Summary of activities of WG4: River monitoring

Dariia STRELNIKOVA[1], Matthew T. PERKS[2]

[1] School of Geoinformation, Carinthia University of Applied Sciences, Villach, Austria,
[2] School of Geography, Politics and Sociology, Newcastle University, Newcastle Upon Tyne, United Kingdom

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Funded by the Horizon 2020 Framework Programme of the European Union

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Content

- Main research topics
- Meetings
- STSMs
- Publications
- Cooperation with WG1

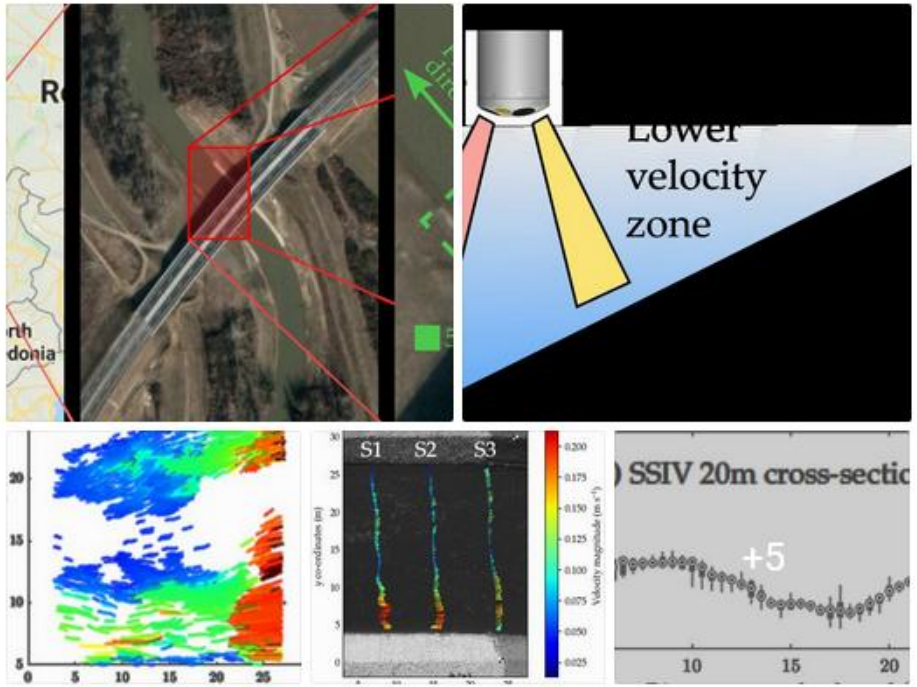
Main research topics (1)

River flow monitoring: Best practices

- A book chapter by Strelnikova *et al.*

Algorithms for image velocimetry

- A comparative analysis of 5 image velocimetry algorithms: 1 field campaign, 2 STSMs (Sophie Pearce and Robert Ljubičić) and a paper by Pearce *et al*., 2020



An Evaluation of Image Velocimetry Techniques under Low Flow Conditions and High Seeding Densities Using Unmanned Aerial Systems

Article Jan 2020

Sophie Pearce · Robert Ljubičić · Salvador Peña-Haro · [...] · Salvatore Manfreda

Image velocimetry has proven to be a promising technique for monitoring river flows using remotely operated platforms such as Unmanned Aerial Systems (UAS). However, the application of various image velocimetry algorithms has n... …

View

6 Recommendations · 646 Reads · 41 Citations

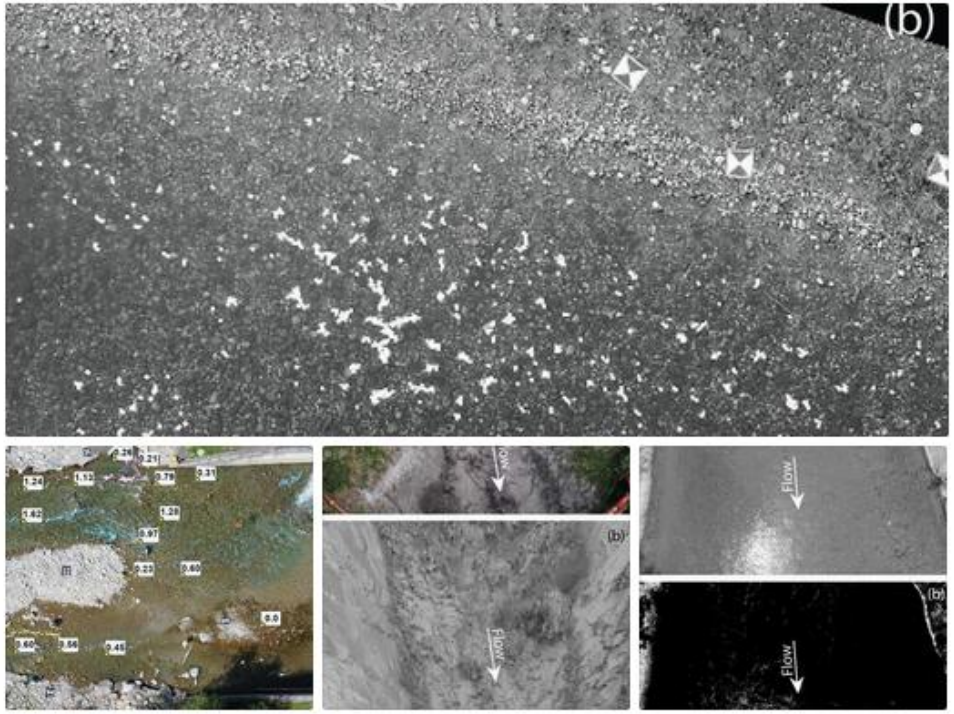
Main research topics (2)

