KONFERENCE GISÁČEK 2021

ÚSTAV GEOGRAFIE
Prírodovedecká fakulta UPJŠ v Košiciach

MODELOVANIE POVRCHU RIEČNEHO DNA POMOCOU BLÍZKEJ FOTOGRAMETRIE S POHĽADOM CEZ VODU

MGR. DANIELA LAUBERTOVÁ

VEDÚCI PRÁCE:
DOC. MGR. MICHAL GALLAY, PHD.

19.03. 2021

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MODELLING RIVER BED SURFACE USING THROUGH-WATER DIGITAL IMAGERY AND CLOSE-RANGE PHOTOGRAMMETRY

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THESIS SUPERVISOR:
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OBJECTIVES

- “THE MAIN OBJECTIVE IS TO GENERATE A DIGITAL MODEL OF A RIVER BED AND ITS ADJACENT LAND SURFACE USING CLOSE-RANGE PHOTOGRAMMETRY FROM AN UAV AND IMAGE MATCHING TECHNIQUES.
- THE QUALITY OF THE MODEL WILL BE ASSESSED BASED ON GNSS AND LEVELLING TECHNIQUES.
- THE CASE STUDY WILL BE ELABORATED USING THE DATA FROM THE UPPER PART OF THE JIZERA RIVER OF THE CZECH-POLISH BORDER.“

METHODS USED FOR BATHYMETRIC SURVEYS

- GROUND-BASED SURVEYING
- WATER-BORNE MAPPING
- AIRBORNE LASER BATHYMETRY
- SPECTRAL REGRESSION
- AIRBORNE THROUGH-WATER CLOSE-RANGE PHOTOGRAMMETRY

RESEARCH BACKGROUND

REFRACTION CORRECTION

- REFRACTION CORRECTION
  - ROBUST APPROACH
    - WIMMER (2016)
    - DIETRICH (2017)
  - SIMPLIFIED APPROACH
    - WOODGET ET AL. (2015)

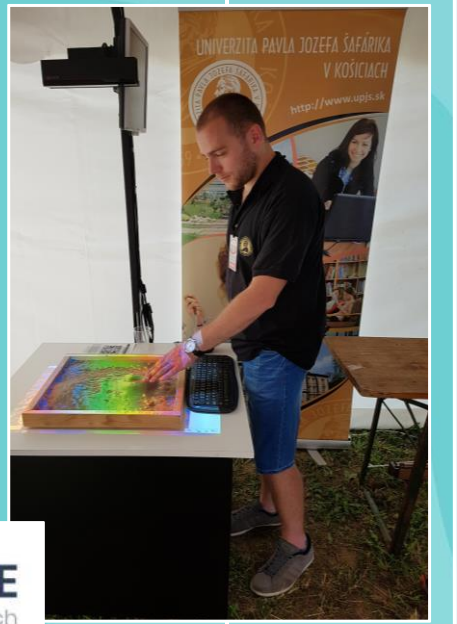
THE MAIN BARRIER TO ACCURATE BATHYMETRIC MAPPING WITH ANY PHOTOGRAMMETRIC TECHNIQUE (AND ALSO WITH ALB SYSTEMS) IS CORRECTING FOR THE REFRACTION OF LIGHT AS IT PASSES BETWEEN TWO DIFFERENT MEDIA (AIR AND WATER INTERFACE).

REFRACTION OF LIGHT CAUSES WATER DEPTHS TO APPEAR SHALLOWER THAN THEY ARE.

SNELL'S LAW $h = 1.34 \times h_A$

INSTITUTE OF GEOGRAPHY, FACULTY OF SCIENCE, PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE

SLOVAK RESEARCH TEAM



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DOC. RNDR. JÁN
KAŇUK, PHD.

DOC. MGR. MICHAL
GALLAY, PHD.

