Institut für Photogrammetrie

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Universität Stuttgart

The UAS@LGL BW Project – A NMCA Case Study

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Photogrammetric Week 2013

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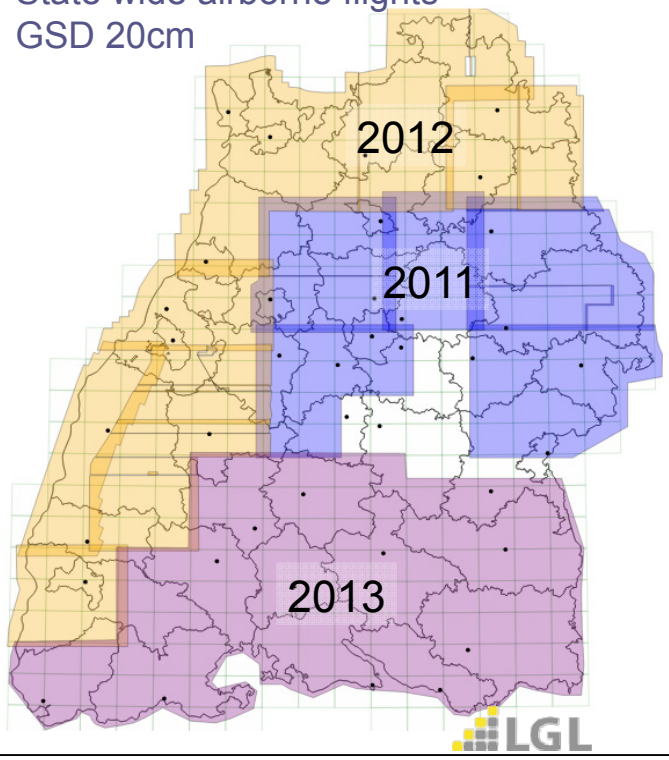
Situation in National Mapping

- Definition NMA / NMCA: “organisation, usually publicly owned, that **produces topographic maps and geographic information of a country**. Some national mapping agencies also deal with **cadastral matters**”

- Geo-information mostly is derived from airborne sensors / flights
  - Large format photogrammetric digital cameras (up to 260 Mpix/Image)
  - Laser scanners
  - Other airborne sensors, i.e. Radar, hyperspectral sensors, …

Situation in National Mapping

State wide airborne flights
GSD 20cm



Photoflight Airplane

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Standard-Mapping vs UAS-Mapping?

Are there any UAS-applications in national mapping?

Will UAS-mapping provide sufficient accuracy?

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UAS Application Fields for NMAs

Ordnance Survey
Great Britain

Flexible mapping – sea coast/cliffs, high/low water surveys

Kadaster
Netherlands

Verification process of cadastral borders of ownership

IGN
France

Dyke surveys, more general use of UAS (own UAS-camera development)

EuroSDR

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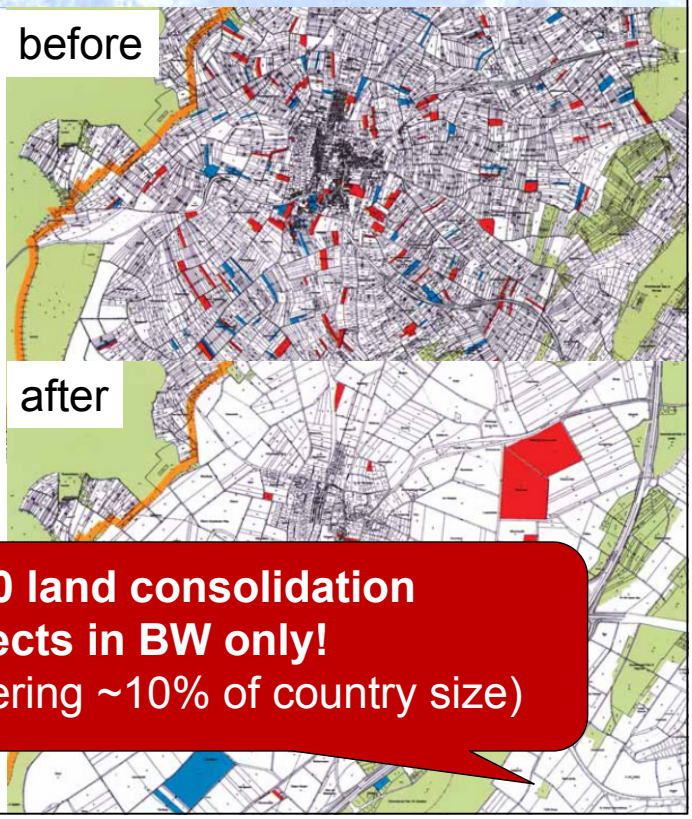
UAS Application Fields for NMAs

