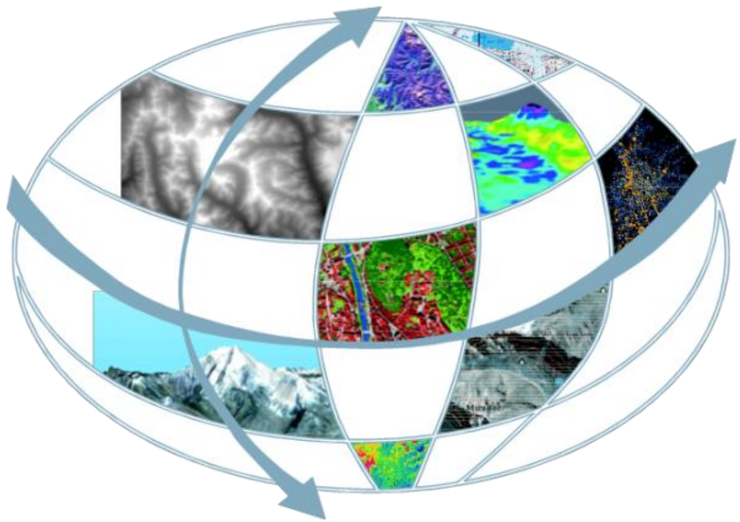
Monitoring of alpine natural hazards by means of UAV´s – case studies from Austria

Wolfgang **Sulzer**, Gernot **Seier**, Viktor **Kaufmann**



INSTITUTE FOR GEOGRAPHY AND REGIONAL SCIENCES and INSTITUTE FOR GEODESY

NAWI GRAZ AG GEOSPATIAL TECHNOLOGIES

University of Graz / Graz University of Technology

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Contents

- Introduction
  - Institute for Geography / Geospatial Technologies

- Environmental Monitoring by means of UAV´s
  - UAV – legal situation in Austria
  - Case Studies

- Résumé / Outlook

Contents

- Introduction
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  - Case Studies

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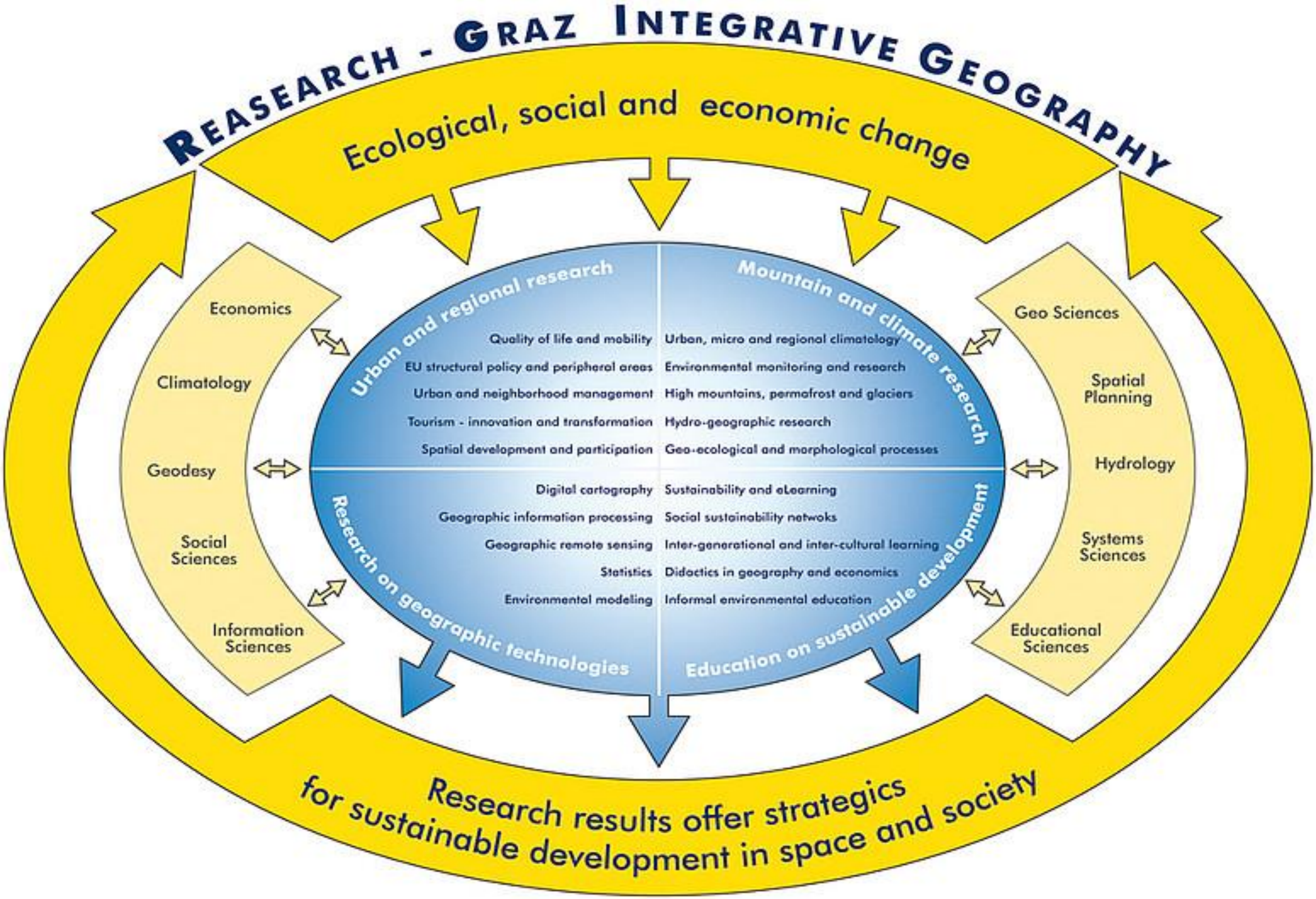


Reasearch - Graz Integrative Geography
Ecological, social and economic change
Economics
Climatology
Geodesy
Social Sciences
Information Sciences
Geo Sciences
Spatial Planning
Hydrology
Systems Sciences
Educational Sciences
Urban and regional research
Quality of life and mobility
EU structural policy and peripheral areas
Urban and neighborhood management
Tourism - innovation and transformation
Spatial development and participation
Mountain and climate research
Urban, micro and regional climatology
Environmental monitoring and research
High mountains, permafrost and glaciers
Hydro-geographic research
Geo-ecological and morphological processes
Research on geographic technologies
Digital cartography
Geographic information processing
Geographic remote sensing
Statistics
Environmental modeling
Education on sustainable development
Sustainability and eLearning
Social sustainability netwoks
Inter-generational and inter-cultural learning
Didactics in geography and economics
Informal environmental education
Research results offer strategics
for sustainable development in space and society

Institute for Geography and Regional Sciences

Physical Geography
- Geomorphology
- Glaciology
- Climate Geography
- ....

Human Geography
- Regional Planing
- Social Geography
- Economics Geography
- ...

Geospatial Technologies
- GIS
- Remote Sensing
- Cartography
- ...

Research Environmental Monitoring

Master Studies: Geospatial Technologies

Research Topics:

- Integration of Remote Sensing in alpine monitoring
- Change detection of natural and artificial surfaces
- Urban planning, design and spatial analyses
- Monitoring dynamic system Earth – climate change

Study Programme

- Study programme at the IGR

  - Bachelor in Geography
  - Bachelor in Environmental Systems Sciences / Geography

  - Master in Mountain and Climate Geography
  - Master in Sustainable Urban and Regional Sciences
  - Master in Environmental Systems Sciences / Geography
  - Master in Geospatial Technologies

  - Teaching Degree Geography and Economics
  - Joint Degree: Sustainable Development
  - Global Studies
  - Erasmus Mundus Master´s Programme in Industrial Ecology

  - Doctoral School Geography

Contents

Multiple terms for UAV´s

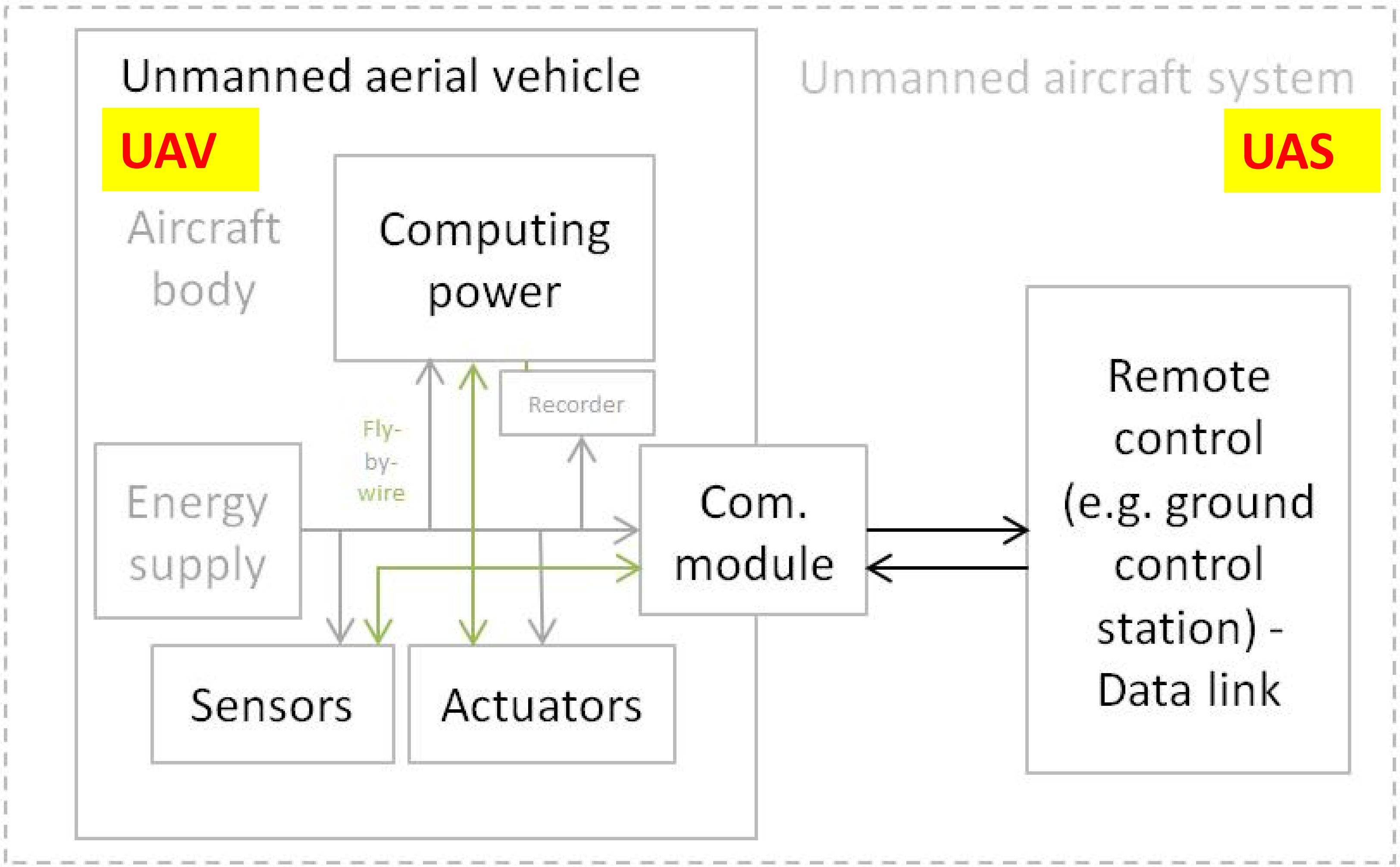
The term **DRONE**, more widely used by the public

The term **unmanned aircraft system (UAS)** emphasizes the importance of elements other than the aircraft. It includes elements such as ground control stations, data links and other support equipment. A similar term is an unmanned-aircraft vehicle system (UAVS) remotely piloted aerial vehicle (RPAV), remotely piloted aircraft system (RPAS). Many similar terms are in use.

A **unmanned aircraft vehicle (UAV)** is defined as a "powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload".
UAVs may or may not include model aircraft. Some jurisdictions base their definition on size or weight, however, the US Federal Aviation Administration defines any unmanned flying craft as a UAV regardless of size.

For recreational uses, a drone (as apposed to a UAV) is a model aircraft that has first person video, autonomous capabilities or both.

Multiple terms for UAV´s



Austrian Law for UAV´s

- Law since 1.1.2014

- Legalisation from Austrian Control
  - **Type 1**: Visual line of sight (VLOS)
  - **Type 2**: Beyond visual line of sight (BVLOS)

GRAZ, DIENSTAG, 3. DEZEMBER 2013

www.kleinezeitung.at

KLEINE ZEITUNG

Himmel voller Drohnen

Gehört die Zukunft der Luftpost? Amazon will Pakete mittels Fluggeräten zustellen.

SEITEN 2/3

Austrian Law for UAV´s

Categorisation of UAS Class 1 (VLOS) by Austrocontrol (LBTH 67)

see: www.austrocontrol.at/en/aviation_agency/licenses_permissions/flight_permissions/rpas

- Four categories (A to D), depending on weight and area of operation
- Light UAS in unpopulated areas face easier rules (certific./operation)
- Heavier UAS or UAS flying above populated areas face stricter rules

austro CONTROL

	UAS Class 1 (VLOS) – Area of Operation			
	I undeveloped (no buildings)	II unpopulated	III populated	IV densely populated (except crowds)
MTOW up to and including 5 kg	A	A	B	C
MTOW up to and including 25 kg	A	B	C	D
MTOW above 25 kg and up to and including 150 kg	B	C	D	D

Austrian Law for UAV´s

- The majority of sold **drones** (quadrocopter) are exclusively for **category A**
- In Category A, you can fly with an aircraft **up to 5kg in undeveloped or unpopulated area** with line of sight and up to a **height of 150m**
- The use of UAV´s in areas with **crowded people** (festival, sports events, concerts, etc.) is **forbidden** due to safety reasons , single permissions can be possible
- **No flight zones are in the vicinity of airports**
- **An assurance is obligatory**
- Austro Control gives the permission for the UAV itselfs. **The owner and pilot is responsible to take care for the relevant law** (e.g. data protection, usage within National Parks, ask the owner for starting permission, safety areas, physical fitness of pilot ....).

Monitoring of alpine natural hazards by means of UAV´s – case studies from Austria

(Environmental) Monitoring

- The investigation of **environmental processes by means of physical methods** is in the focus of the environmental monitoring
- In this context, **all processes** that **indirectly or directly influence the human environment** are understood as environmental processes (this definition of environment is somewhat anthropocentric).
- However, this 'mediateness' leads **geoscientists** virtually into all **subsystems (compartments) of the earth**, such as the **atmosphere, hydrosphere, cryosphere, lithosphere, pedosphere** and the **biosphere**.

