HARMONIOUS
UAS Techniques for Environmental Monitoring
Flavia Tauro – Valencia, February 15th 2018
Streamflow observations from UASs: technical challenges and image processing
Agenda

- Objective: improving and increasing observations
- State of the art on streamflow observations
- Methodology: setup and algorithms
- Case study
- Conclusions
Improving and increasing observations

- Hydrological process understanding demands data
- What is needed:
  - New measurement techniques and equipment
  - More field measurements and monitoring
- Greatest challenge:
  - Maintenance of monitoring networks
Improving and increasing observations

- Traditional monitoring systems

- Where we stand: [http://www.bafg.de]
  - Limited spatial and time coverage
  - Expensive equipment
  - High maintenance costs
Improving and increasing observations

- Novel sensing systems
  - Multi-disciplinarity
  - Innovation (smart, opportunistic measurements)
  - Affordable solutions

Measurements and Observations in the XXI century (MOXXI): innovation and multi-disciplinarity to sense the hydrological cycle

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State of the art: streamflow observations

- How is streamflow currently measured?

- Pointwise observations at selected cross-sections
- Often invasive measurements
- Expensive equipment
- Rare measurement campaigns
State of the art: streamflow observations

- Multiscale and heterogeneity

RILLS:
- hillslope rills:
  - from a few to several cm
  - turbidity
  - vegetation

STREAMS:
- streams:
  - sediments
  - high regime
  - shallow depths
  - irregular beds
  - reflections

RIVERS:
- rivers:
  - high flow regime
  - vegetation
  - large cross-section and depths
State of the art: streamflow observations

- Difficult-to-access environments
  - Sensor deployment
  - Operators’ safety issues
State of the art: streamflow observations

- Fastly evolving processes
Proposed methodology

- Using optic technology and image analysis to measure streamflow

Diagram:
- Stream flow
- Overland flow
- Channel flow
Methodology

- Images offer several advantages
  - Noninvasive observations
  - Spatially distributed measurements
  - Potentially high time resolution
  - Observations at multiple scales
Methodology: algorithms

- From raw to usable data

1. Frame extraction
2. Camera calibration
3. Image orthorectification
4. Frame calibration
5. Frame enhancement
Methodology: algorithms

- Large Scale Particle Image velocimetry
Methodology: algorithms

- Particle Tracking Velocimetry
Methodology: setup

- Unmanned aerial systems for surface flow velocity field observations
Case study

- Feasibility assessment

[Tauro et al., 2016, *J. Hydrol.*]
Case study

- Surface flow measurements

Conclusions

- UASs offer several advantages with respect to traditional instrumentation for streamflow observations
- Low-cost platforms have led to reliable surface flow velocity maps
- Image processing with alternative algorithms may lead to quicker measurements

Future directions

- Fully remote discharge measurements
- Real-time streamflow measurements