LGL Baden-Württemberg
Germany

Land consolidation



> 450 land consolidation projects in BW only!
(covering ~10% of country size)

EuroSDR

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Project Definition @ LGL BW

Especially for

- **updating** and quality assurance of geo-basis information,
- for **land consolidation projects** (special photogrammetric 3D-evaluations),
- for **publicity** and for **documentation purposes** (e.g. oblique aerial images for land consolidation projects and tourism, virtual fly-through-landscape simulations)

the LGL BW checks **more efficient and flexible** data acquisition methods **to complement or as an alternative** to the traditional large-area (manned) flight missions.

UAS @ LGL BW study - First study of use of UAS in national mapping in Germany – pilot project between LGL BW & University of Stuttgart (Institute for Photogrammetry ifp & Institute of Flight Mechanics iFR)

[from project definition LGL Baden-Württemberg, 2012]

UAS @ LGL BW Project Test Site „Felsengärten Hessigheim“

Parameter	Value
Area size	1000 x 400 m²
Terrain Z_{max}	275 m
Terrain Z_{min}	180 m
Δ Z	~ 100 m
Flying height above ground	180 m
aspired GSD	<10 cm (5 – 8 cm)

Felsengärten Hessigheim
25 km north of Stuttgart at Neckar River

Flight System Components
UAS-Platform & Camera

	Ricoh GXR Mount A12 with Zeiss Biogon 21 mm
No. Pixel	4288 × 2848
Pixelsize	5.5 µm
Sensorsize	23.6 × 15.7 mm²
Lens	Zeiss Biogon T* 21 mm (fix focus)
Weight	650 g
Prize (ca.)	1950 EUR (05.2012)

Wing span: 220cm
Take of weight: ca. <4kg, including
- camera: 650g
- power supply: 550g
- electronics: 300g

(UAS-micro category)