Monitoring of alpine natural hazards by means of UAV´s – case studies from Austria

"Monitoring is to record change" (BAYFIELD 1996)

Environmental monitoring can be concentrated on five points, which can be achieved by **the single use of Remote Sensing** and by a combined analyses within a **Geographical Information System:**

1. **Long-term observation of indicators**
2. **Observing and documenting**
3. **Documentation / analyzing / modelling**
4. **Condition and change detection and evaluation - also as a success control of environmental measures**
5. **Develop, discuss and implement recommendations for action**

Workflow of an UAV-Project

- Definition of requirements
- Flight plan
- Ground Control Points
- Flight and data acquisition
- Postprocessing
- Photogrammetry
- Analyses

„Structure-from-Motion“

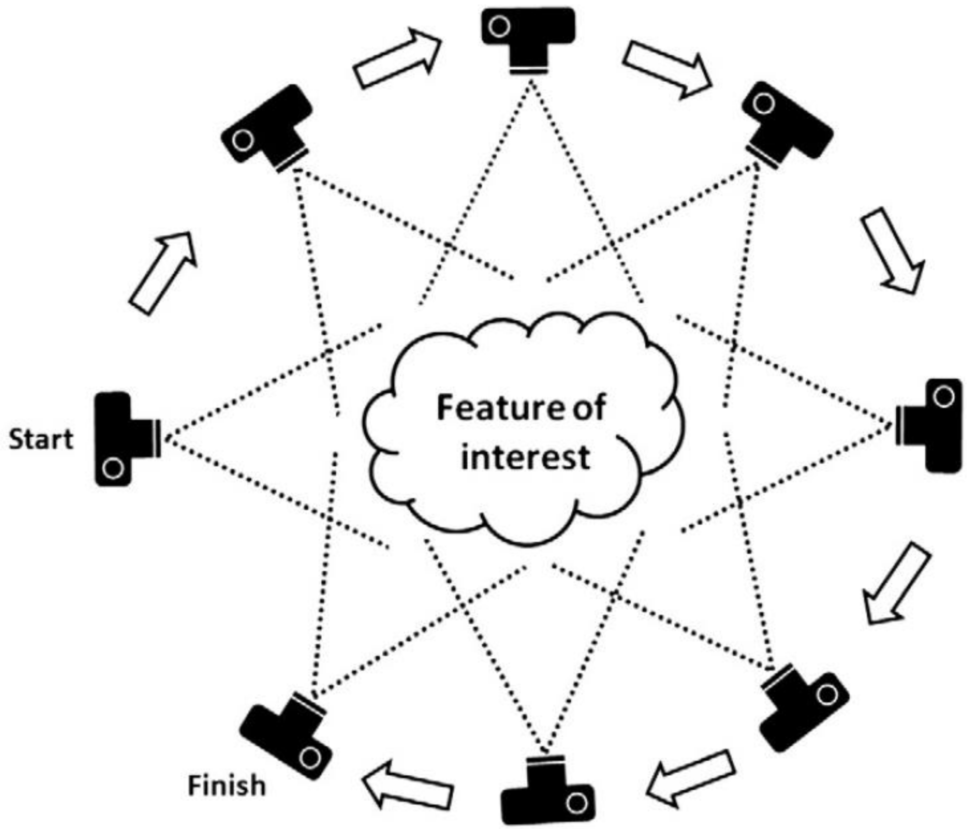


Fig. 1. Structure-from-Motion (SfM). Instead of a single stereo pair, the SfM technique requires multiple, overlapping photographs as input to feature extraction and 3-D reconstruction algorithms.

Quelle: Westoby, M.J., Brasington, J., Glasser, N.F., Hambrey, M.J., & Reynolds, J.M. (2012). ‘Structure-from-Motion’ photogrammetry: A low-cost, effective tool for geoscience applications. *Geomorphology*, *179*, 300–314. doi:10.1016/j.geomorph.2012.08.021

Contents

- Introduction
  - Institute for Geography / Geospatial Technologies
- Environmental Monitoring by means of UAV´s
  - …
  - Case Studies
    - Equipment
    - Cryosphere (Glacier and Rock glacier)
      - ✓ Pasterze
      - ✓ Rock glacier
    - Reliefsphere / Lithosphere (Sediment dynamic)
      - ✓ Schöttlbach / Oberwölz
      - ✓ Langgriesgraben/ Gesäuse
    - Reliefsphere / Lithosphere (Landslide, Rockfall)
      - ✓ Galgenwald /Murau
    - Reliefsphere/ Biosphere (Torrent inspection)
      - ✓ Weng / Gesäuse
- Résumé / Outlook

NAWI GRAZ UAV´s

Hexacopter (TwinHex v3.0)

- Camera Ricoh GXR
- Payload: max. 2,5kg
- Flight time: max. 35 minutes
- Regions: difficult terrain, gorges, rock walls
- max 1 km^2 / day

Quest UAV

- Sony α 6000
- Payload: max.1kg
- Flight time: : max. 70 minutes
- Regions: large areas
- Max. 5 km^2 / day

DJI Phantom 4

- Payload: max. 0,38 kg
- Flight time: max. 28 minutes
- Regions: small areas, oblique images
- Max 1 km^2 / day

Additional Equipment

dGPS

Topcon HiPerV dual-frequency GNSS receiver

TLS

RIEGL LMSZ-620

SfM

Canon EOS 5D Mark II

Contents

Glaciermonitoring: Pasterze / National Park Hohe Tauern

Aim of the project:

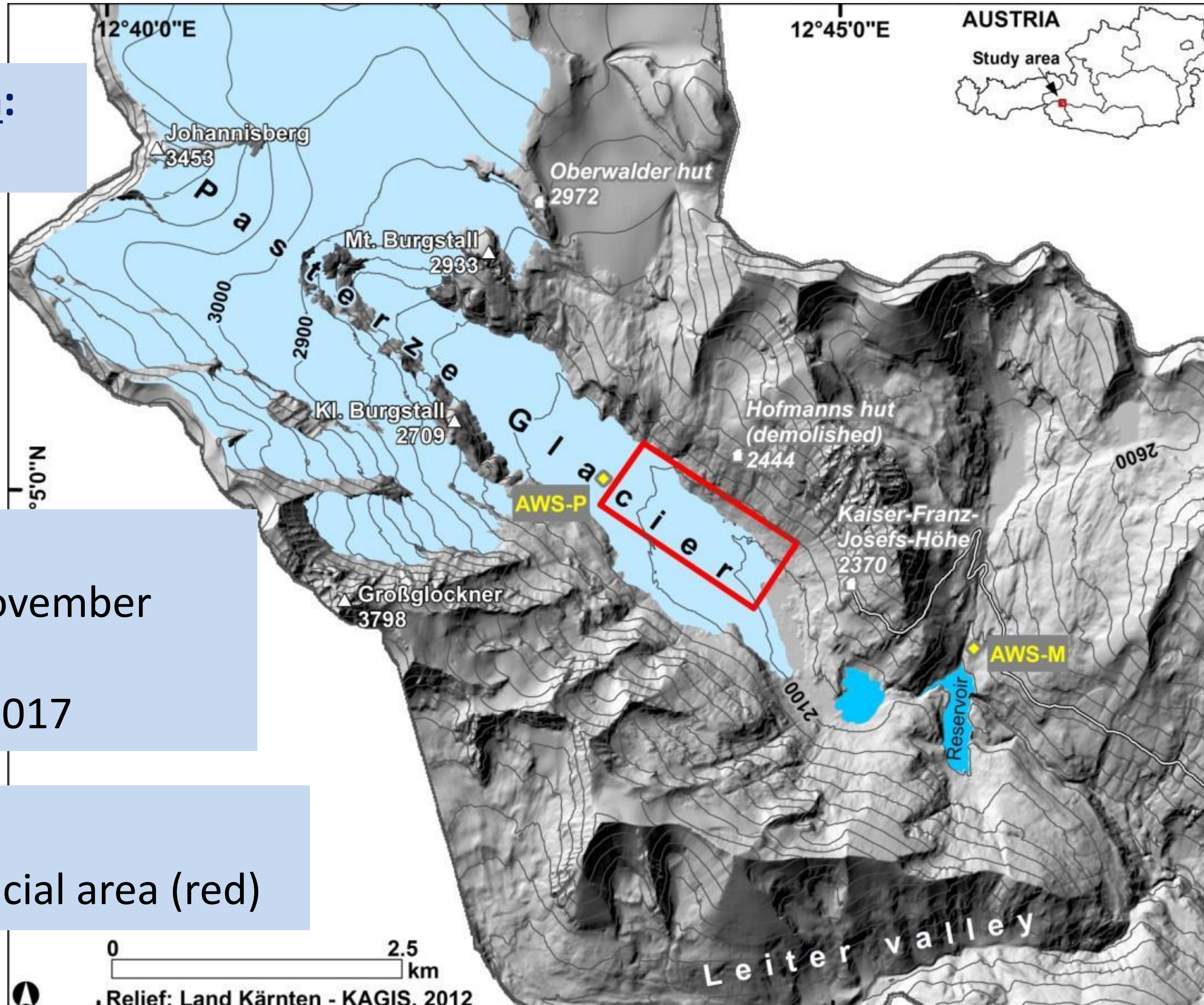
- Proof the usage of UAV in context with glacier monitoring
- Detect the behavior of **crevasses**
- Map the development of surface changes and movements
- Detect the **ablation of glacier** and mapping the recent extent of the glacier border
- Investigations of **dead ice** in the proglacial area

Glaciermonitoring: Pasterze / National Park Hohe Tauern

➢ **Investigation area:**
- Pasterze glacier

➢ **Flight campaign:**
- September und November 2016
- July and October 2017

➢ **Special AOI**
- Tongue and proglacial area (red)

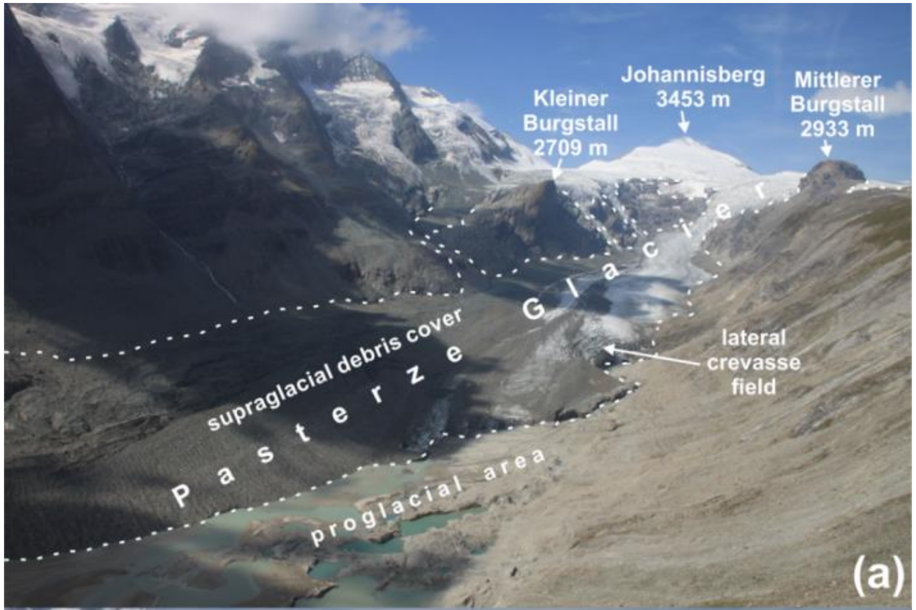


Glaciermonitoring: Pasterze / National Park Hohe Tauern

- **Weather conditions** during flights

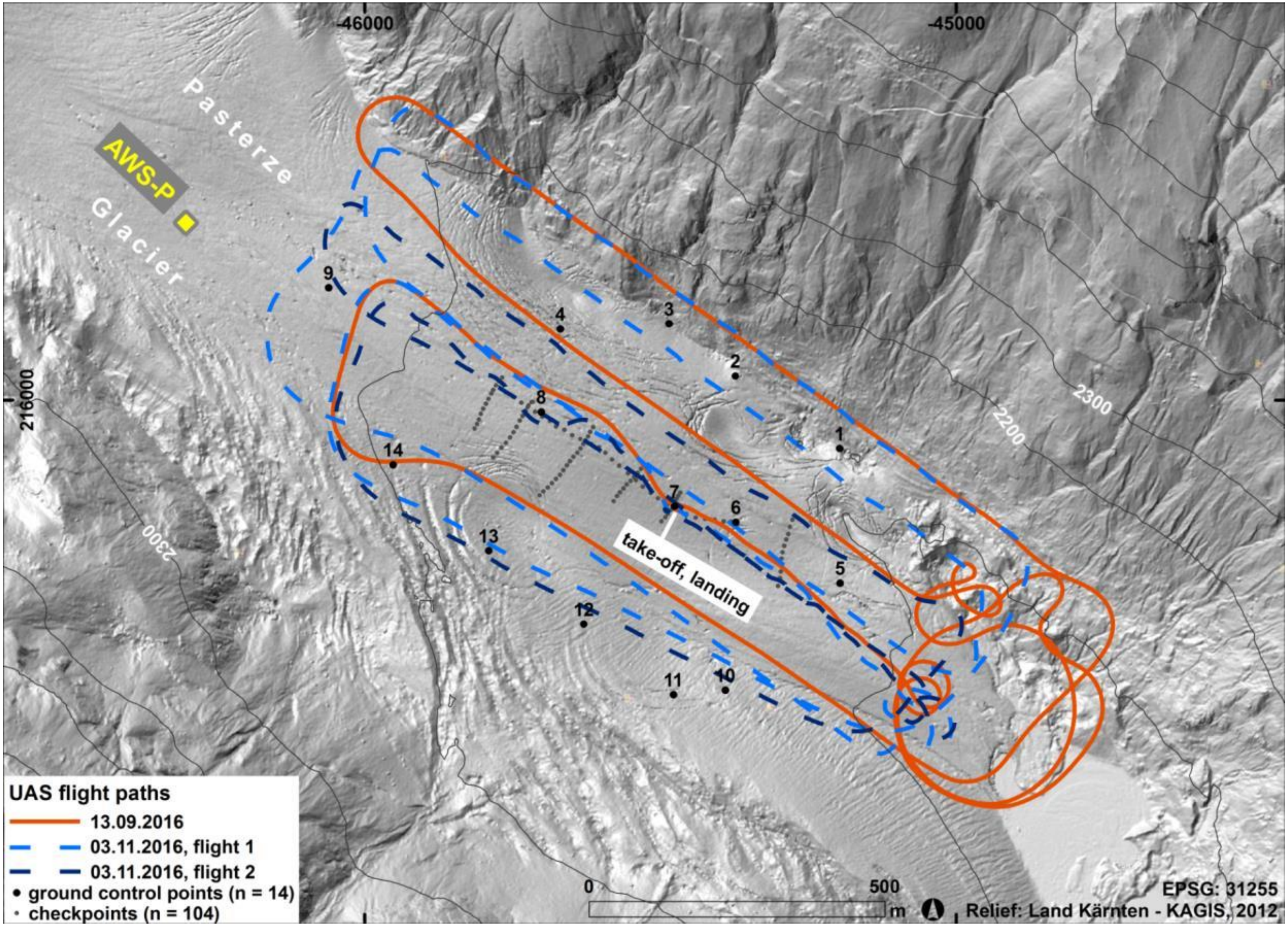
- **<u>Character Pasterze glacier</u>**
  - Side crevasses
  - Mainly debris covered
  - Scree in proglacial parts
  - Collapse areas

