EGU General Assembly 2022

ÖSTERREICHISCHE BUNDESFORSTE

universität wien
Institut für Geographie und Regionalforschung

ENGAGE
Geomorphological Systems & Risk Research

Mapping, monitoring and modelling past, present and potential future channel changes in an Alpine River system in Austria

Jakob Pamminger and Ronald Pöppl

Introduction

- In the administrative area of the Austrian Federal Forests on the Salza River in Styria, Austria a large flooding event in 2014 caused a prominent bank erosion hotspot.

- The uncertain further development of the erosion hotspot resulted in a cooperation between the Austrian Federal Forests and the Department of Geography and Regional Research, University of Vienna to monitor the hotspot as well as analyze the study area.

- The need to study this hotspot as well as other hydro-geomorphic changes in the study area and also river systems in Austria in general, can be seen by examining the scientific predictions regarding the effects of climate change on European rivers.
  - *"By the middle of the 21st century, runoff from many European rivers increases by more than 20%". (WETHERALD et al. 2002: ACL7-14)*
  - *(BLÖSCHL et al. 2019: 2) found a 0-5% increase in the "Change in mean annual flood discharge per decade" from 1960 - 2010 for central and western Austria.*

- The research gap and objective was to locate, map and quantify past and current hydro-geomorphic changes as well as assess the potential future hydro-geomorphic changes by modelling the River course for the timeframe 2019 - 2050 using four different discharge scenarios and the software CAESAR-Lisflood.

Study area

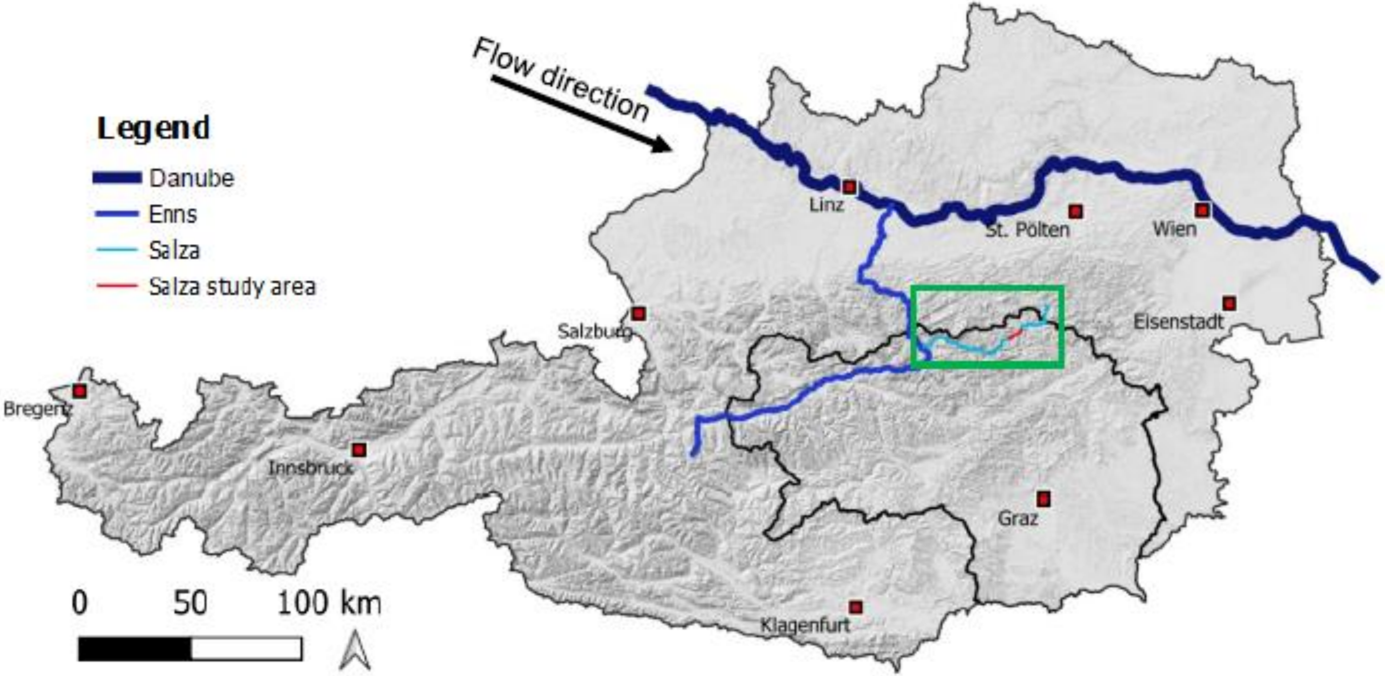


Figure 2: Location of the Salza River study area (red line) in Austria in relation to its overriding larger rivers (adapted Basemap: basemap.at [1]).

