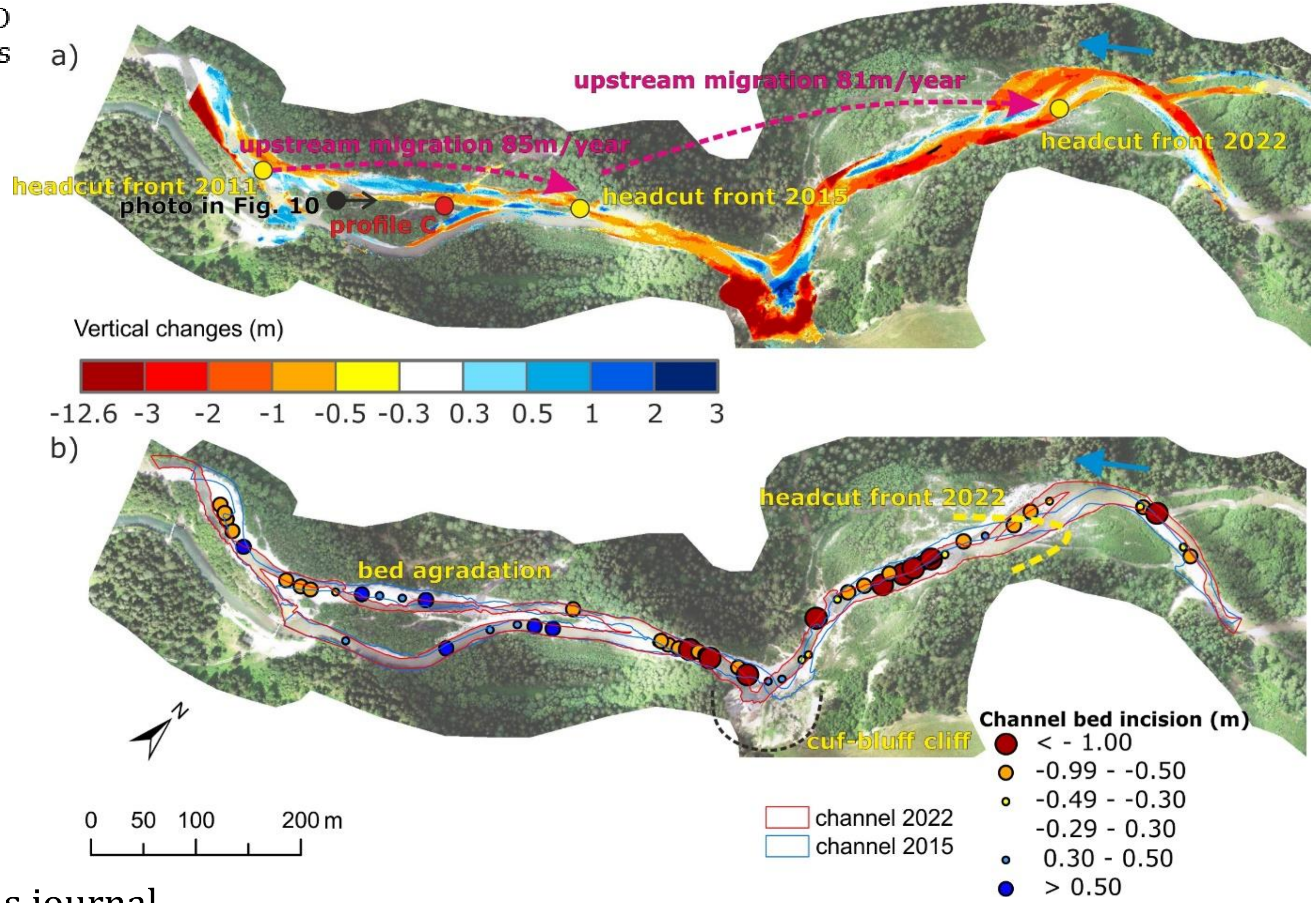
Tab. 5. Propagated uncertainties in Z dimension (m) calculated for DOD (δuDOD) and propagated uncertainties at 95% confidence intervals (δuDOD95%) for different sources of δu.