13.09.2016



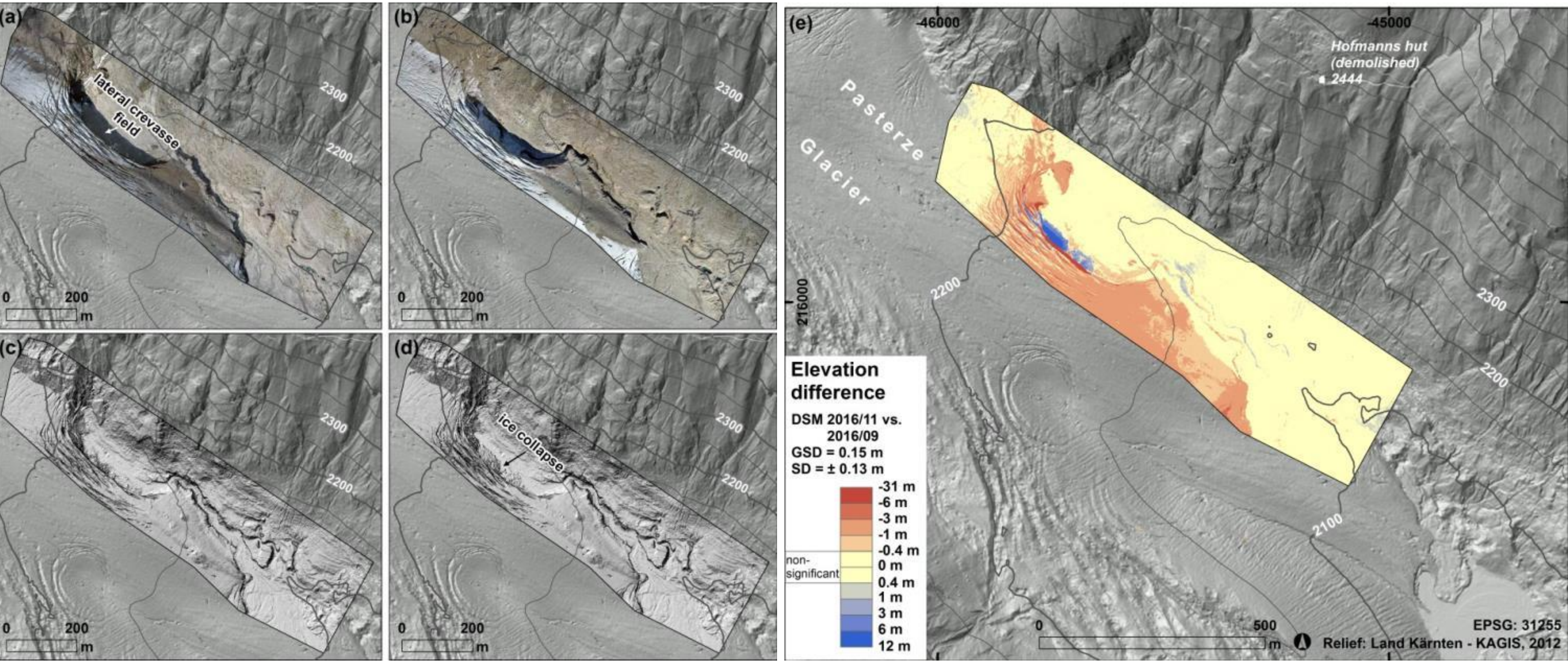
03.11.2016

Glaciermonitoring: Pasterze / National Park Hohe Tauern



UNI GRAZ | geo raum Institut für Geographie und Raumforschung | NAWI Graz | ifG | TU Graz

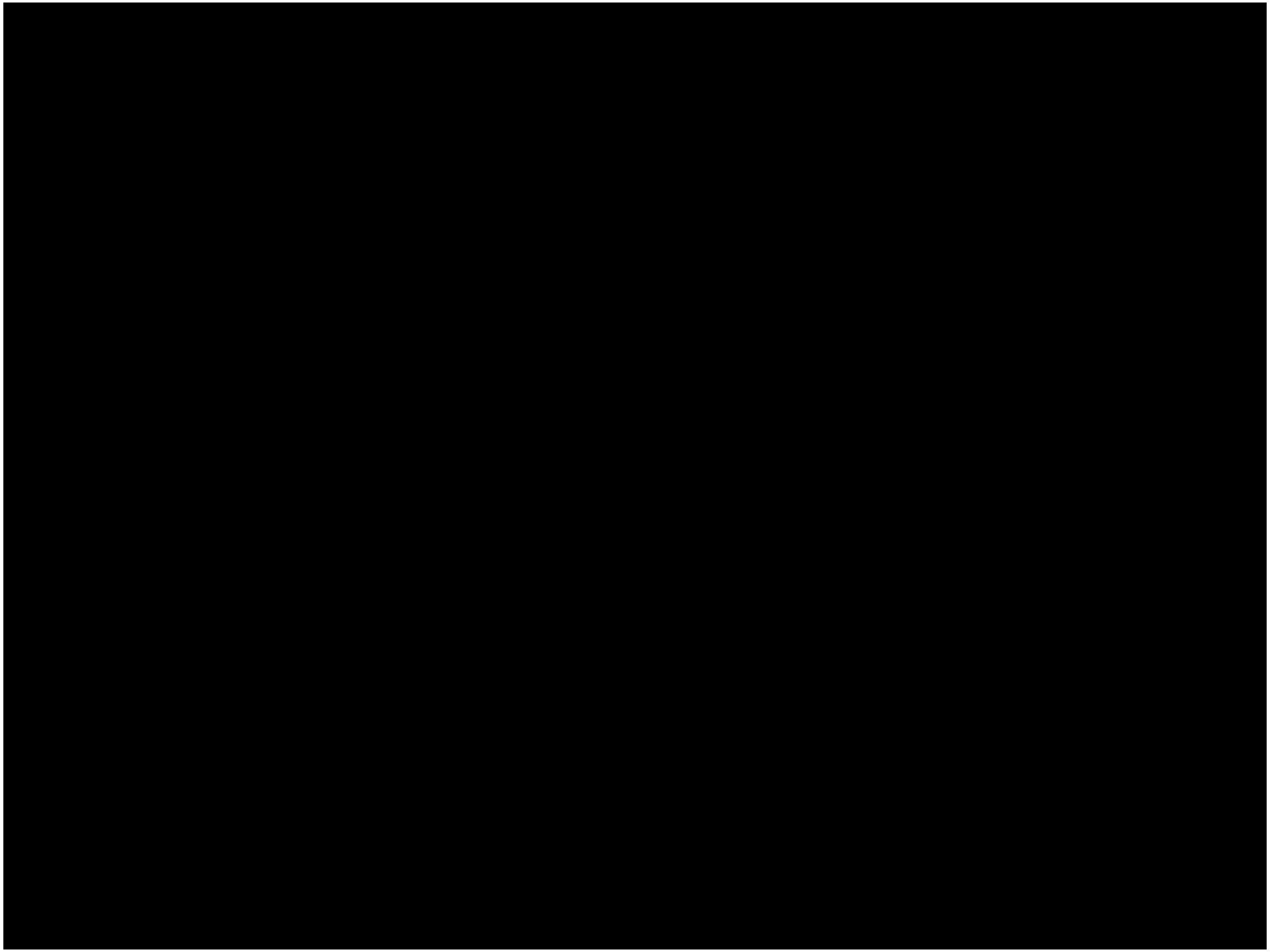
Glaciermonitoring: Pasterze / National Park Hohe Tauern



(a) Orthophotos 2016/09 and **(b)** 2016/11
(c) Shaded relief 2016/09 and **(d)** 2016/11

(e) Height differences of DEM
2016/11 and 2016/09, GSD = 0.15 m

Glaciermonitoring: Pasterze / National Park Hohe Tauern



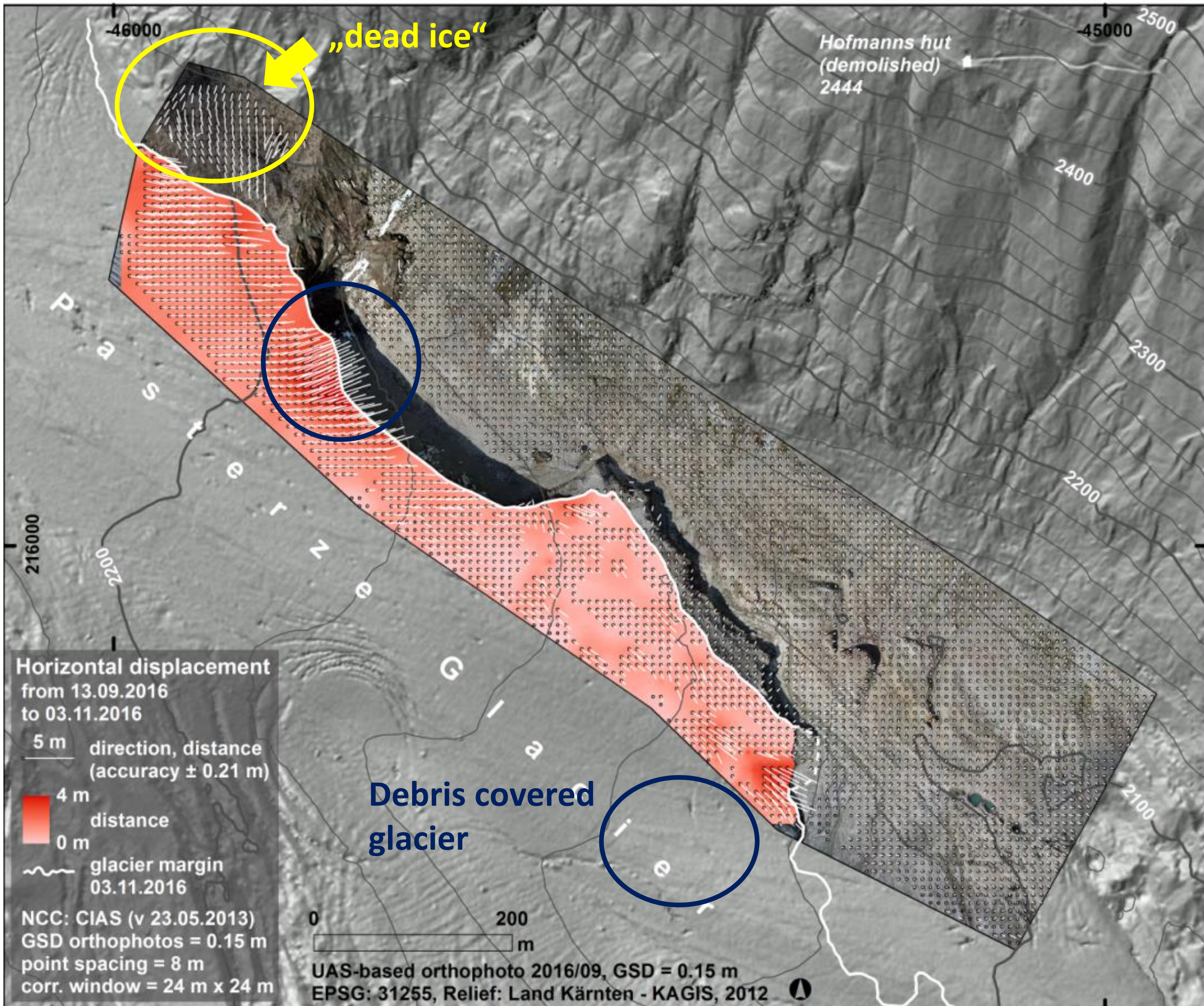
Glaciermonitoring: Pasterze / National Park Hohe Tauern

➢ Horicontal Movement

- Between **13.09.2016** und **03.11.2016**
- Downward and sideward directions
- Maximum 3.5 m

➢ ERT-Measurements

- electric resistivity tomography



Glaciermonitoring: Pasterze / National Park Hohe Tauern

Outcome

- **Height differences** of glacier surface 2016/09 and 2016/11
  mean value -0.9 m / -0.02 m d^{-1}
- **Glacier movement: mean movement 0.93 m, max. 3.5 m / 0.02 md^{-1},**
  max. 0.07 m d^{-1}
- **Ice fall in the area of the lateral crevasses max. 31 m.**
- **Surface of proglacial area: no significant changes** (height, horizontal movements)
- **UAV** are useful to **document changes of glaciers**
- **UAV** are useful to **supply traditional measurements** (mapping and monitoring of large areas)

Seier, G., Kellerer-Pirklbauer, A., Wecht, M., Hirschmann, S., Kaufmann, V., Lieb, G.K., Sulzer, W., 2017: ***UAS-based change detection of the glacial and proglacial transition zone at Pasterze Glacier, Austria****. Remote Sensing, 1-21p.*

Change Detection Tschadinhorn - Rockglacier

August 2017

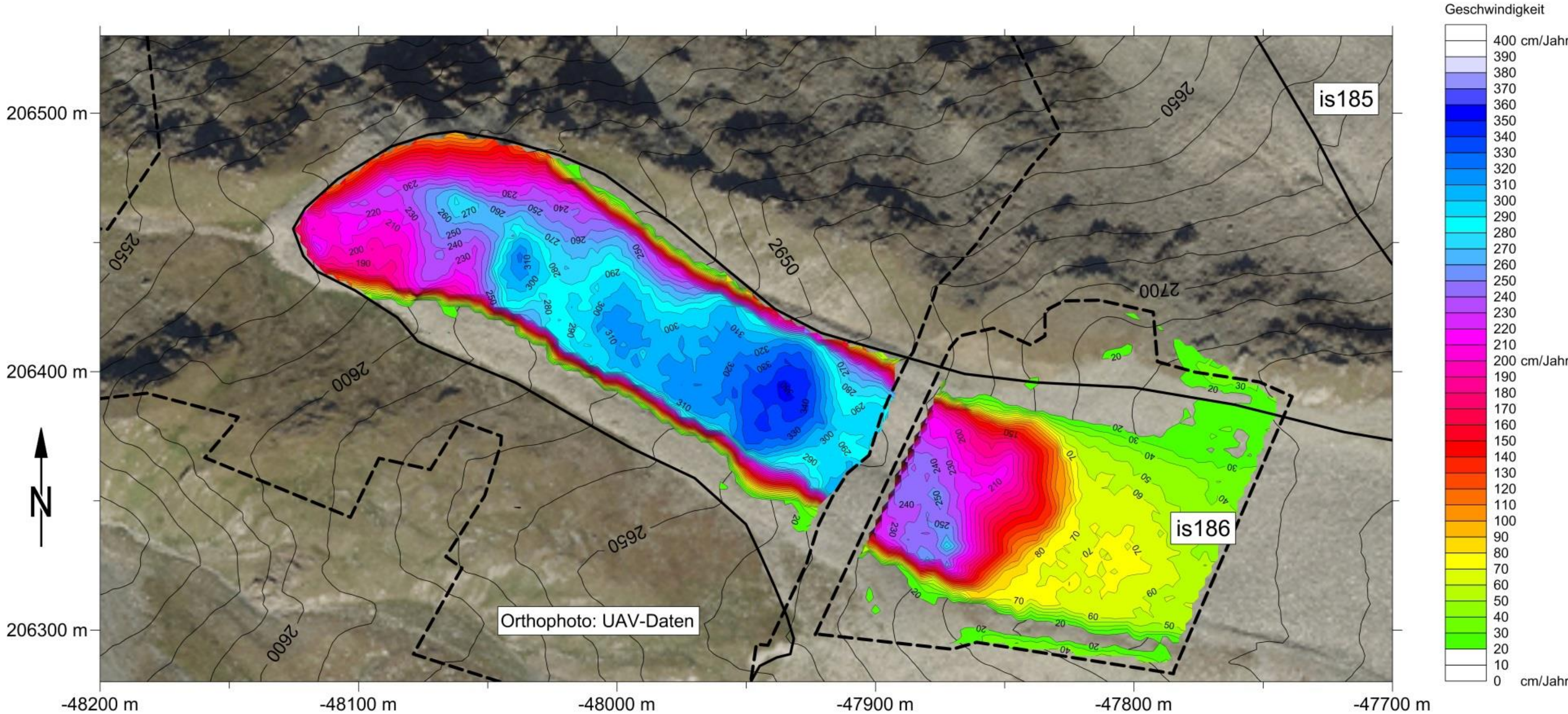
- **TU Graz: Institute for Computer Graphics and Vision**
- **TU Graz: Institute for Earth Sciences**
- **TU Graz: Institute for Geodesy**
- **Uni Graz: Institute for Geography and Regional Sciences**

Goal of the project:

- 1 task and 4 different UAV´s
- Master thesis: Comparison of image acquisition quality and comparison of different work flows