Study area

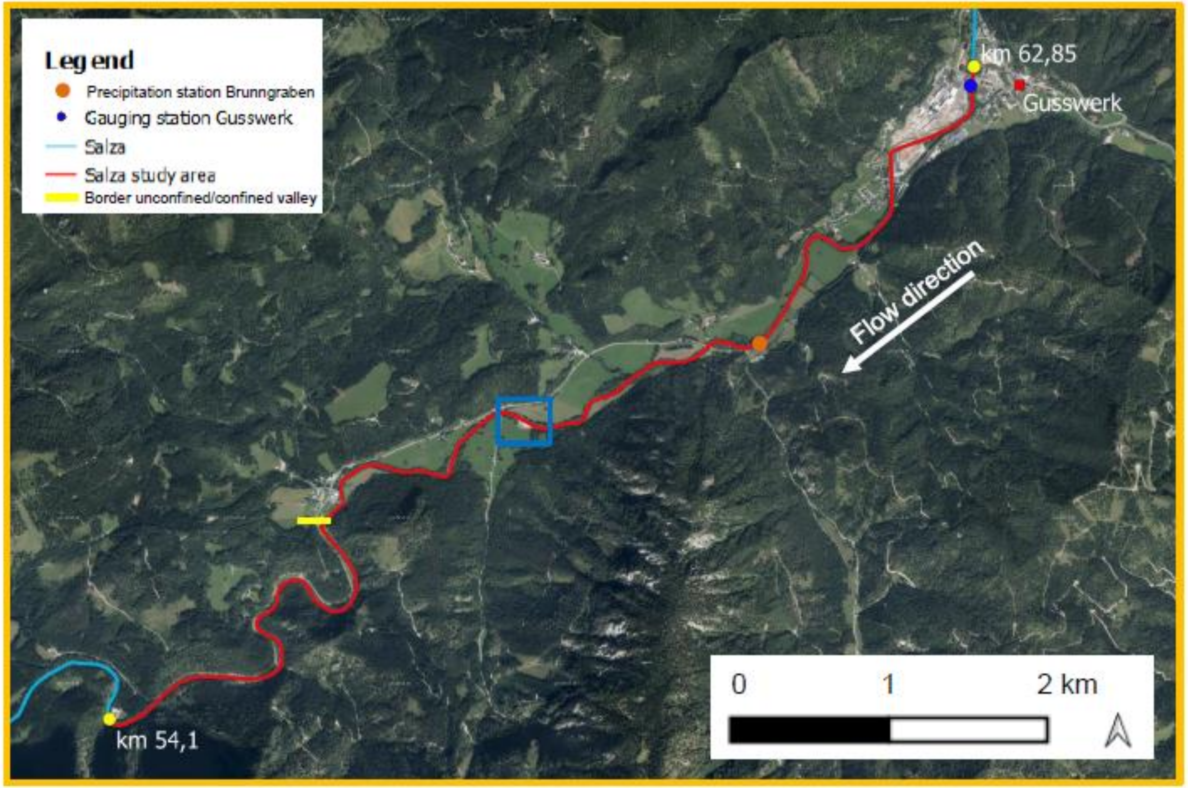


Figure 4: Closeup of the Salza River study area (red line) (adapted Basemap: basemap.at [1]).

Study area

Figure 6: On the left: orthophoto (2011 - 2013) of the hotspot before the flooding event (SteiermarkGIS [4]). On the right: orthophoto (2013 - 2015) of the hotspot after the flooding event (SteiermarkGIS [4]).