source of uncertainties	δu_{DOD}	$\delta u_{DOD}95\%$
dry-dry	0.0575	0.0946
dry-wet	0.1108	0.1823
wet-dry	0.1324	0.2177
wet-wet	0.1628	0.2678

Tab. 3. Volumetric changes in different zones of the Bela River channel with net volume and ED index (rate between eroded and deposited material) between UAV survey 2015 and 2022.

zone	description	volume (m³) eroded	deposited	net	ED	average bed elev. changes	process
A	*downstream channel*	-3,068	346	-2,722	-8.9	**-0.814[a]**	LA, I
B	*former main channel*	-2,446	885	-1,561	-2.8	-0.059	LA,GD
C	*supply channel*	-750	886	136	0.8	0.172	BAL
D	*channel under cut-bluff*	-1,363	11	-1,352	-119.4	**-0.645[a]**	I
E	*meander undercutting cut-bluff*	-4,203	891	-3,312	-4.7	-0.195	LA, GB
F	*upstream channel*	-15,378	1,159	-14,219	-13.3	**-0.582[a,b]**	LA, I, GB
G	*cut-bluff sediment input*	**input: 3,368 m³/year** (Rusnák et al., 2020)					

[a] higher than minLOD; [b] downstream half of the F zone reach -0.882 m with maximum -1.282 m; [c]process: lateral erosion (LA), incision (I), gravel deposition (GD), balanced reach (BAL)

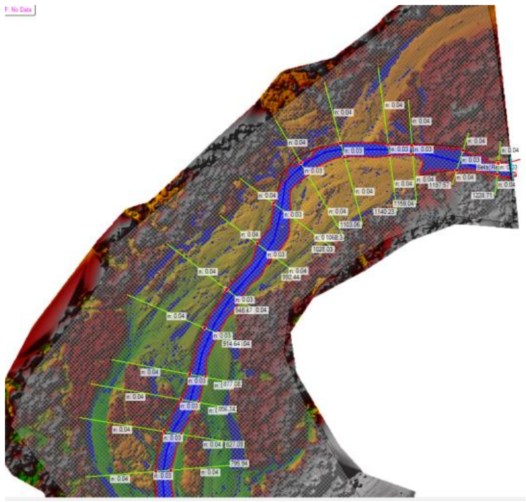


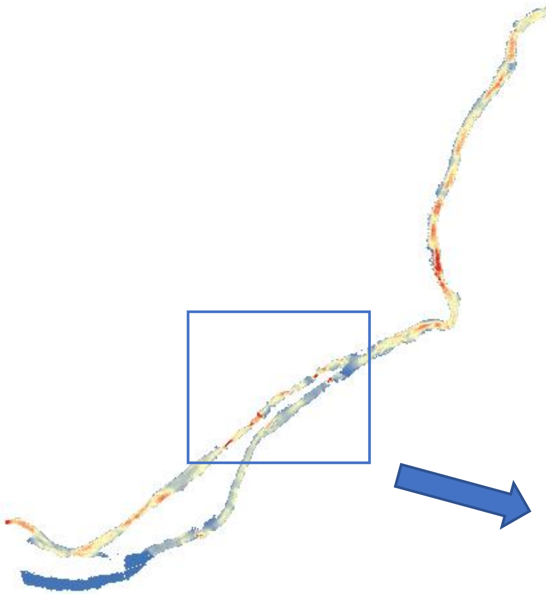
Rusnák et al. (2024) Earth Surface Processes and Landforms journal