Tschadinhorn Blockgletscher 1 : 2 500

Mittlere jährliche horizontale Fließbewegung 2015 - 2016



Datenquellen:
Orthophoto Epoche 1: 28. August 2015, RGB, GSD 16 cm, UltraCam-Daten (c) Land Tirol
Orthophoto Epoche 2: 26. Juli 2016, 1. Flug, RGB, GSD 4.5 cm, UAV-Daten (c) TU/UNI Graz
Digitales Geländemodell (DGM): Laserscannerbefliegung 20. August 2009, 1m-Raster, Daten (c) Land Tirol

Zeitraum: 333 Tage (0.911704 Jahre)
Berechnung der Verschiebungsvektoren durch Image Matching (Methode NCC).
Punktabstand 2.5 m, GSD 10 cm, W 31 px (3.1 m), min. NCC 0.4, BMD < 1 px, 2000 Punkte
Blockgletscher is186: max. Geschwindigkeit 283 cm/Jahr

Finanzielle Unterstützung: Kärntner Nationalparkfonds Hohe Tauern, Döllach 14, 9843 Großkirchheim

V. KAUFMANN, K. ROTH und G. SEIER, 2017: Tschadinhorn Blockgletscher, Schobergruppe, Hohe Tauern – ein Beitrag zur aktuellen Kinematik. In: W. Lienhart (Hrsg.): Ingenieurvermessung 2017, Herbert Wichmann Verlag, im DrucK“

Contents

UAV and TLS for monitoring a creek in an alpine environment

Background:

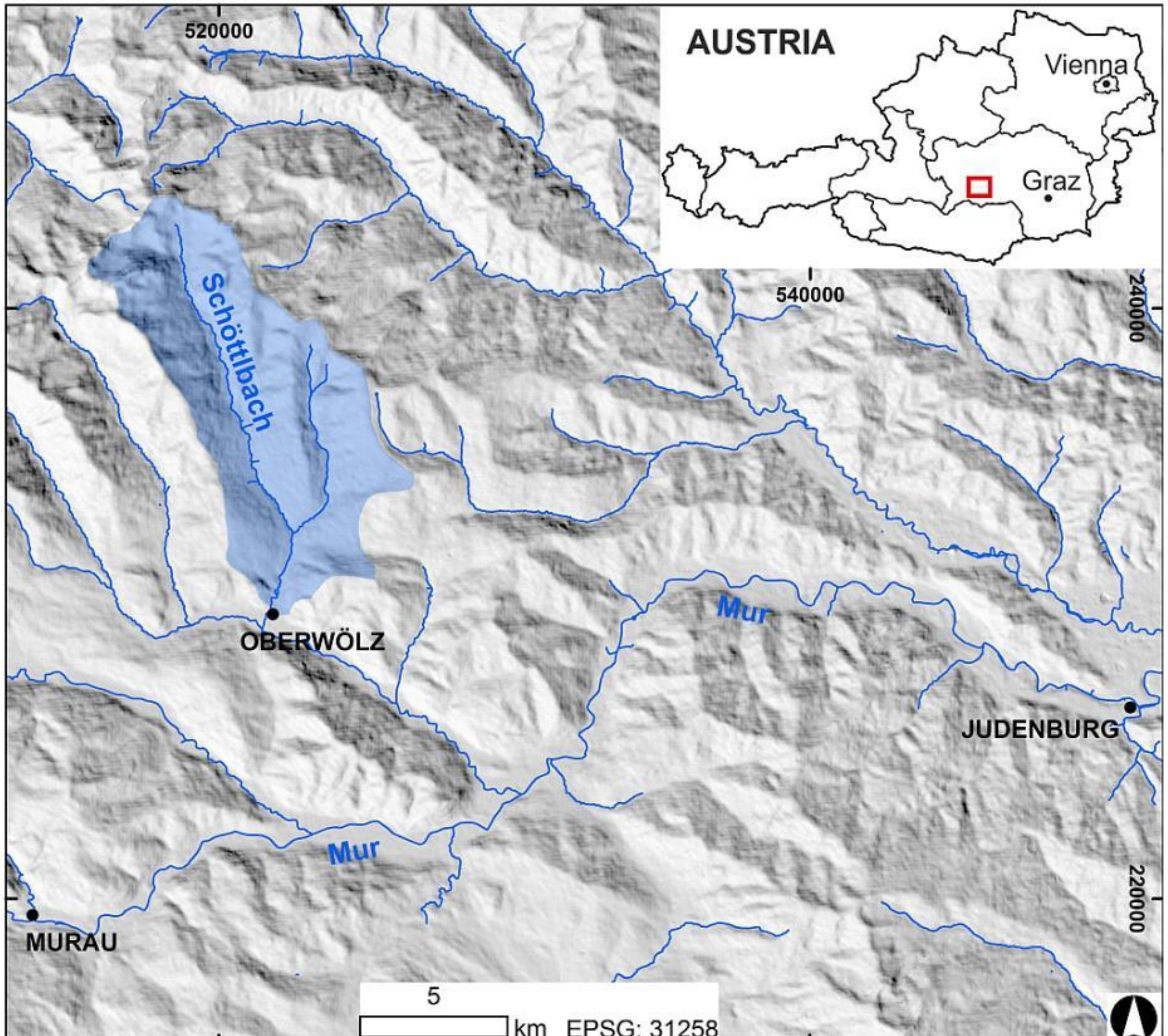
- **Flood:** 7. July 2011 and 24.8.2017 in Oberwölz (Styria, Austria)
- **“Open” the sedimentary body**
- **Low Precipitation** causes relatively high sediment loads
- From the **fluvial morphological perspective,** the investigation area is ideal to **investigate sediment budgets** (decrease – transportation – sedimentation)

Aim of the project:

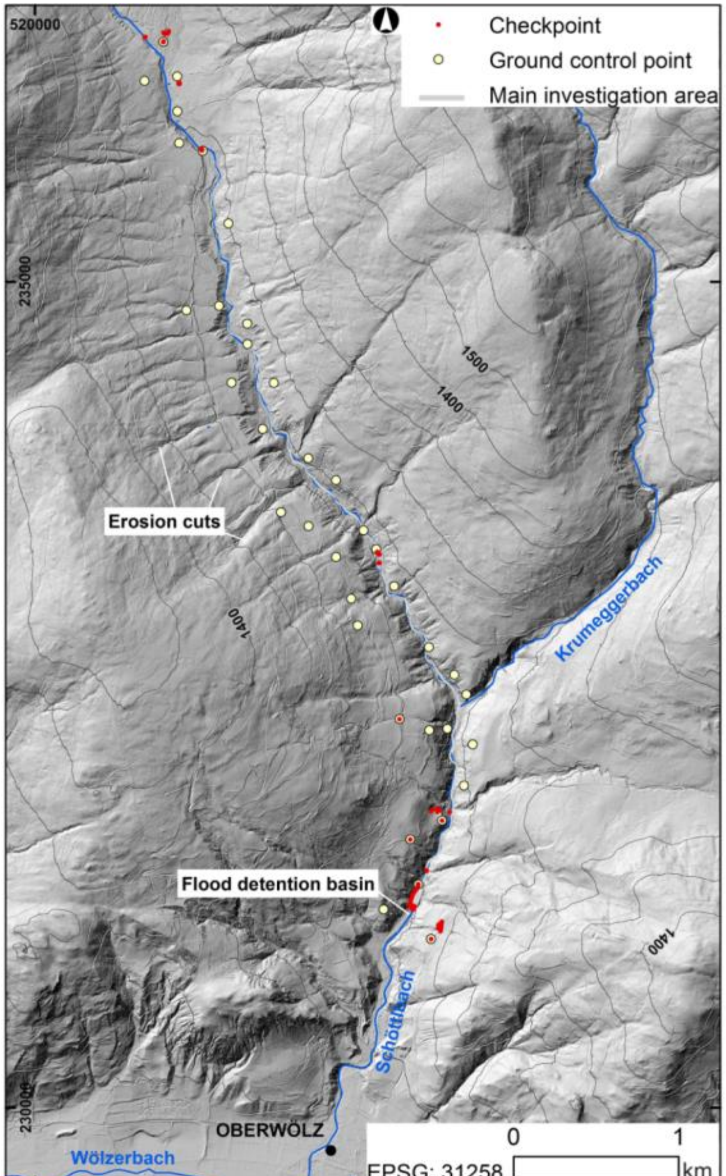
- Identification for **erosion and sedimentation areas**
- To **understand** better the **sediment cascade**
- Requirements are **high resolution geodata** (DSM, Orthophotos).
- There is a need of studies to improve the **applications of UAVs / SfM-Photogrammetry in the field of fluvial morphology**

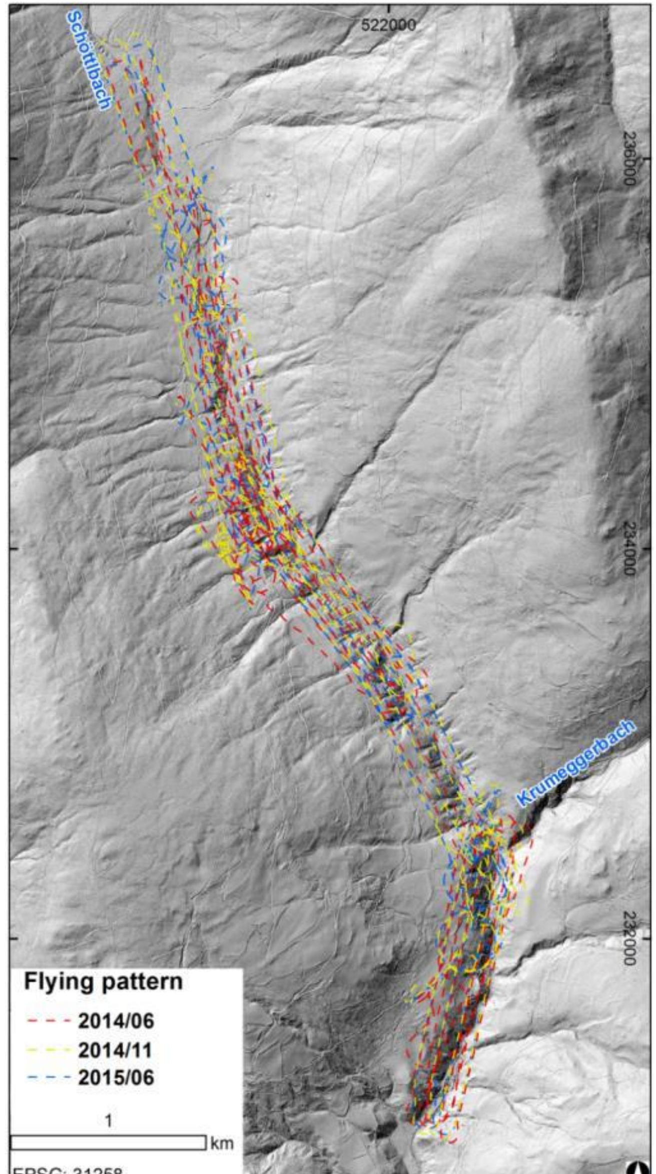
V and TLS for monitoring a creek in an alpine environment

UAV and TLS for monitoring a creek in an alpine environment



UAV and TLS for monitoring a creek in an alpine environment





Flight campaigns :

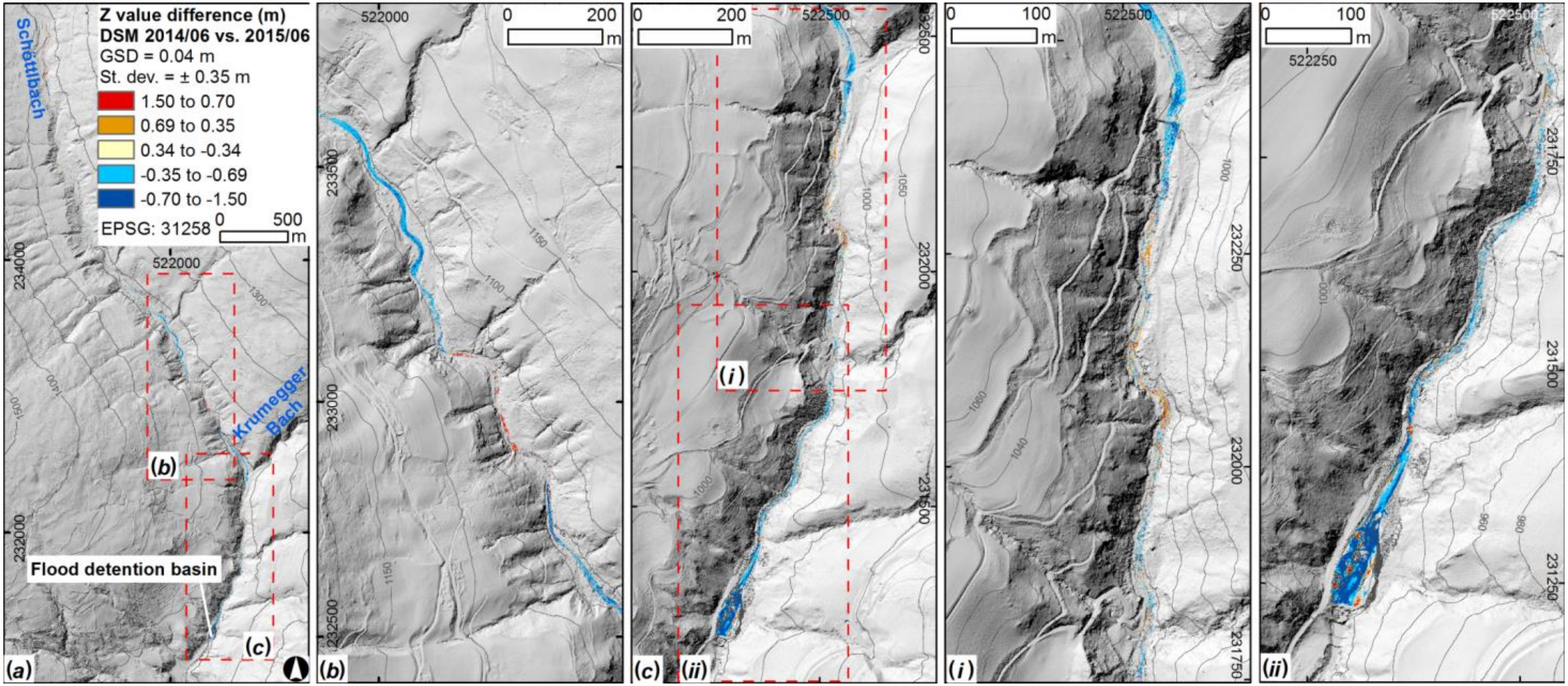
- 2014/06
- 2014/11
- 2015/06
- 2017/05
- 2017/11

Valey:

- appr. 8 km

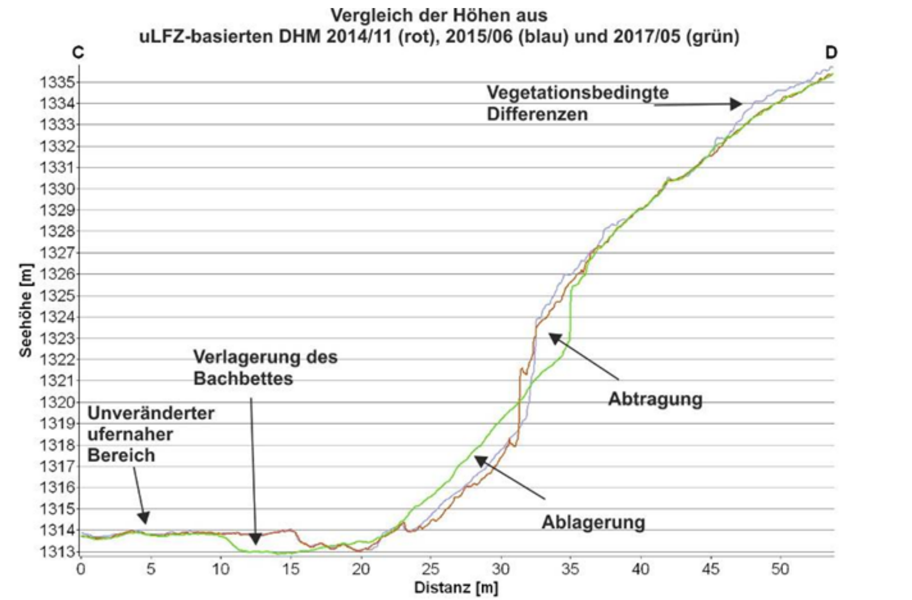
UAV and TLS for monitoring a creek in an alpine environment