ÖSTERREICHISCHE BUNDESFORSTE

universität wien
Institut für Geographie und Regionalforschung

State of the art

Methods

- **Reconstruction** of past hydro-geomorphic changes of the Salza River
  - Descriptive Analysis (as used by ZLINSZKY et al. 2013 and FUCHS et al. 2015)
  - Sinuosity Index (as used by KALANTAR et al. 2020, GARCÍA et al. 2019, KAR et al. 2020 and MOMIN et al. 2020.
- **Mapping** of in and out-of-channel geomorphic units
  - Mapping framework (WHEATON et al. 2013)
- **Monitoring** of the erosion hotspot
  - Erosion Pins (LAWLER 1992: 784)
  - Photogrammetry (LAWLER 1992: 784)
- **Modelling** of future hydro-geomorphic changes of the Salza River
  - Riverbed grain size approximation (FEHR 1987: 1109)
  - Using CAESAR-Lisflood (COULTHARD et al. 2013: 1897)
    - Data preparation
    - Parametrization (pre-modelling)
    - Final modelling

ÖSTERREICHISCHE BUNDESFORSTE

universität wien
Institut für Geographie und Regionalforschung

Results

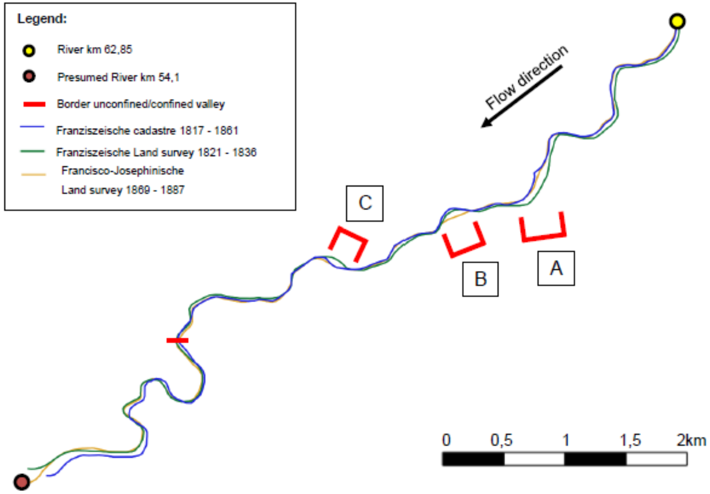


Figure 96: Overlapping the thalwegs of the three historic maps of the Salza River study area.

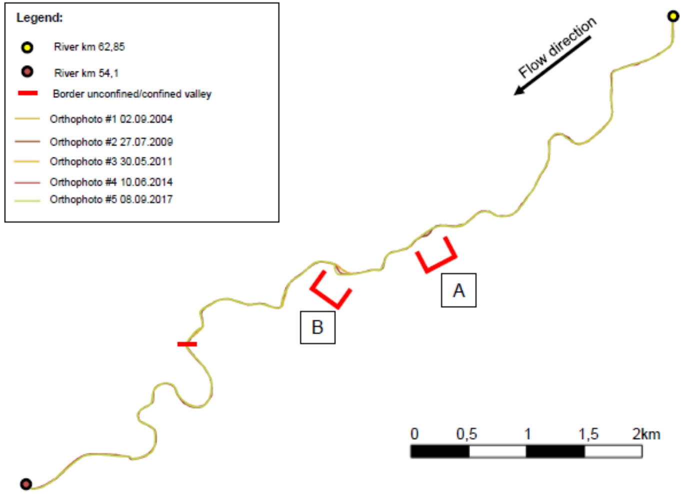


Figure 98: Overlapping the thalwegs of the orthophotos of the Salza River study area.

Results

Figure 100: Changes of the erosion hotspot in all orthophotos of the Salza River study area.

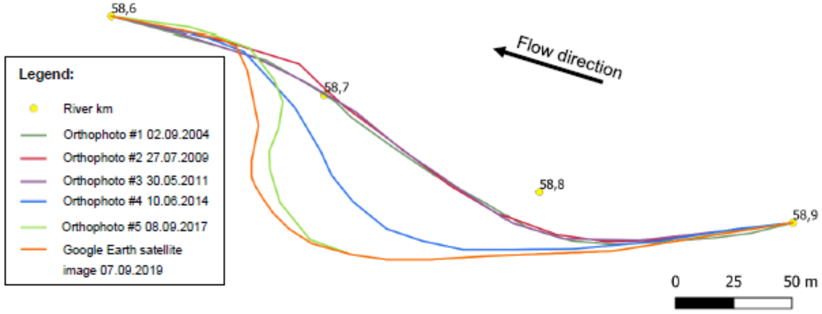


Figure 99: Overlapping the thalwegs of the orthophotos of the erosion hotspot in the Salza River study area.