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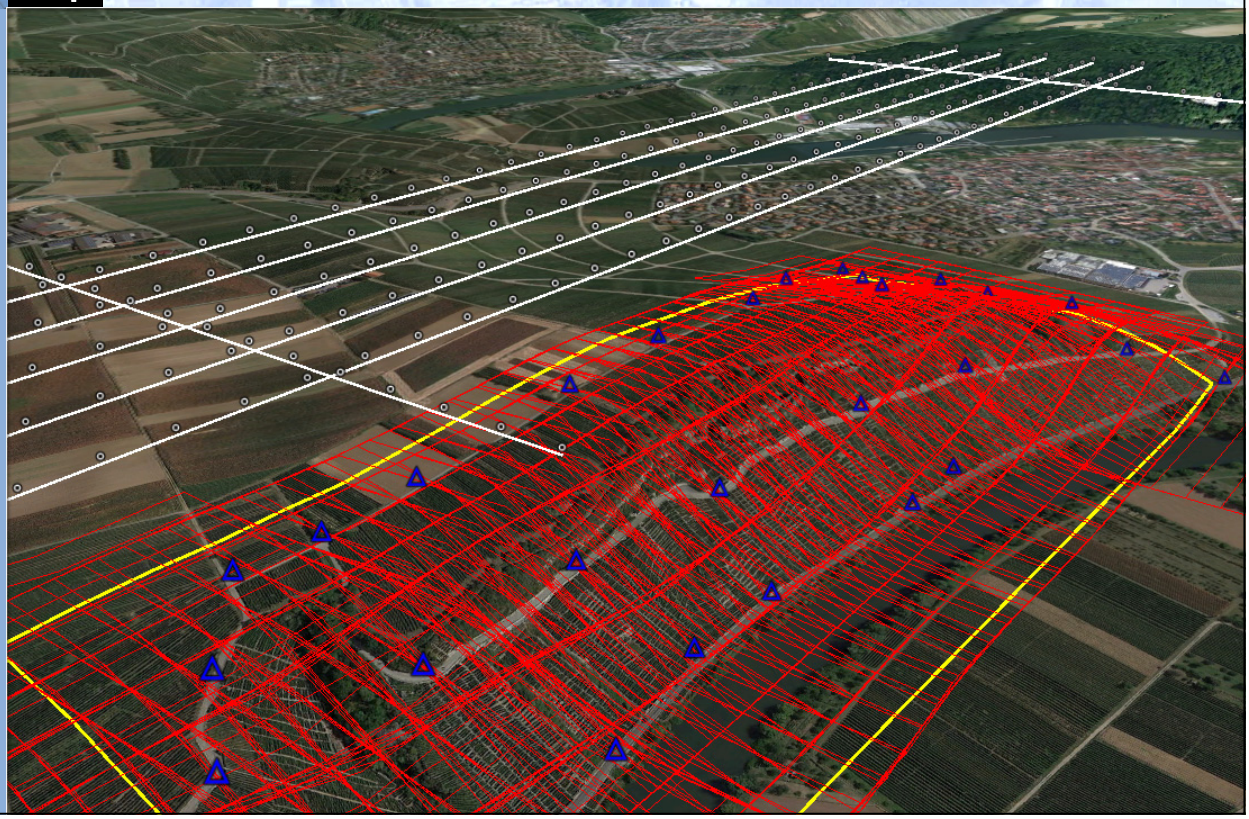
UAS @ LGL BW Project Test Site
Flight Planning



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UAS Imagery: Ricoh/Zeiss Camera
Photoflight Aug 23, 2012