Height differences DSM 2014/06 to 2015/06

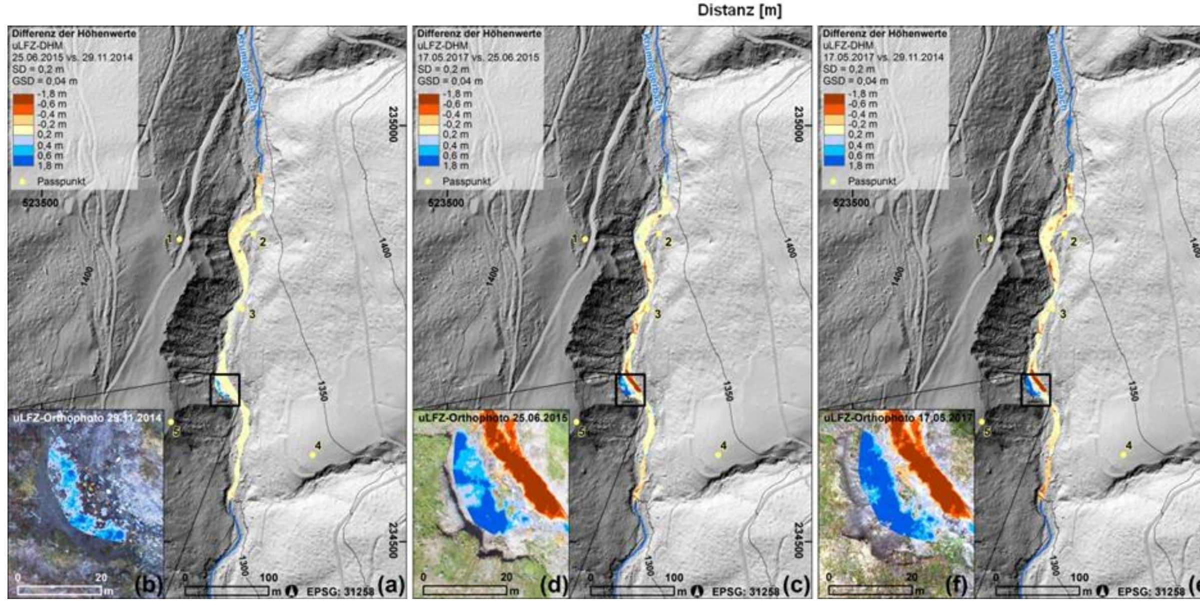


- **Erosion** (light blue: −0.35 to −0.69 m, dark blue: −0.70 to −1.50 m)
- **Sedimentation**(orange: 0.35–0.69 m, red: 0.70–1.50 m)
- **No markable changes** (yellow: −0.34 to 0.34 m)

UAV and TLS for monitoring a creek in an alpine environment



Height differences of
(a) UAV DEM 2014/11 and 2015/06,
(c) UAV DEM 2015/06 and 2017/05 und
(e) UAV-DEM 2014/11 and 2017/05,

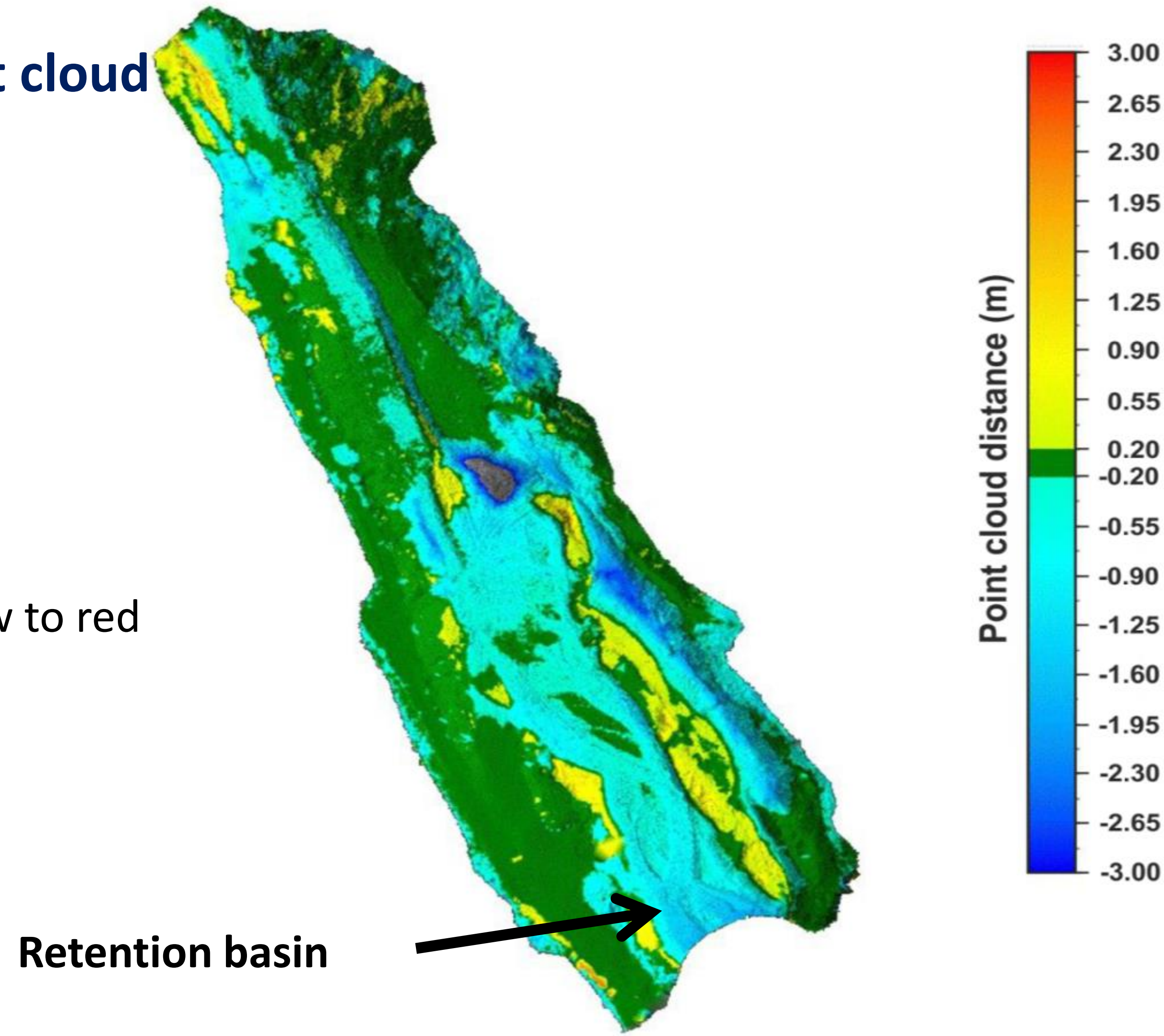


UAV and TLS for monitoring a creek in an alpine environment

Comparison of point cloud distances

TLS Acquisition:
•August 2014 and
•April 2015

Erosion: blue
Sedimentation: yellow to red



UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches

Outcomes

- **Uncertainties**:
  - complex, vegetation covered area
  - Reduced availability of GNNS
- **Geomorphological interpretation** :
  - Identification of erosion- and sedimentation areas
- **UAV** provides geodata with **high resolution and maximum aerial extent, which was not available until the campaign**
- DEM of the whole catchment (riverbed)
- **Combined use of UAV** with **TLS and SfM**

Seier, G., Stangl, J., Schöttl, S., Sulzer, W., Sass, O. (2017): ***UAV and TLS for monitoring a creek in an alpine environment, Styria, Austria.*** *Intern. Journ. of Remote Sensing, 38, 2903–2920, doi:10.1080/01431161.2016.1277045*

Seier, G,. Sulzer, W., Wecht, M,. Schöttl, St. und O. Sass, 2017: ***Veränderungsdetektion eines Wildbaches mittels unbemanntem Luftfahrzeug.*** *In: AGIT – Journal für Angewandte Geoinformatik, 2017, Wichmann Verlag, im Druck.*

UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches – Nationalpark Gesäuse

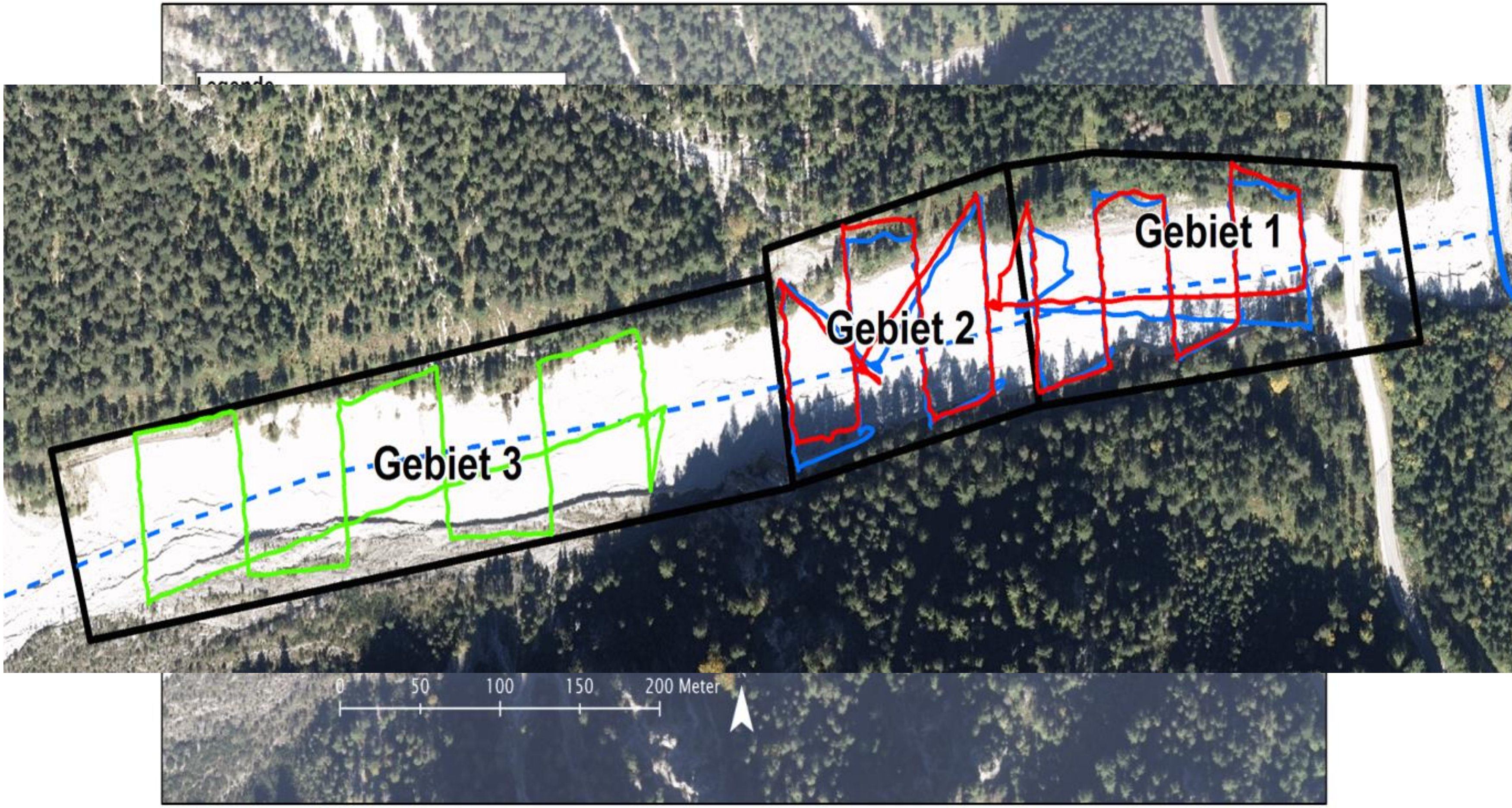
Aim of the project:

- **Acquisition of high resolution UAV-images**, Langgriesgraben (test area) for different time steps, generation of a ground control point network
- **Generation of Point Clouds, DSM and Orthophotos** from UAV-images
- **Comparison of UAV** with **TLS-, ALS-data and dGPS-measurements** for accuracy assessment
- **Analyses of surface changes**
- Statements about the potential of UAV campaigns

Langgriesgraben

UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches – Nationalpark Gesäuse

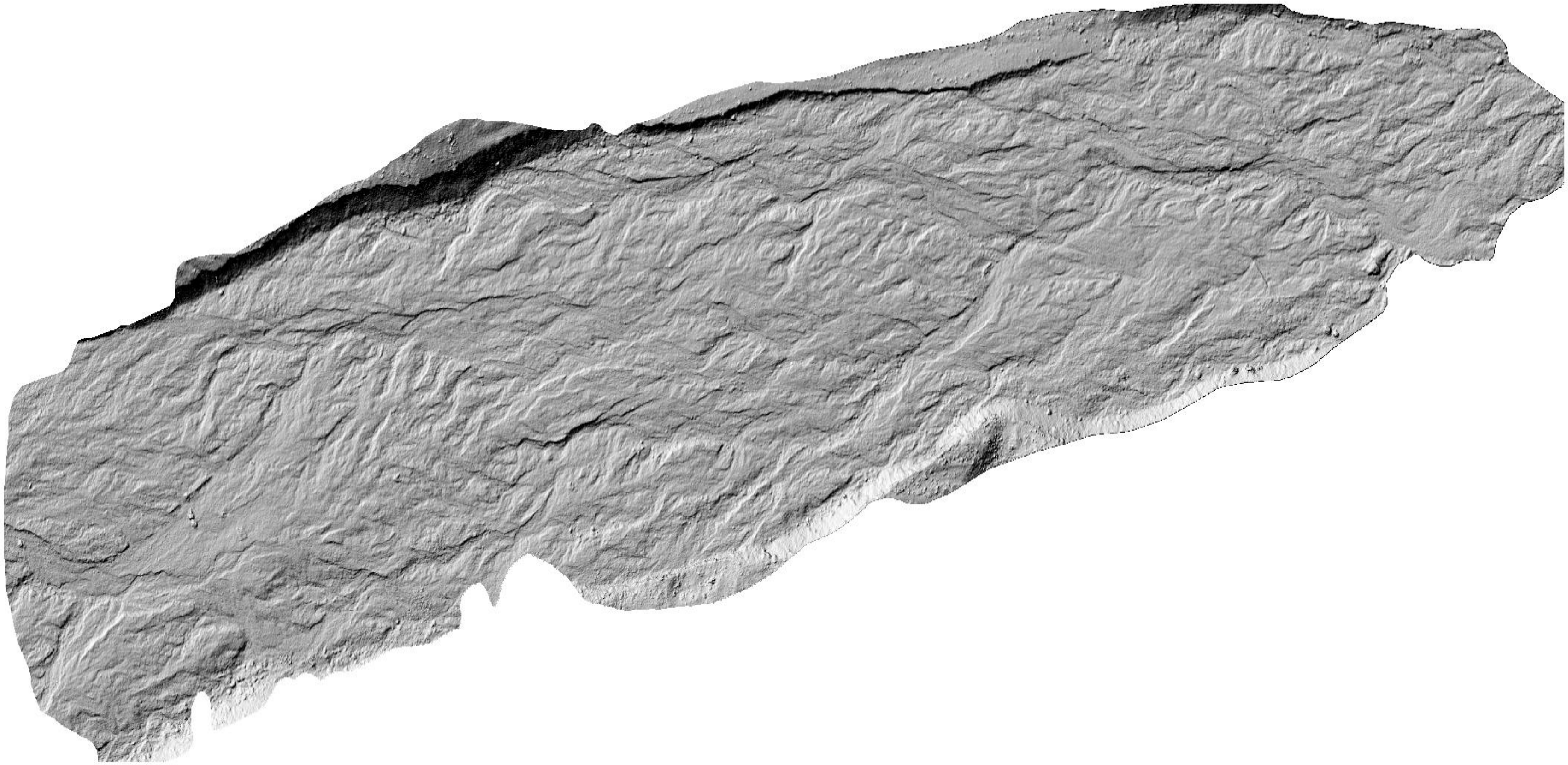
Test Area



UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches – Nationalpark Gesäuse