Table 14: Changes in Riverbed displacement at the erosion hotspot in the Salza River study area.

orthophoto	Scan flight date	Riverbed displacement of left bank (m)	Σ Riverbed displacement of left bank (m)
#1	02.09.2004	0	-
#2	27.07.2009	0	-
#3	30.05.2011	0	-
#4	10.06.2014	26.78	26.78
#5	08.09.2017	19.08	45.86
#6	07.09.2019	5.55	51.41

ÖSTERREICHISCHE BUNDESFORSTE

universität wien
Institut für Geographie und Regionalforschung

Results

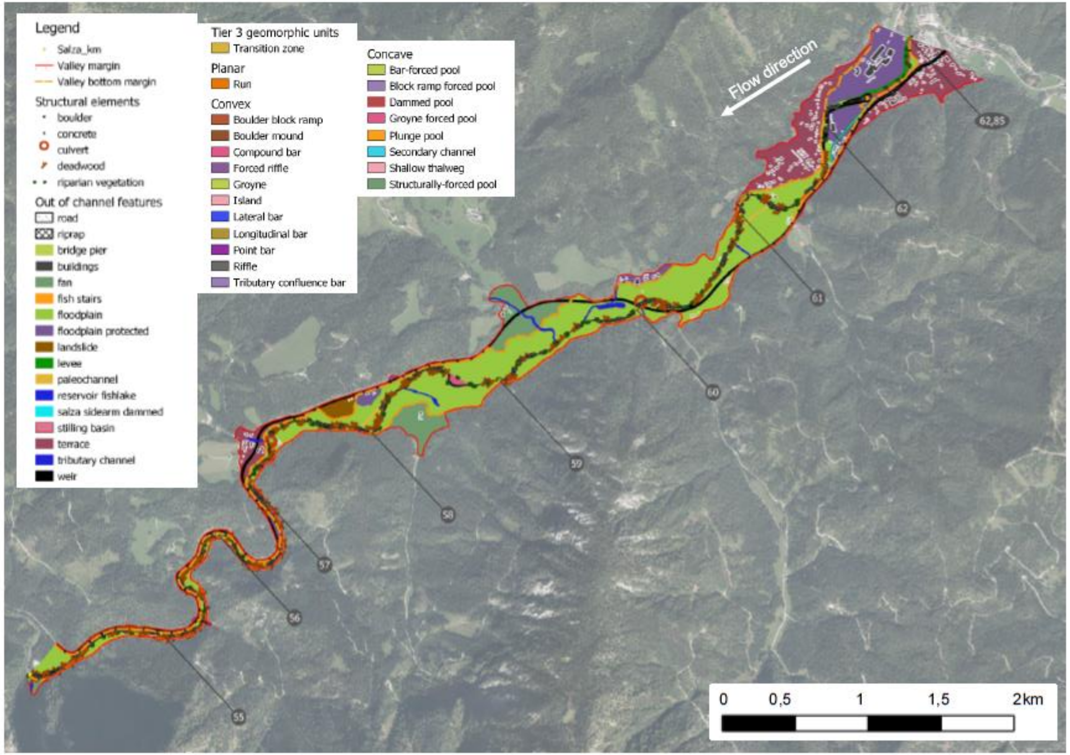


Figure 109: Mapped Tier 3 geomorphic units for the whole Salza River study area.

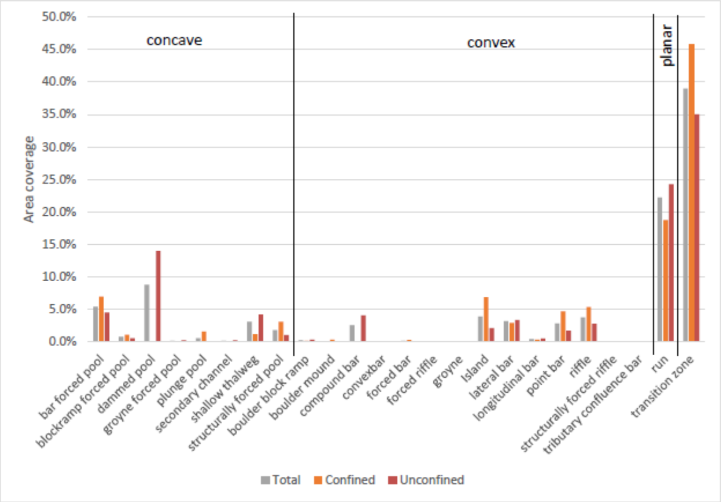


Figure 113: Area coverage of Tier 3 geomorphic units in the total, confined and unconfined Salza River study area.

Results

Figure 119: Set up of erosion pin method 2 at the erosion hotspot in the Salza River study area.

Table 24: Measurements for the second erosion pin method.