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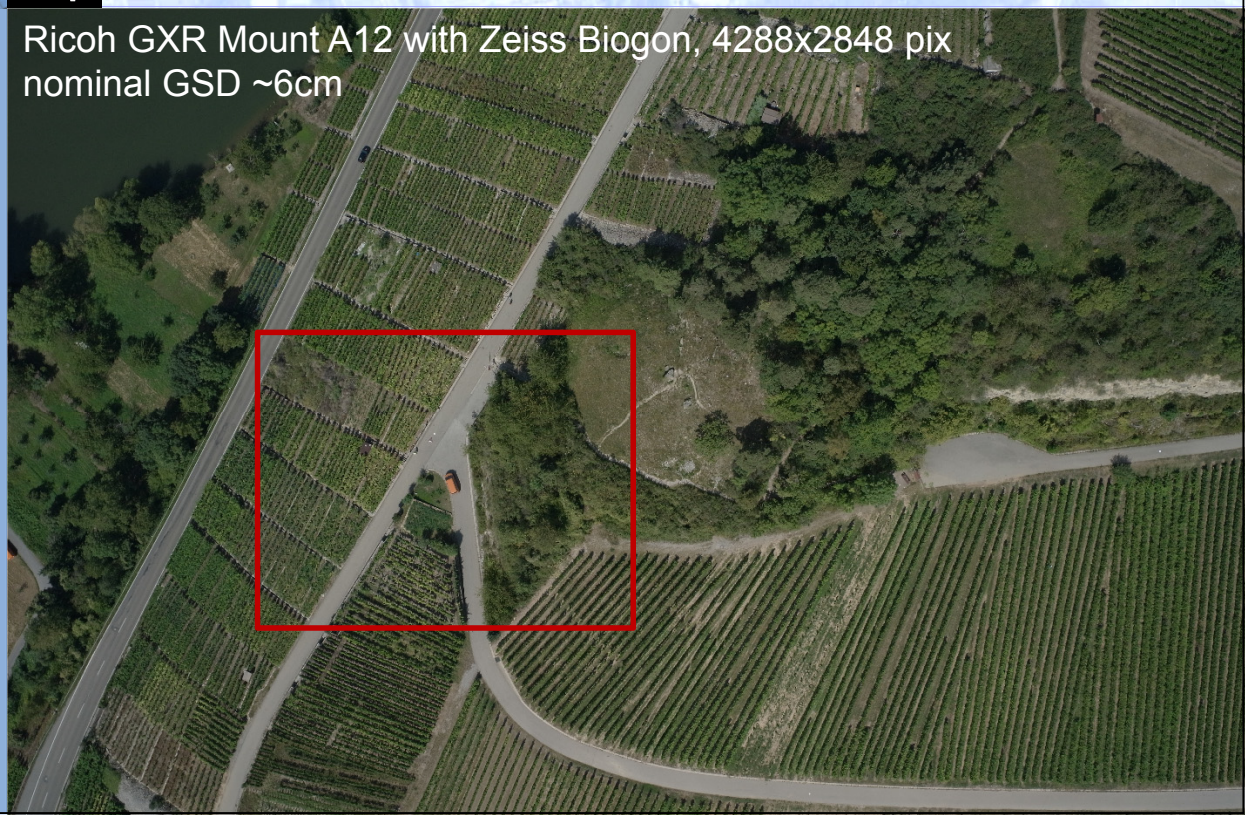

UAS Imagery: Ricoh/Zeiss Camera Photoflight Aug 23, 2012

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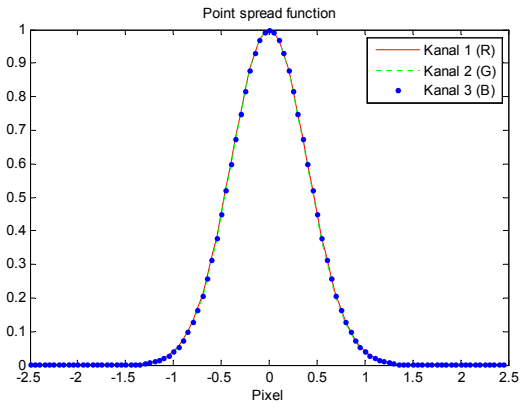
JPG @ 200%



GSD nominal: 4.942 cm

	R	G	B
sigma_psf (pix)	0.397	0.392	0.395
RP_FWHM (cm)	**4.615**	**4.558**	**4.592**