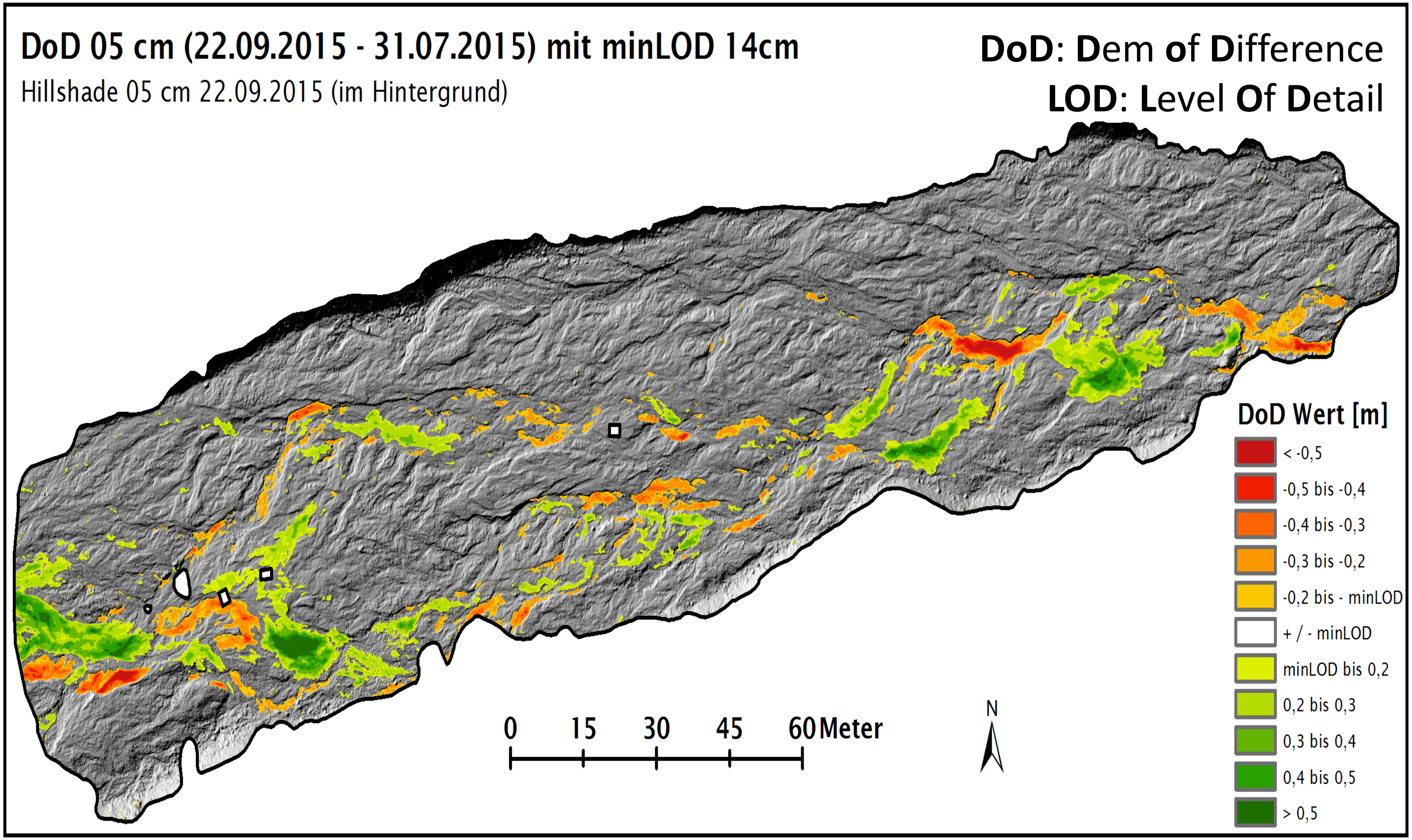
DSM

UAV-DGM (31.07.2015)



UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches – Nationalpark Gesäuse

Changes



UAV und TLS im Einsatz für das Monitoring eines alpinen Wildbaches – Nationalpark Gesäuse

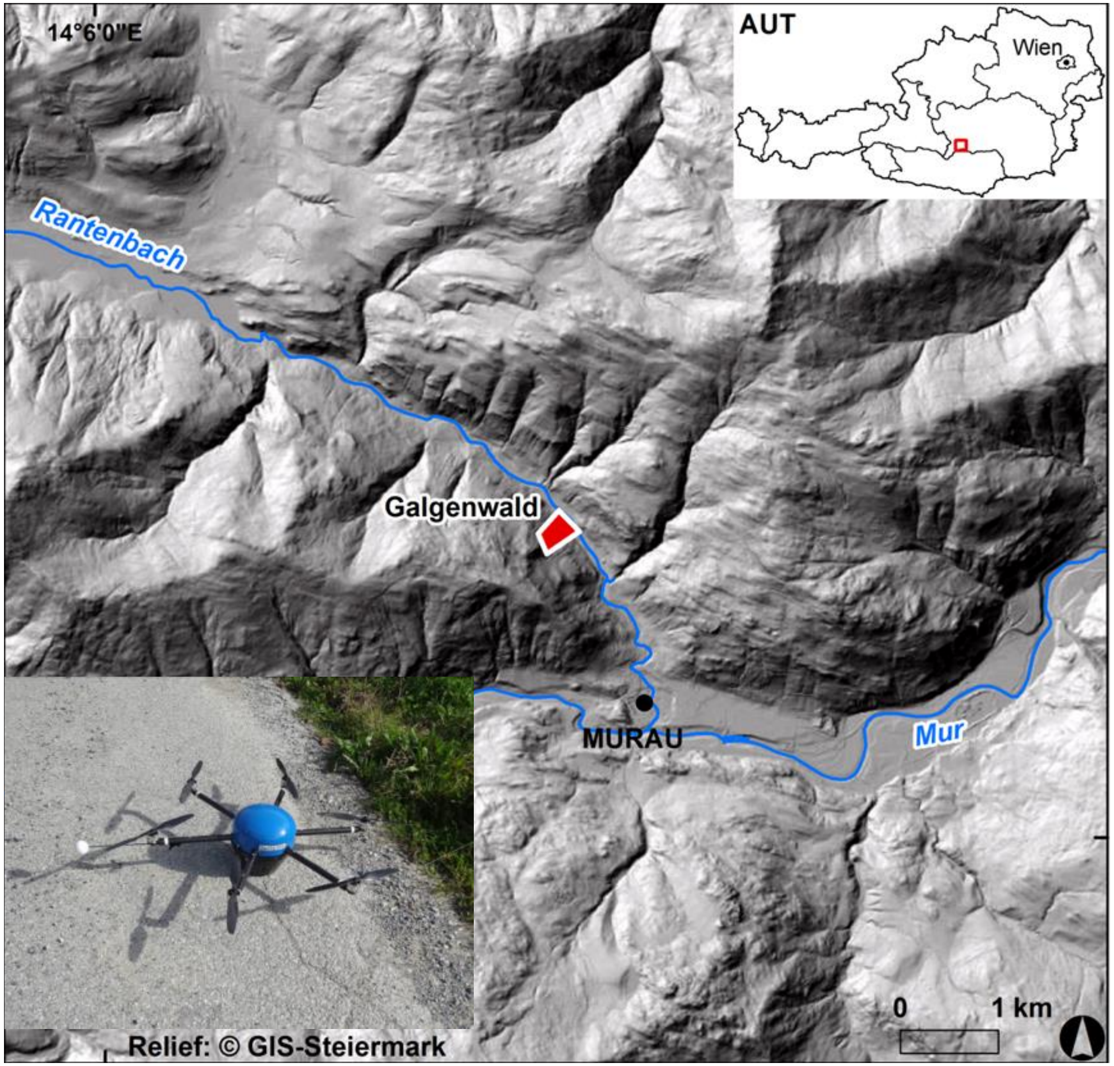
Outcomes

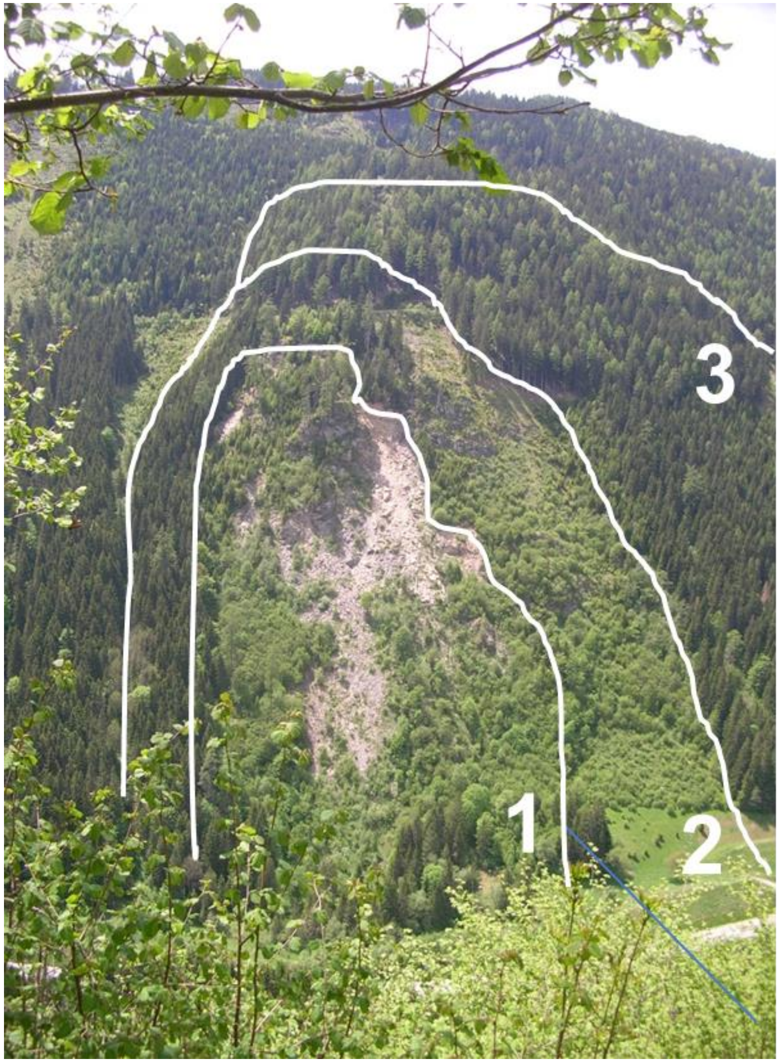
- **Technical problems** UAV, GPS-acquisition, camera…
- **Environmental influences** e.g. wind, sun angle, shadow
- Permanent **GPC Network**
- Validitation SfM-MVS
- **Change Detection :** on which data level? Accuracy assessment
- **ALS Data**

St. Schöttl, G.Seier, E.Rascher, W. Sulzer, and O.Sass, 2016:
UAS-based quantification of sedimentary body changes at Langgriesgraben, Styria, Austria.
In: Geophysical Research Abstracts Vol. 18, EGU2016-15077-1, 2016

Contents

UAV based Monitoring of „Lärchberg-Galgenwald“ landslide





UAV based Monitoring of „Lärchberg-Galgenwald“ landslide

Aim of the project:

- Costly annual inspection/survey
- Survey is time and money consuming
- Difficult access and steep relief
- Measure the movement/activity of the landslide
- Finding of alternatives and/or additional methods