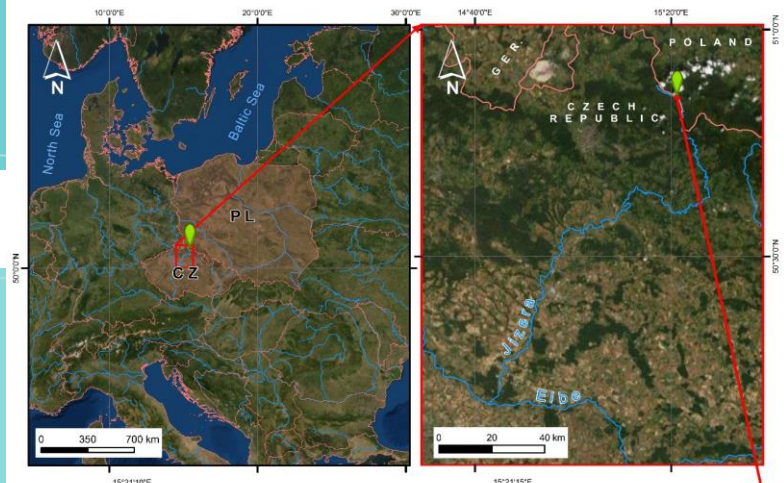
MGR. JÁN
ŠAŠAK

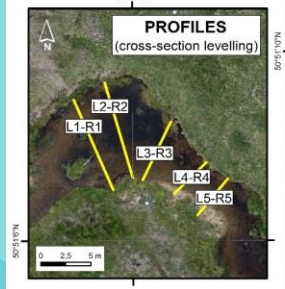
STUDY AREA

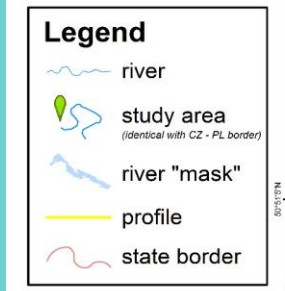
JIZERA RIVER

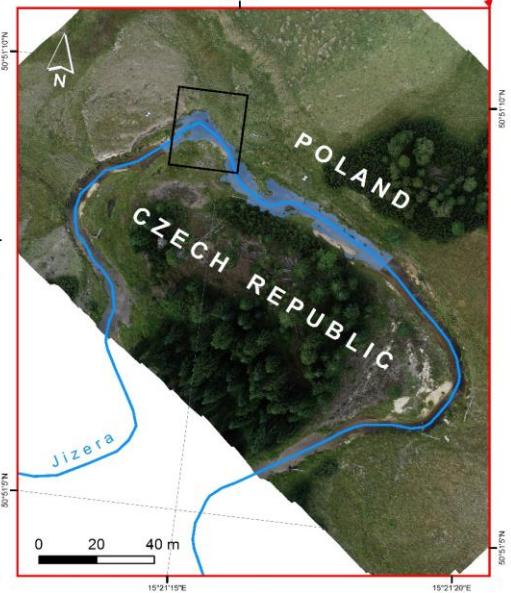
50°51'05.5"N 15°21'12.3"E
50.851516, 15.353411

SMALL UPPER PART OF THE JIZERA RIVER









OPTIMAL SITE CONDITIONS:

- ✓ CLEAR & SHALLOW WATER
- ✓ MINIMAL SURFACE WAVES
- ✓ SLOW WATER FLOW
- ✓ OPTIMAL WEATHER CONDITIONS

THE MAPPED PART OF THE JIZERA RIVER WAS SELECTED BY THE POLISH TEAM FROM UNIVERSITY OF WROCLAW AS A SUITABLE RIVER CHANNEL WITH SLOW WATER FLOW AND CLEAN WATER PROVIDING **FAVOURABLE CONDITIONS TO TEST THE CAPABILITIES OF THE UAV TWO-MEDIA PHOTOGRAMMETRY.**