Height above star: 188.7 m

Image Processing

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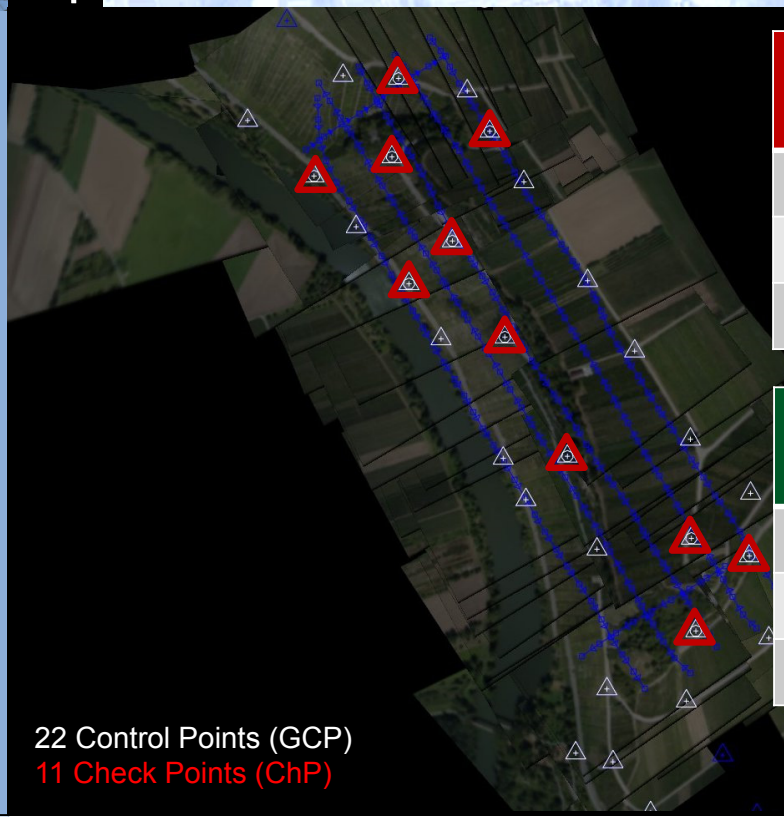
Standard mapping		UAS mapping
GNSS/inertial data „leveled“ camera	Initial Orientation / Set-up of Image Block	GNSS (code only) Attitudes > 0…5 deg
AAT (tie points from FBM/LSM)	Refinement of Image Orientation of Block	Structure from Motion (SIFT tie points)
GNSS supported AT few control points	Transformation into Mapping Frame	few control points
self-calibration (math. models)	Calibration of Camera	Full in-situ camera calibration (physical models)
lfp-processing	Product Generation DSM & Orthophoto	
PIX4uav Desktop		

Photogrammetric Processing
3D Object Point Accuracy



Match-AT	Accuracy (RMS)
East	0.029 m
North	0.024 m
Vertical	0.043 m

PIX4 uav	Accuracy (RMS)
East	0.017 m
North	0.014 m
Vertical	0.061 m

Notice:
GSD 5 – 8 cm

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Surface Model Generation

ifp SURE – Semi Global Matching SGM

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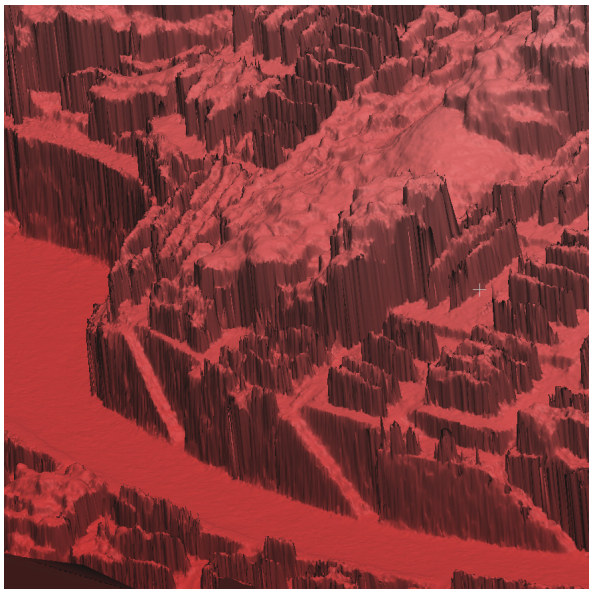
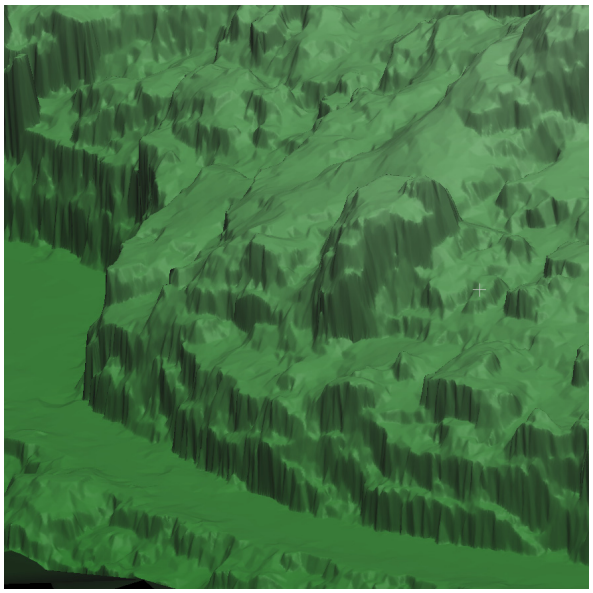
Surface Model Generation
Comparison SURE & PIX4uav