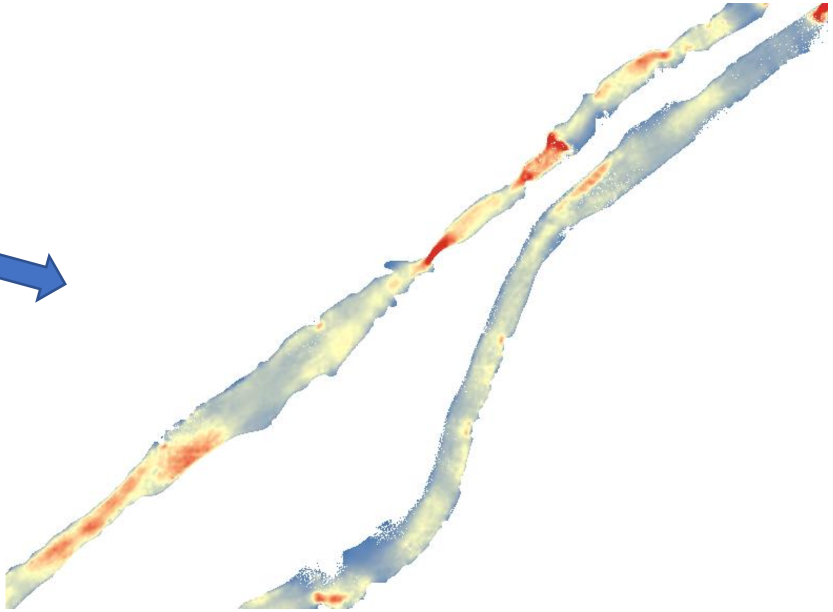
Application – habitat assessment

- velocity

- HecRAS modelling
- average discharge 5.6 $m^3.s^{-1}$
- calibration – channel extend

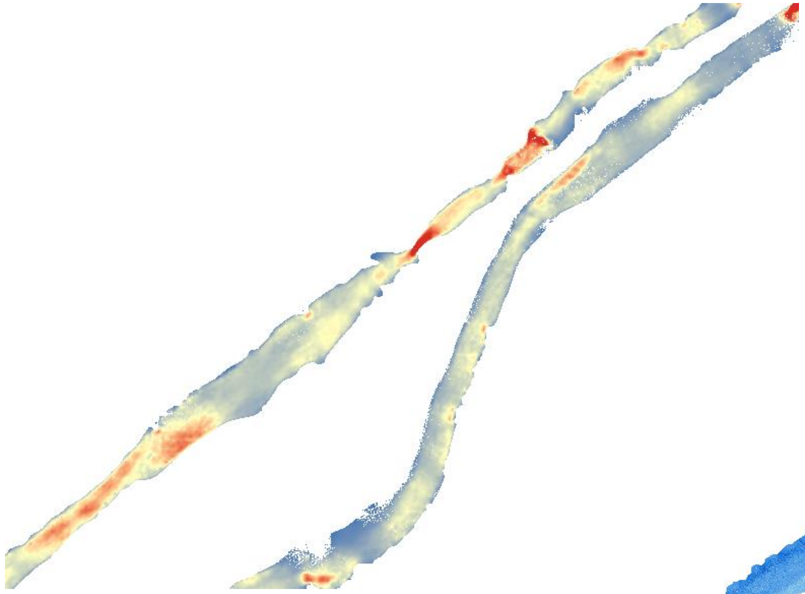


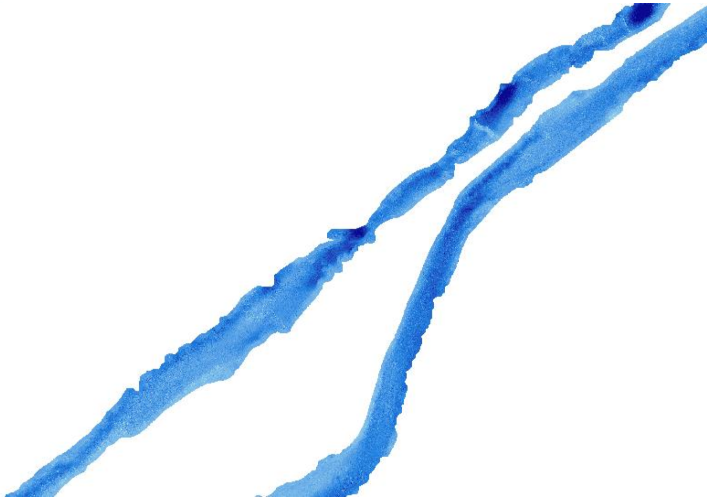




Application – habitat assessment

- Velocity + Bathymetry





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Are dynamic fluvial morphological unit assemblages statistically stationary through floods of less than ten times bankfull discharge?