Pin	Meter	Distance pin to bank edge (cm) #1-15.06.2017	#2-11.07.2017	Difference #2 - #1 (cm)
1	0	284	281.5	-2.5
2	10	251.5	251.5	0
3	20	314.5	313.5	-1
4	30	332.5	320	-12.5
5	40	272	272	0
6	50	298.5	298	-0.5
7	60	337	337	0
8	70	272	271	-1
9	80	323	320.5	-2.5
10	90	328	327.5	-0.5
11	100	273	274	1
12	106.5	321	321	0

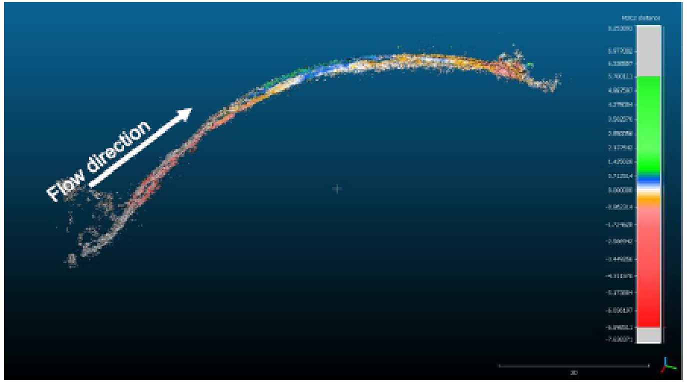


Figure 124: Comparison of any 2D changes (in metres) from cloud #1 to cloud #5.

Table 26: 2.5D volume changes and additional metrics of the computed point clouds of the erosion hotspot in the Salza River study area.

Cloud	Added volume (m^3)	Removed volume (m^3)	Volume change (m^3)	Matching cells (%)	Non-matching cells (%) Ground	Ceiling	Average neighbour per cell
#2 with #1	+118	-295	-177	40.1	16.8	43.1	5,6/8
#3 with #2	+320	-337	-17	45.9	34.4	19.7	6/8
#4 with #3	+231	-325	-94	56	19.2	24.9	6/8
#5 with #4	+199	-250	-52	38.4	44.7	16.8	5,8/8
	Sum		-340				
#5 with #1	+115	-434	-319	47.3	33.0	19.7	5,9/8

Results

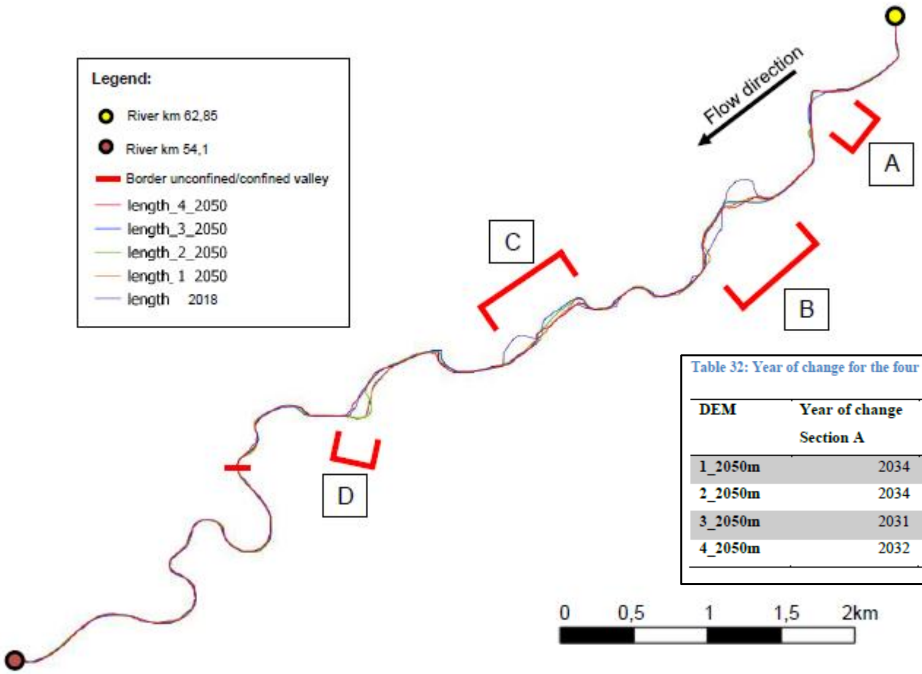


Table 32: Year of change for the four main sections marked in Figure 135.