UAV based Monitoring of „Lärchberg-Galgenwald“ landslide

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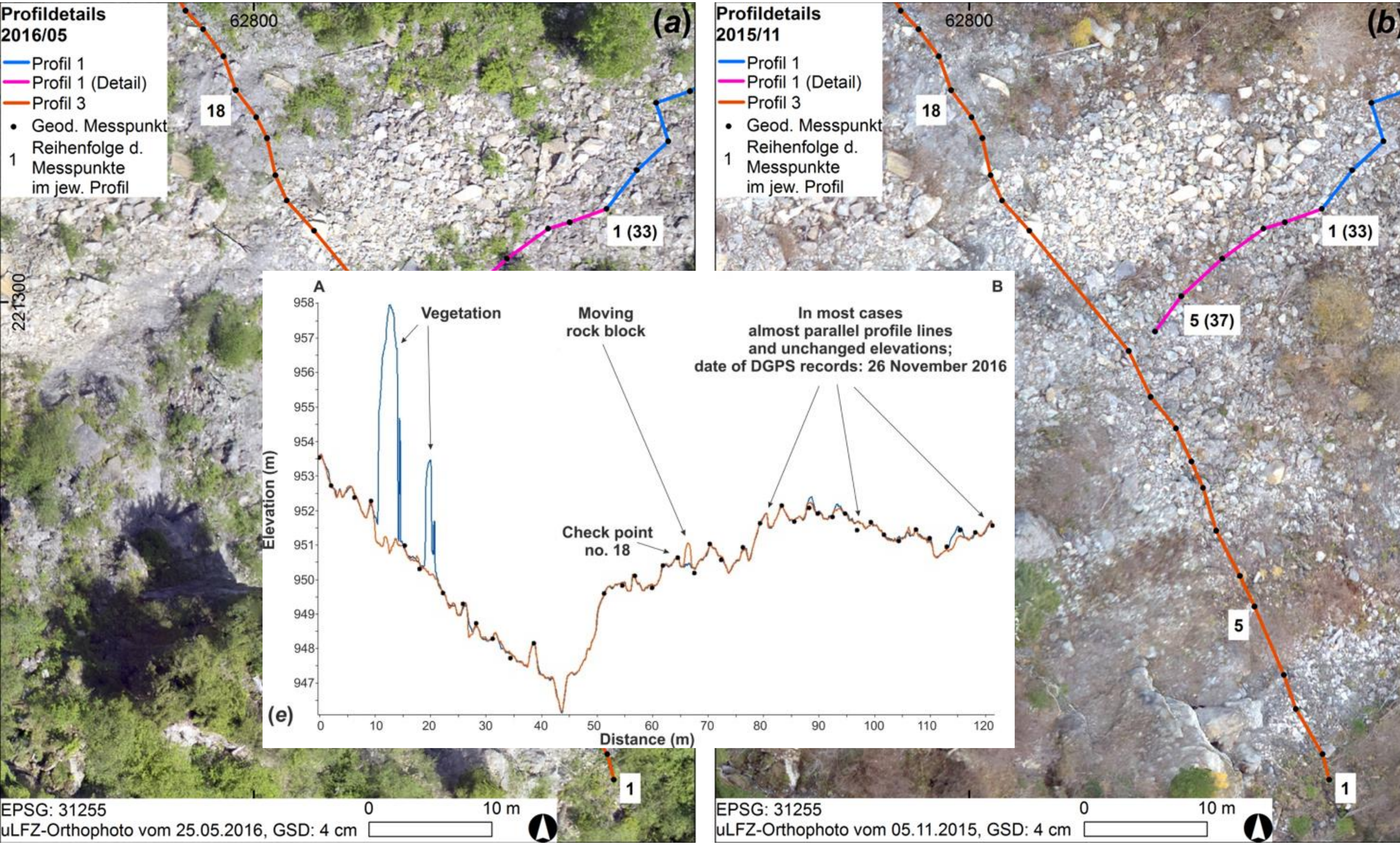
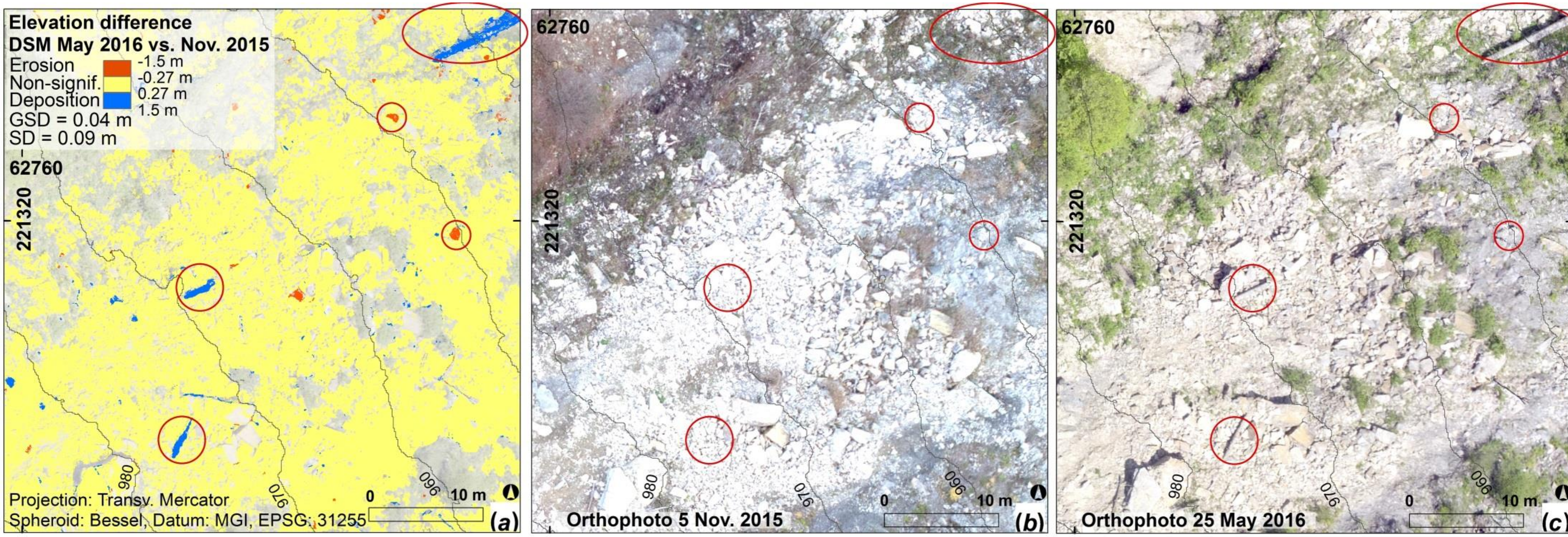
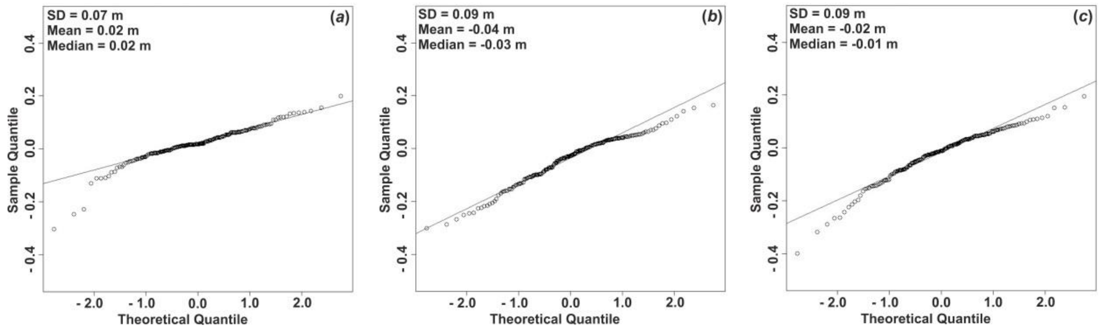


UAV based Monitoring of „Lärchberg-Galgenwald“ landslide

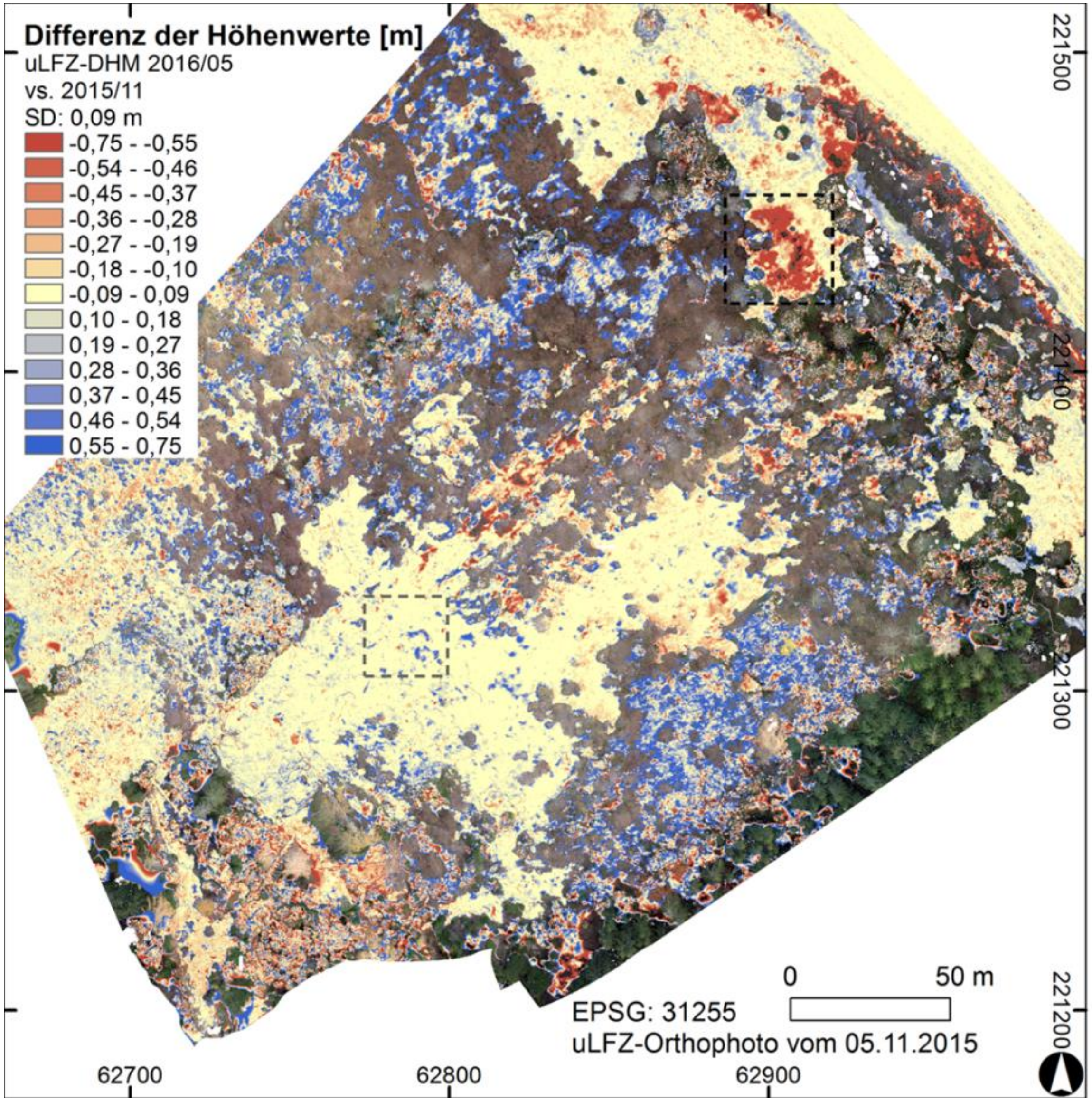
Height differences Nov.2015 vs. May 2016 in the active central part



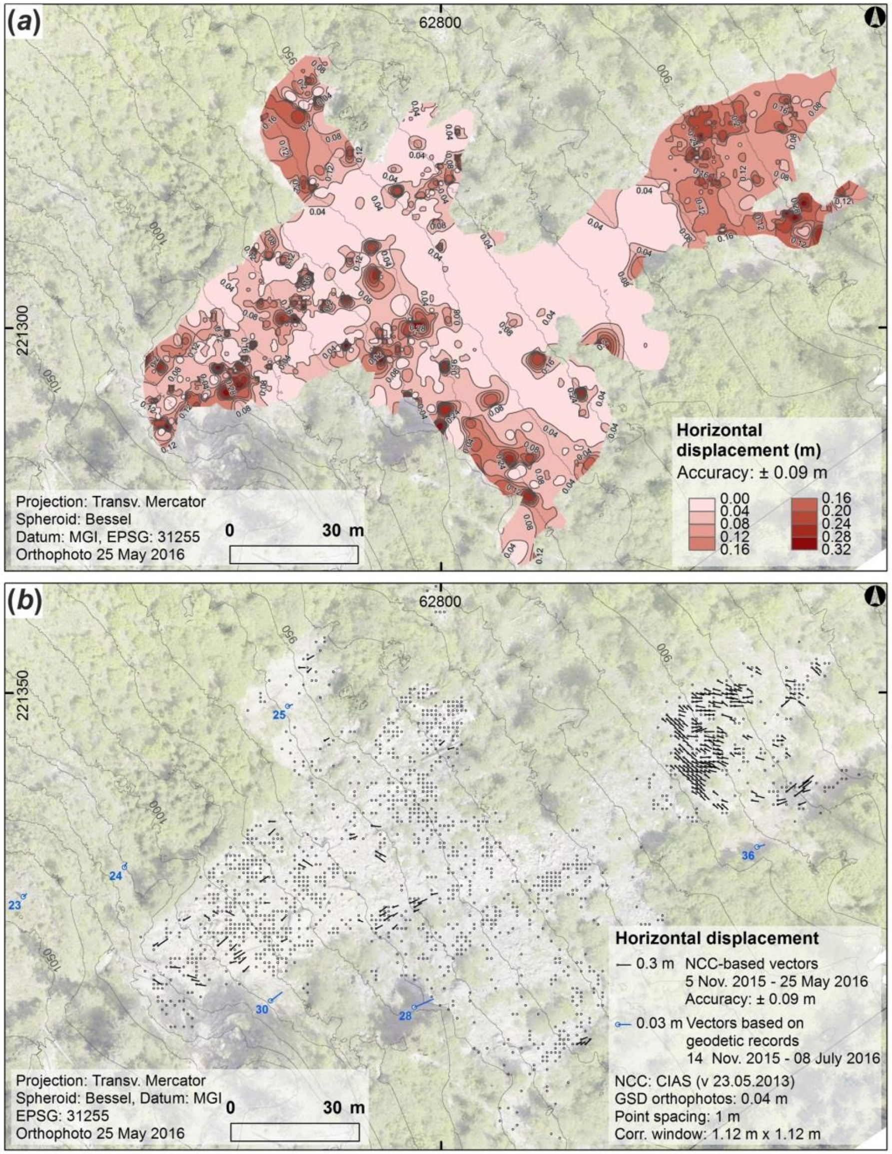


UAV based Monitoring of „Lärchberg-Galgenwald“ landslide

Height differences
Nov.2015 vs. May 2016



UAV based Monitoring of „Lärchberg-Galgenwald“ landslide



UAV based Monitoring of „Lärchberg-Galgenwald“ landslide

Outcomes

- **DEM differencing**: surface height lowering of: mean -0.07 m from November 2015 to May 2016
- **Orthophotos**: Mean **surface movement of 0.07 m** during that period
- **Accuracy of orthophotos**: 4cm
- **Accuracy of DEM** (geodetic Check points): within 9 cm
- Number of **GCPs can be reduced** to 5, if they are well distributed, without a meaningful loss of accuracy. This will reduce the time and risk in situ.
- UAV-based data **enhance the previous data base** and hence provide the basis for a more comprehensive assessment of the landslide’s activity.
- Therefore, we formed the **basis for a monitoring programme including UAV**.

*Gernot Seier, Wolfgang Sulzer, Paul Lindbichler, Josef Gspurning, Siegfried Hermann, Hermann M. Konrad, Gerhard Irlinger, Raimund Adelwöhrer, 2017**: UAS-based change detection of the Lärchberg-Galgenwald landslide, Austria**. Small Unmanned Aerial Systems for Environmental Research – 5th Edition, in press.*

Contents

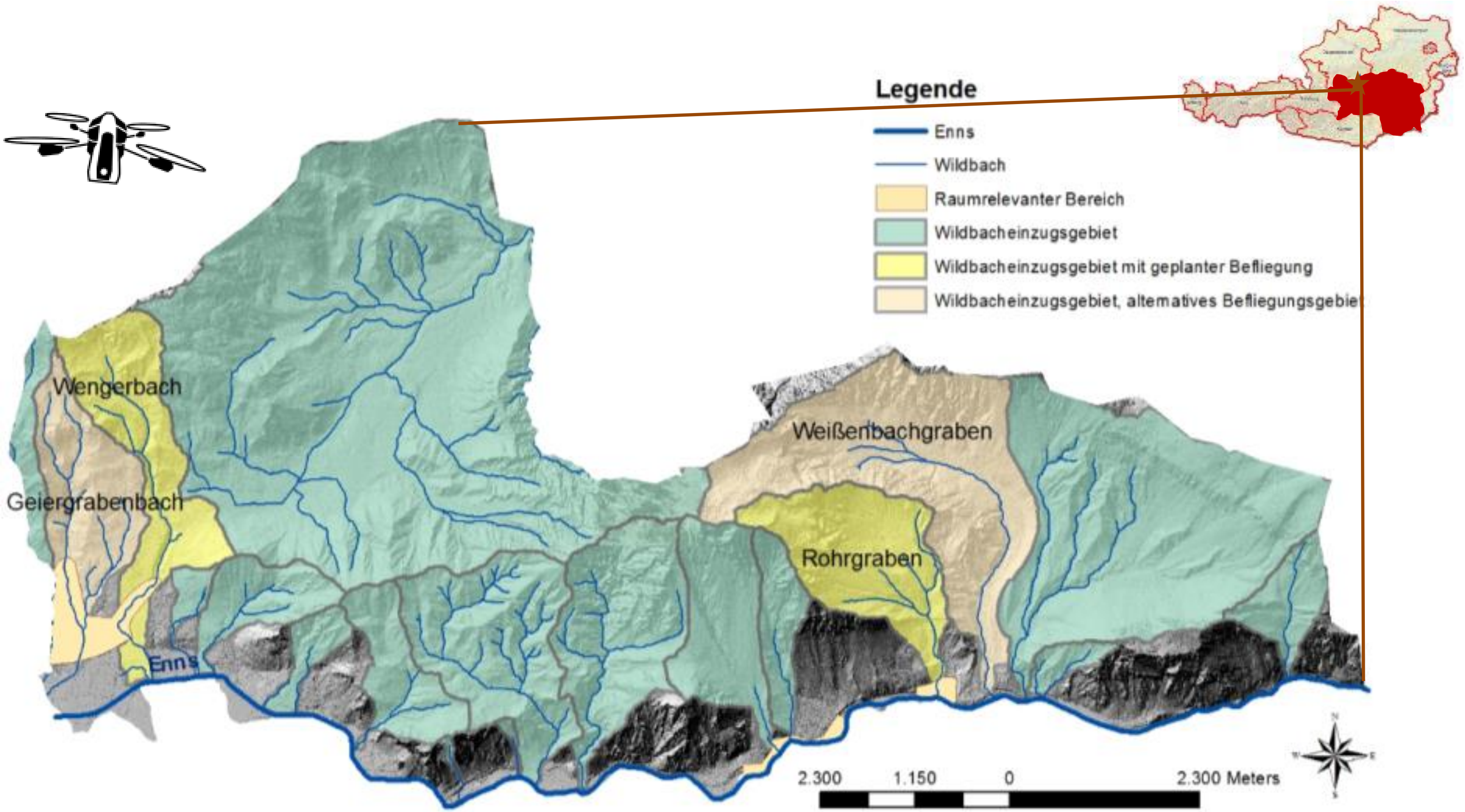
- Introduction
  - Institute for Geography / Geospatial Technologies
- Environmental Monitoring by means of UAV´s
  - UAV – legal situation in Austria
  - UAV Equipment and SFM
  - Case Studies
    - Cryosphere (Glacier and Rock glacier)
      - ✓ Pasterze
      - ✓ Rock glacier
    - Reliefsphere / Lithosphere (Sediment dynamic)
      - ✓ Schöttlbach / Oberwölz
      - ✓ Langgriesgraben/ Gesäuse
    - Reliefsphere / Lithosphere (Landslide, Rockfall)
      - ✓ Galgenwald /Murau
    - Reliefsphere/ Biosphere (Torrent inspection)
      - ✓ Weng / Gesäuse
- Résumé / Outlook