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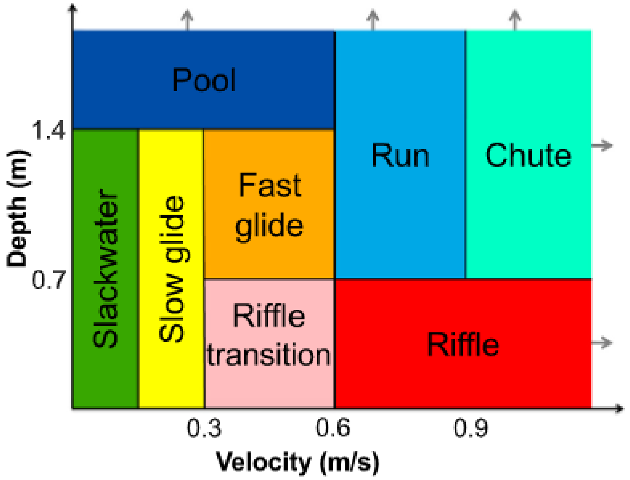
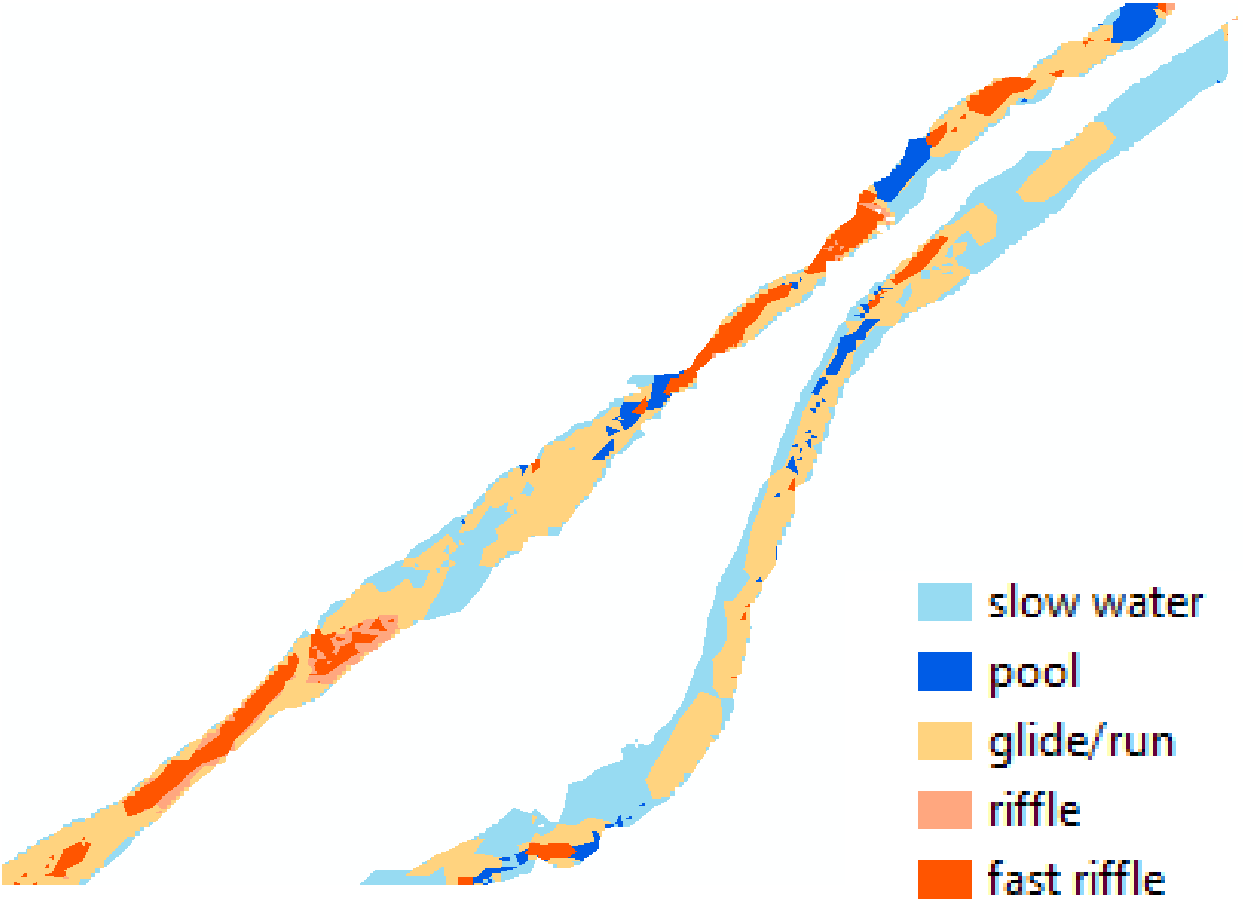
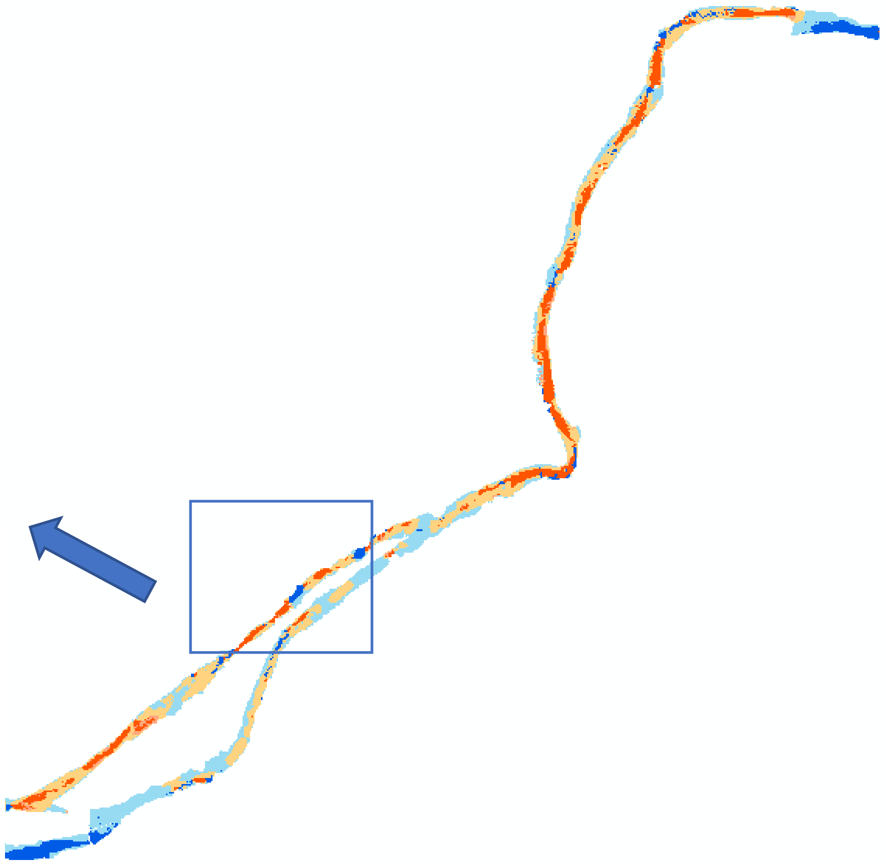


Application – habitat assessment





FUTURE PERSPECTIVE

- knowledge transfer between the technicians, river scientists and managers;
- technical availability of user-friendly methods and their routine application in river research;
- effectiveness of RS techniques for information mining;
- transfer of pixel data to processes-oriented information and the integration of quantitative and qualitative information;
- near real-time monitoring;
- data mining;
- open data repositories and policies.

a)

THANKS!

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