ifp SURE
Regular raster, 6cm grid



PIX4uav Desktop (Version 2.2.3)
Regular raster, 6.1cm grid

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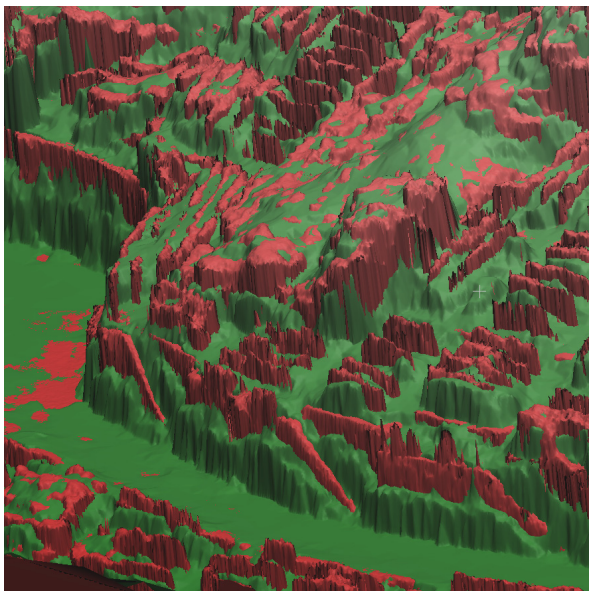
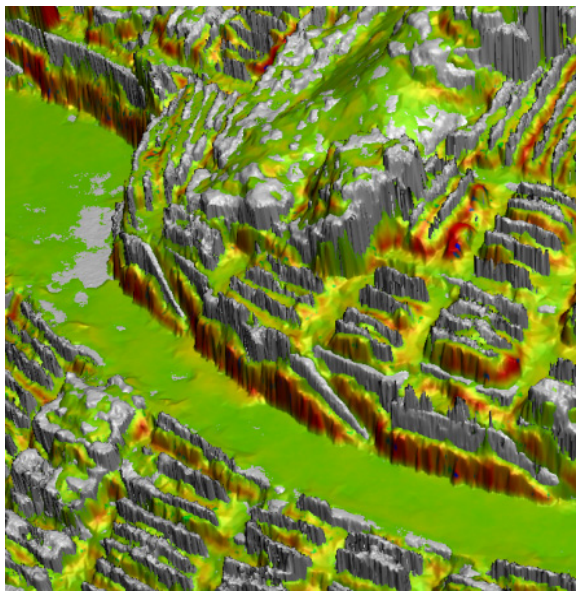
Surface Model Generation
Comparison SURE & PIX4uav



Overlay SURE & PIX4uav



Difference Δ = SURE - PIX4uav

green $|\Delta| < 0.3m$ gray $|\Delta| > 1.6m$
red $0.3m < \Delta < 1.6m$
blue $-1.6m < \Delta < -0.3m$