UAV for torrent inspection/survey in Weng / Gesäuse

Aim of the project:

- **Annual torrent inspection/survey by law (Austrian Forest Act)**
- **Survey is time and money consuming**
- **Difficult access and steep relief**
- **No legal consequences when no survey has been done**
- **Can Remote Sensing (UAV, aerial photographs satellite images) to support the survey?**

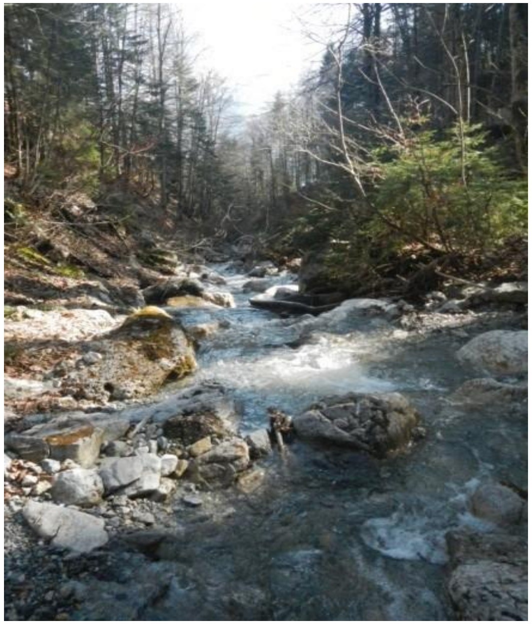
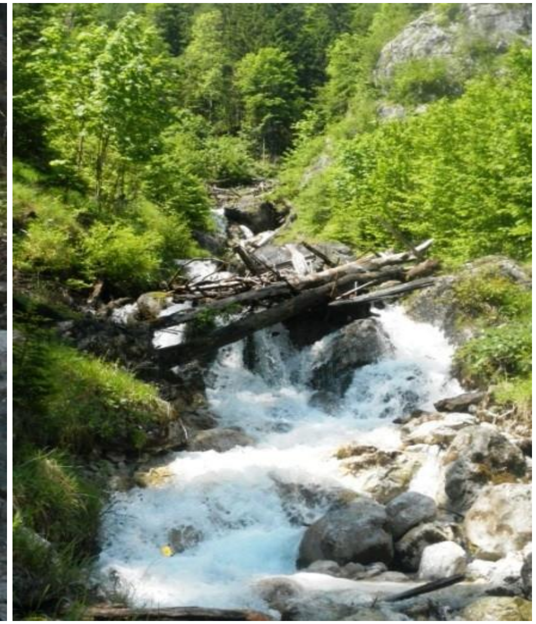
UAV for torrent inspection/survey in Weng / Gesäuse



UAV for torrent inspection/survey in Weng / Gesäuse

Possible influences on floods and mudflows!

UAV for torrent inspection/survey in Weng / Gesäuse


UAV for torrent inspection/survey in Weng / Gesäuse

UAV for torrent inspection/survey in Weng / Gesäuse

Orthophoto 2014
UAV 3 cm

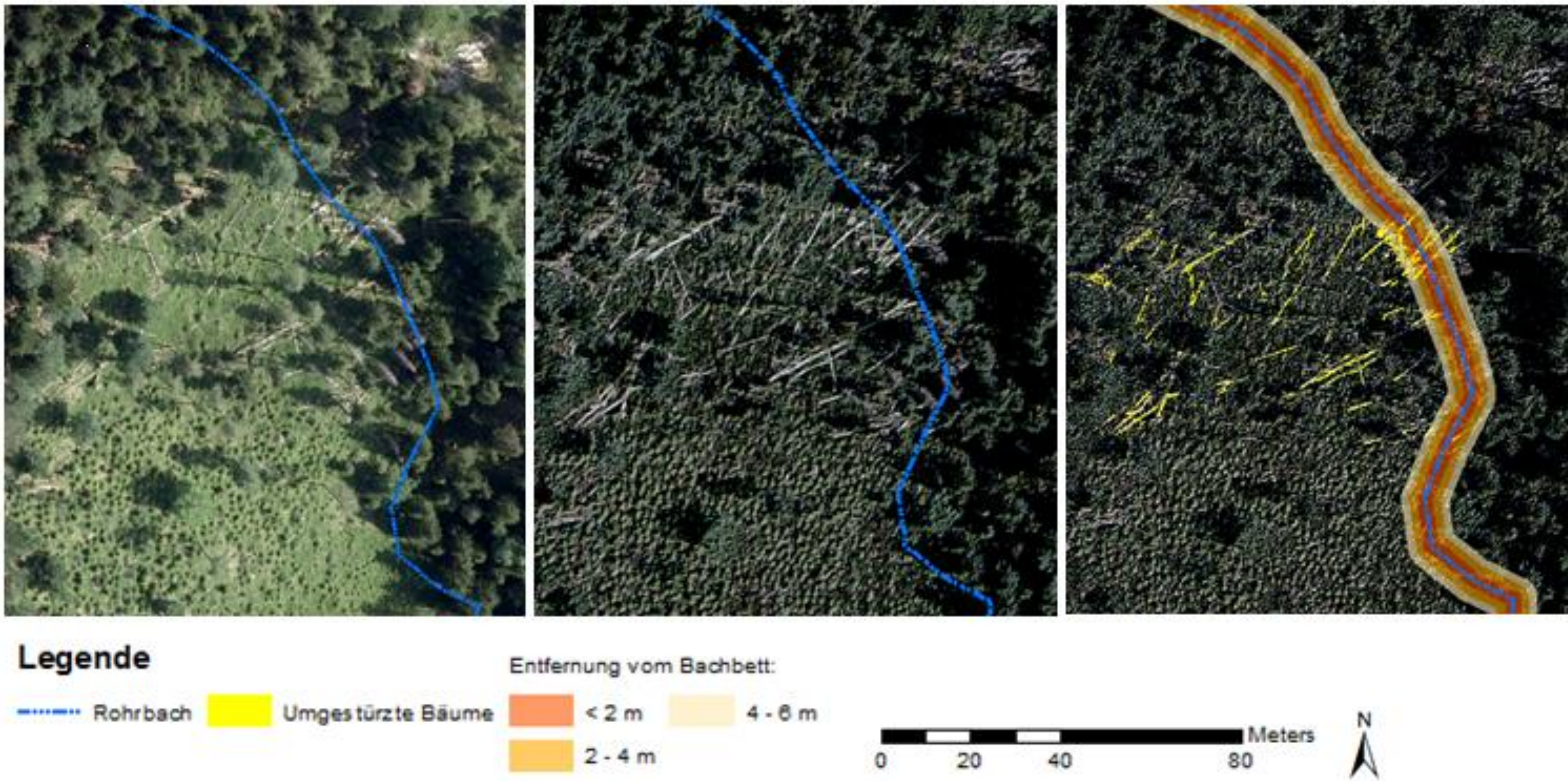
Orthophoto 2014
UC 10 cm

Orthophoto 2010
UC 20 cm

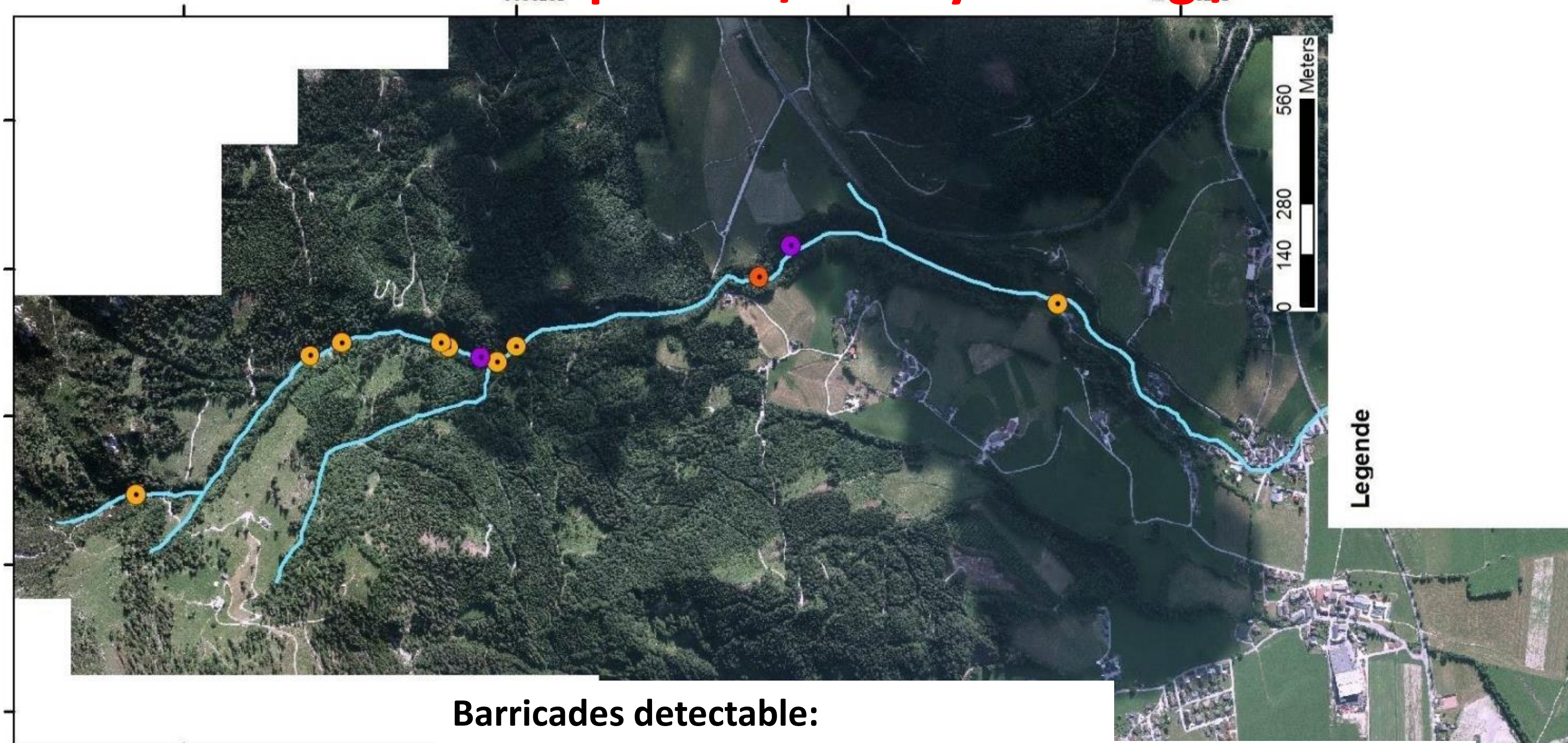
Field Work 2014

UAV for torrent inspection/survey in Weng / Gesäuse

Orthophoto 2014 UAV 3 cm	Orthophoto 2014 UC 10 cm	Orthophoto 2010 UC 20 cm



UAV for torrent inspection/survey in Weng / Gesäuse



Barricades detectable:

- in all media
- only in UAV images
- in UAV images and UltraCam Eagle
- only during field survey

UAV for torrent inspection/survey in Weng / Gesäuse

Outcomes

- **Additional to field survey**
- **In remote and inaccessible, steep areas**
- **Weather conditions** in spring time, just before or at the beginning of vegetation period
- **Limits in** sight (riparian vegetation, shadow, acquisition angle (FOV), clouds)
- **Not all barricades are detectable**
- **GPS Acquisition, GCP measurements, starting point, Autopilot**

*Tillian, M. and Sulzer, W., 2016: **Remote Sensing (UAV) for torrent inspection/survey in the alpine municipality of Weng im Gesäuse (Austria).** In: Halada, Ľ., Bača, A., Boltižiar, M. (eds Landscape and Landscape Ecology. Proceedings of the 17th International Symposium on Landscape Ecology, 27-29 May 2015, Nitra, Slovakia, Institute of Landscape Ecology, Slovak Academy of Sciences, Bratislava, Branch Nitra, 192-202. http://www.uke.sav.sk/old/phocadownload/symposium/o22_Tillian-et-al_ORAL_Symp2015.pdf*

Résumé

Strengthen and weakness of the use of UAV

Strengthen		Weakness
✓ High geometric resolution		▪ Legal restrictions
✓ High point cloud		▪ Technical restrictions
✓ Constant point cloud		▪ Weather restriction: wind, temperature
✓ Perfect viewing angle		▪ Requirement of GCP´s for the workflow
✓ Flexible during flight campain		▪ Limiting vegetation cover
✓ „cheap“		▪ Safe use in difficult topography only with intensive training (TOL)
		▪ Shadow is limiting the model building

Résumé

… The reader should **not be looking for brilliant new methods of analysis and interpretation** of remotely sensed data in these papers.

Most of what is being done is applying established digital photogrammetric methods or remote sensing analysis and interpretation to **data acquired in a new way and to problems that in many cases could not have been tackled previously**. …

Source: Eds. (2017): **Unmanned aerial vehicles for environmental applications.** ***Intern.*** *Journal of Remote Sensing*, 38/8-10, 2029-2036, doi:0.1080/01431161.2017.1301705

Résumé

- New campaigns will bring new data and new challenges
- New UAV Systems
- New laws?
- Cooperation is important !
- The work would not be possible, if

MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

WILDBACH- UND LAWINENVERBAUUNG

Josef Gspurning, Simon Hirschmann, Andreas Kellerer-Pirklbauer-Eulenstein, Walter Krämer, Gerhard Karl Lieb, Robert Leitner, Paul Lindbichler, Eric Rascher , Matthias Rode, Oliver Sass, Stefan Schöttl, Johannes Stangl, Marlene Tillian, Matthias Wecht …

Das Land Steiermark

STADTGEMEINDE MURAU

OBERWÖLZ

NATIONALPARK GESÄUSE






Thank you for your attention !