DATA & DATA ACQUISITION

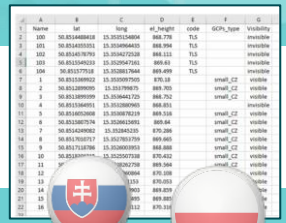
246 UAV IMAGERY – DJI PHANTOM 4 PRO

images	flight duration	resolution	flying altitude *	above-ground height**
165	14:12-14:18	1 cm	±769 m a.s.l	32.5 m
57	14:19-14:23	2 cm	±806 m a.s.l	69.3 m
24	14:24-14:27	3 cm	±842 m a.s.l	108 m

* EXIF

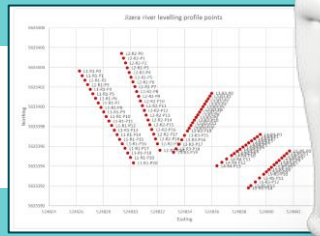
** Agisoft Metashape Professional - report

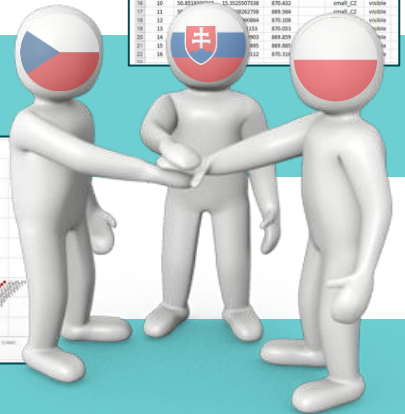
21 COORDINATES OF GROUND CONTROL POINTS



5 PROFILES

91 REFERENCE LEVELLING DATA





DATA PROCESSING

Metashape

1

SFM DATA PROCESSING
IN AGISOFT METASHAPE PROFESSIONAL

2

WATER SURFACE MODELLING

3

REFRACTION CORRECTION

4

GENERATING FINAL DEM OF RIVER BED AND RIVER SURROUNDINGS

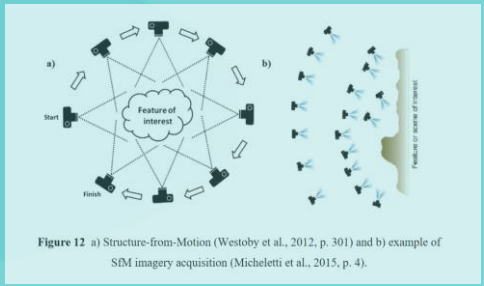


Figure 12 a) Structure-from-Motion (Westoby et al., 2012, p. 301) and b) example of SfM imagery acquisition (Micheletti et al., 2015, p. 4).

DATA PROCESSING

START

1 SFM DATA PROCESSING

AGISOFT METASHAPE PROFESSIONAL

- ADDING PHOTOS
- IMAGE QUALITY CONTROL
- ALIGNING PHOTOS
- GEOREF. POINT CLOUD
- BUILDING DENSE POINT CLOUD
- BUILDING MESH
- BUILDING TEXTURE
- GENERATING PRODUCTS
- ORTHO-MOSAIC
- DEM

2 WATER SURFACE MODELLING

ARCGIS 10.2.2.