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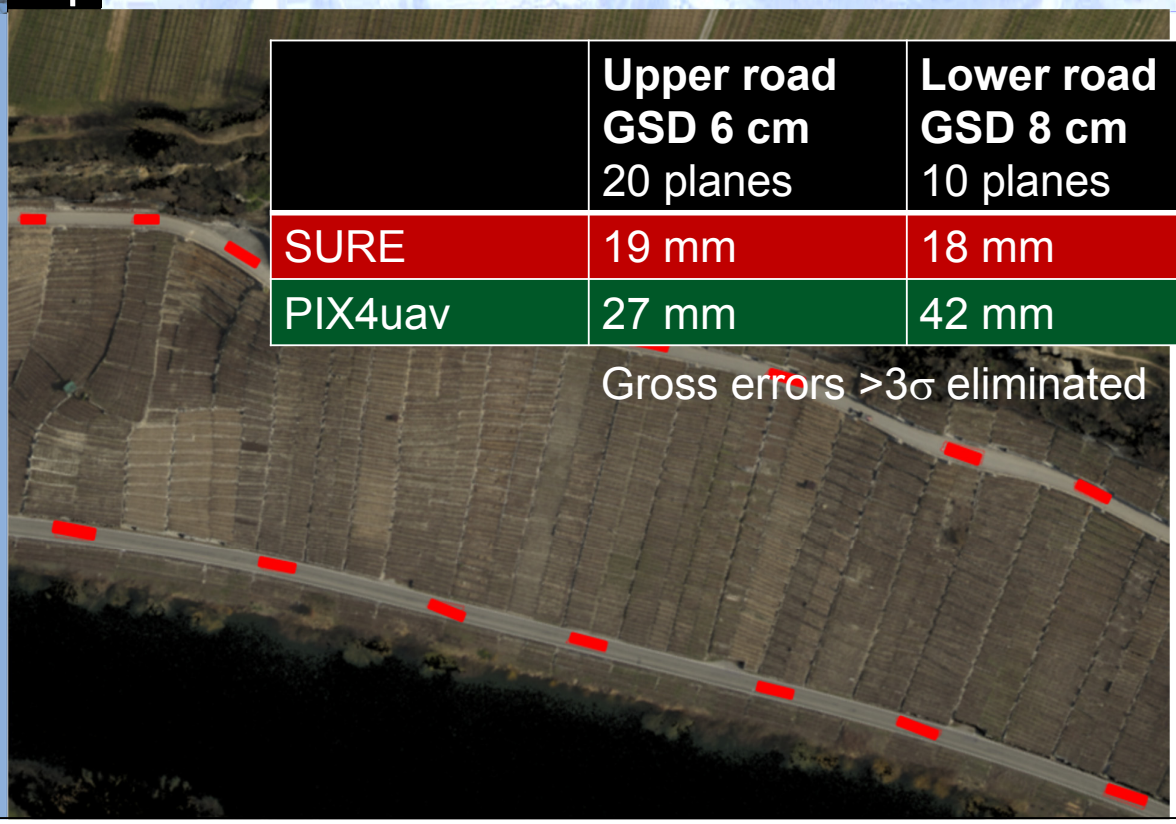
Surface Model Generation
Relative accuracy from 30 reference planes



	Upper road GSD 6 cm 20 planes	Lower road GSD 8 cm 10 planes
SURE	19 mm	18 mm
PIX4uav	27 mm	42 mm

Gross errors >3σ eliminated

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Standard-Mapping vs UAS-Mapping?

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Summary

Results from pilot study UAS@LGL BW

- All requested products had been derived
- Accuracy expectations (over-)fulfilled
- **Flexible & easy data acquisition** (15min flight)
- Frequent flights (**photogrammetry on demand**) possible (in principle)

Use of UAS for NMAs in general

- UAS is of interest and developments are followed by NMAs
- UAS will not replace the traditional large format sensors, but will be advantageous for **local area applications**
- **Harmonized flight regulations** throughout Europe will be the requirement for further use of UAS in NMAs
- Find appropriate **business model**?

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