DEM	Year of change Section A	Year of change Section B	Year of change Section C	Year of change Section D
1_2050m	2034	2043	2024	-
2_2050m	2034	2041	2031	-
3_2050m	2031	2031	2029	2041
4_2050m	2032	2044	2028	2033

Figure 135: Overlapping the thalweg of the pre-modelled 2018 DEM as well as all four 2050 DEMs for the four different discharge scenarios of the Salza River study area.

Results

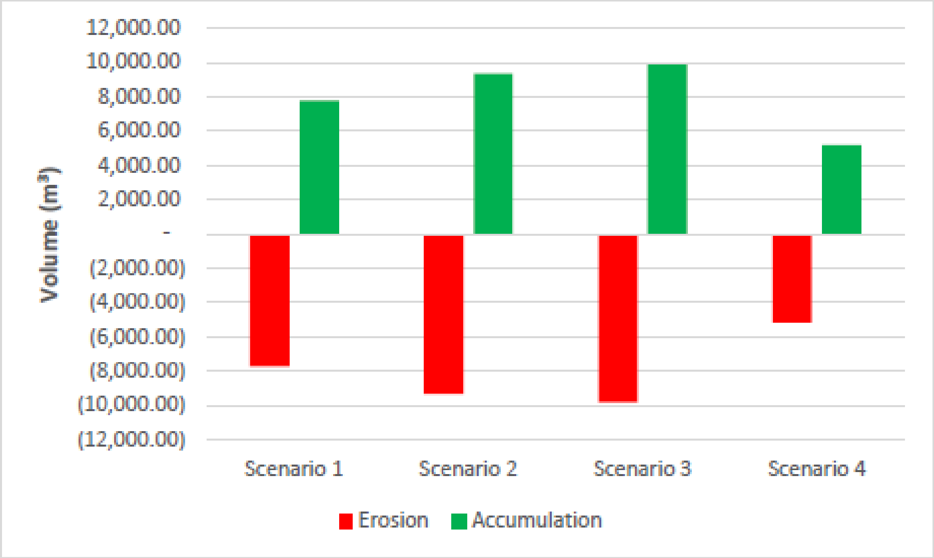


Figure 143: Total erosion and accumulation volumes for all four discharge scenarios for the timeframe 2019 - 2050.

Conclusion

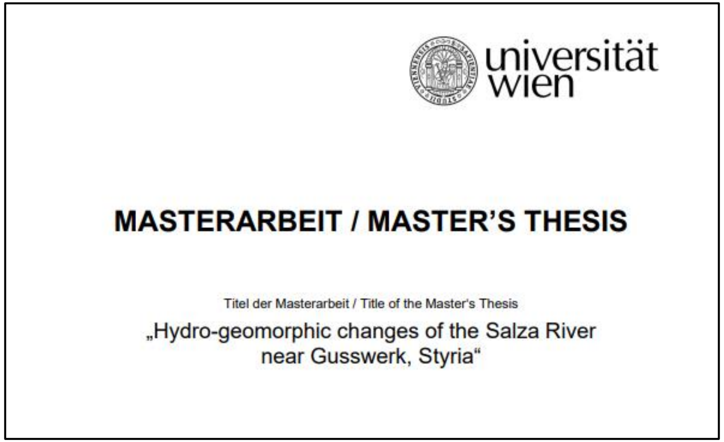
- The Salza River underwent numerous hydro-geomorphic changes in the past, the erosion hotspot being the largest change.
- Mapping the Salza River has shown, it consists mainly of transition zones followed by planar, concave and convex features.
- Erosion pins showed a mean lateral change of -1.63 cm for the one-month timeframe between 15.06.2017 and 11.07.2017. The photogrammetric results show a mean 2D change in the Gauss normal distribution of roughly -2 cm using the M3C2 approach and a 2.5D volume change of -319 m^3 between 06.05.2017 and 11.06.2018.
- Modelling the Salza River study area using the software CAESAR-Lisflood, has shown four prone segments for the time frame 2019 - 2050 depending on discharge scenario.
- The results gathered offer a very detailed insight into the past, present and future hydro-geomorphic changes and present a solid basis and reference point for further technical actions and/or measures and possibly deeper investigations of the study area.

ÖSTERREICHISCHE BUNDESFORSTE

universität wien
Institut für Geographie und Regionalforschung

Literature

- Complete Literature available in chapter Bibliography of my Thesis on pages 177 - 182.
- Link/QR Code to thesis:


universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Hydro-geomorphic changes of the Salza River near Gusswerk, Styria"

Click here

Thank you for listening!