- WATER MASK (POLYGON)
- POINT LAYER (5 CM BUFFER)
- GLOBAL POLYNOMIAL INTERPOLATION
- WATER SURFACE MODEL

3 REFRACTION CORRECTION

RASTER CALCULATOR

DEM_RIVER_BOTTOM_CORRECTED =
1.34* DEM_RIVER_BOTTOM _UNCORRECTED
-0.34* DEM_WATER_SURFACE

4 GENERATING FINAL DEM OF RIVER BED AND RIVER SURROUNDINGS

MOSAIC TO NEW RASTER

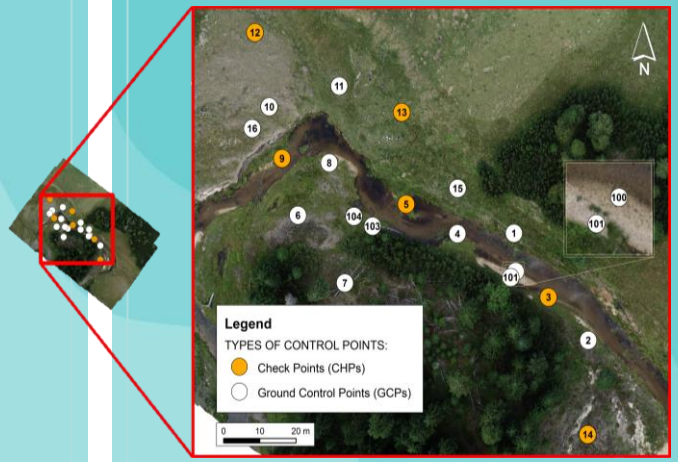
FINISH

ORIGINAL DEMS WERE REPLACED WITH ELEVATION CORRECTED FOR WATER REFRACTION USING THE WATER MASK AND THE DERIVED DEMS OF THE RIVER BED.

GEOREFERENCING ACCURACY OF RESULTING POINT CLOUDS

RESULTS

RESOLUTION	1 CM	2 CM	3 CM
GCP (LARGEST)			

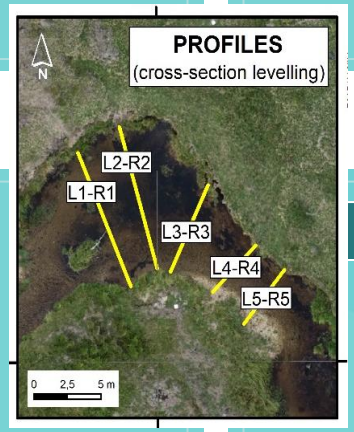


TOTAL VALUES OF VERTICAL AND HORIZONTAL ERRORS ON GROUND CONTROL POINTS USED FOR GEOREFERENCING AND INDEPENDENT CHECK POINTS FOR VALIDATION OF THE GEOREFERENCING:

Cameras	Number of points in a PC		Total error			
	Sparse point cloud	Dense point cloud	Vertical Error [m]		Horizontal Error [pix]	
			Control points		Check points	
165	154,282	103,625,733	0.042	0.227	0.044	0.218
57	56,254	45,202,427	0.043	0.271	0.044	0.261
24	27,840	26,619,921	0.040	0.265	0.045	0.257

COMPARISON OF THE SFM RIVER BED MODEL WITH THE LEVELLING DATA

RESULTS



OVERALL ERROR STATISTICS BEFORE AND AFTER CORRECTING DEM ELEVATIONS:

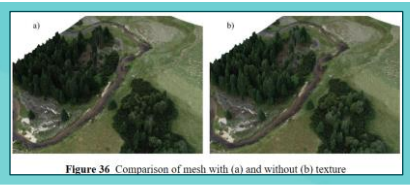
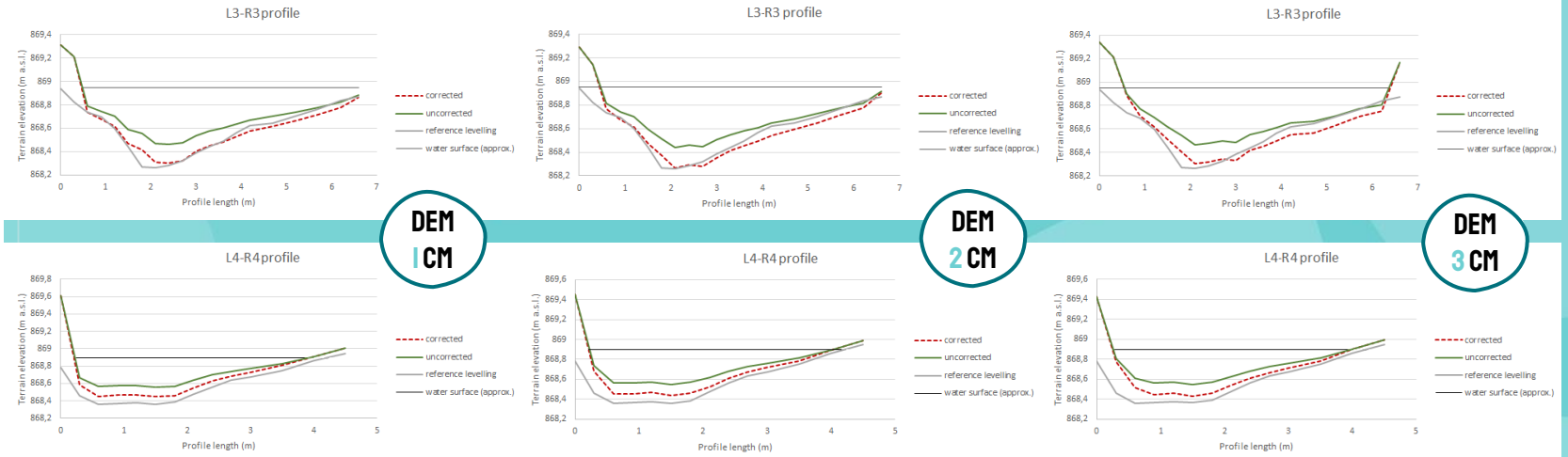


Figure 36 Comparison of mesh with (a) and without (b) texture

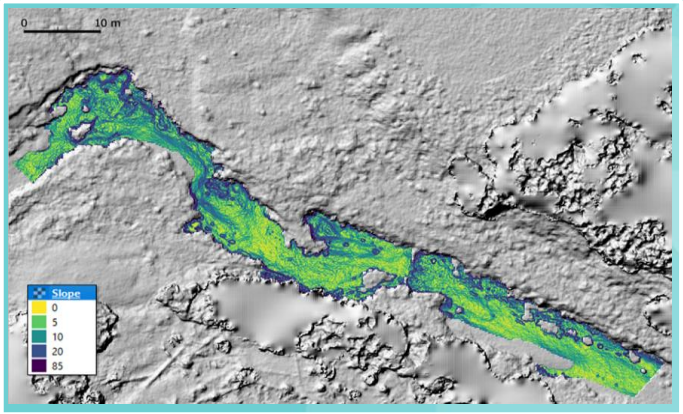
DEM resolution	COUNT REF POINTS	MIN	MAX	MEDIAN	MEAN	MEAN_ABS	STDEV	RMSE
diff_DEM1cm	91	-0,028	0,824	0,167	0,171	0,172	0,120	0,209
diff_DEM2cm	91	-0,034	0,672	0,172	0,168	0,170	0,121	0,207
diff_DEM3cm	91	-0,035	0,647	0,180	0,184	0,186	0,124	0,222
diff_DEM1cm_COR	91	-0,059	0,824	0,064	0,076	0,083	0,107	0,131
diff_DEM2cm_COR	91	-0,079	0,672	0,053	0,071	0,070	0,116	0,136
diff_DEM3cm_COR	91	-0,085	0,647	0,065	0,090	0,094	0,120	0,154

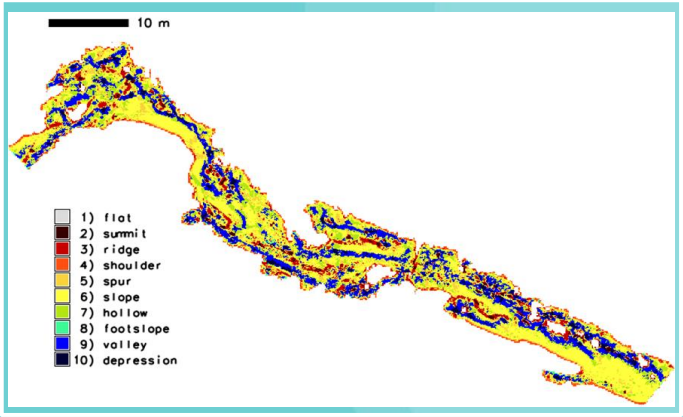
EFFECTS OF REFRACTION CORRECTION ON CHANNEL BED ELEVATIONS:

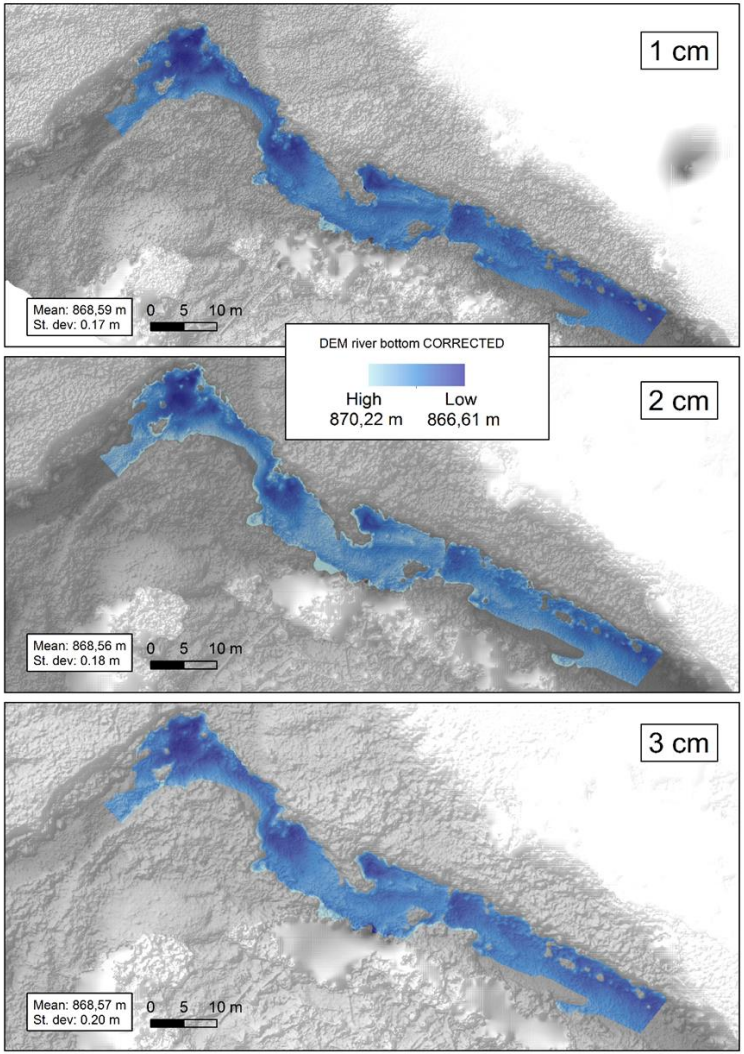


RIVER BED MORPHOLOGY

RESULTS







CONCLUSIONS

STRUCTURE-FROM-MOTION HAS THE POTENTIAL TO BE A POWERFUL AND INEXPENSIVE TOOL FOR FLUVIAL REMOTE SENSING.

FLYING HEIGHTS OF IMAGERY ACQUISITION HAVE AN EFFECT ON THE DIGITAL ELEVATION MODEL QUALITY.

THE GENERATED DEMS PROVIDE HIGHLY DETAILED REPRESENTATION OF THE RIVER BED MORPHOLOGY.

FUTURE RESEARCH: E.G., WHAT RESULTS THE APPLIED METHOD WOULD ACHIEVE ON DIFFERENT TYPES OF OTHER CLEAR WATER BODIES OR WHAT RESULTS WOULD BE ACHIEVED IF THE ROBUST METHOD FOR REFRACTION WAS USED ON OUR DATA.

GISáček 2021
Studentská soutěžní konference

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ĎAKUJEM ZA POZORNOSŤ!

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