Monitoring of river channel dynamics

- A book chapter by Bertalan *et al.*

Data for image velocimetry

- A public archive with river flow videos and reference measurements + a data description paper by Perks *et al.*



Towards harmonisation of image velocimetry techniques for river surface velocity observations

Article Jul 2020

Matthew Thomas Perks · Silvano Fortunato · Silvano Fortunato Dal Sasso · [...] · Salvatore Manfreda

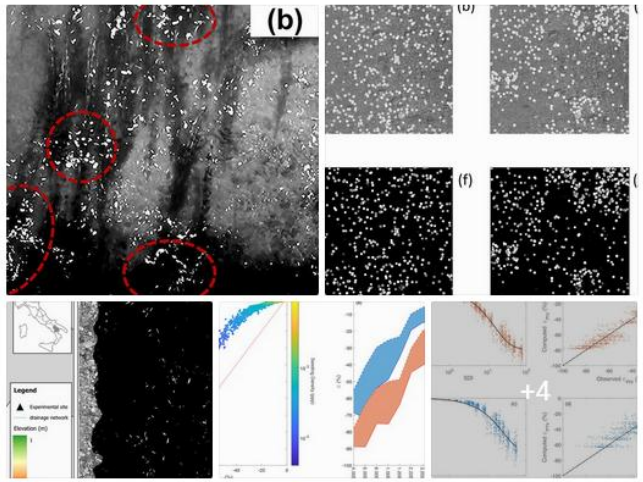
Since the turn of the 21st century, image-based velocimetry techniques have become an increasingly popular approach for determining open-channel flow in a range of hydrological settings across Europe and beyond. Simultaneously, a... …

View 10 Recommendations · 522 Reads · 22 Citations

Main research topics (3)

Seeding in image velocimetry

- A series of papers by Dal Sasso *et al.* & Pizarro *et al.* on characterisation of seeding conditions, quantification of seeding characteristics and optimal spatial distribution of tracers



Identifying the optimal spatial distribution of tracers for optical sensing of stream surface flow

Article Nov 2020

Alonso Pizarro · Silvano Fortunato Dal Sasso · Matthew Thomas Perks · Salvatore Manfreda

River monitoring is of particular interest as a society that faces increasingly complex water management issues. Emerging technologies have contributed to opening new avenues for improving our monitoring capabilities but have also... …

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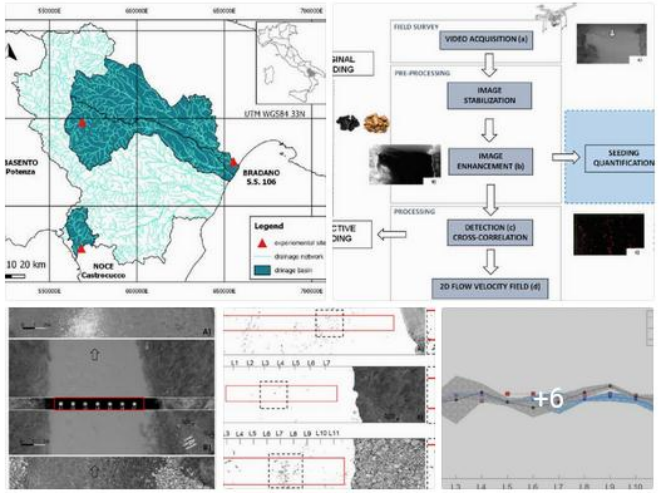


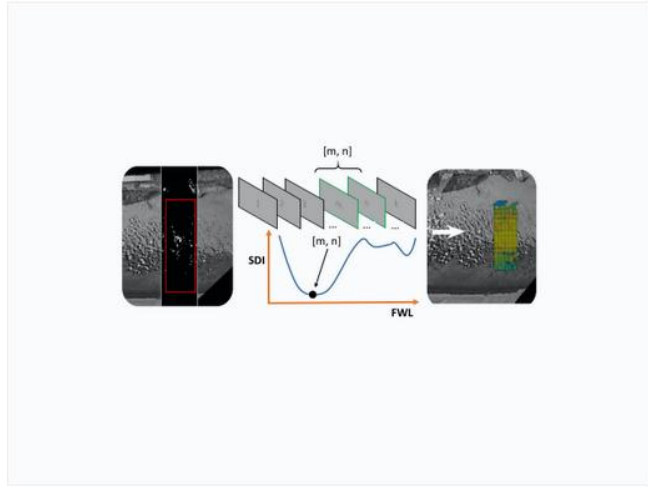
Metrics for the Quantification of Seeding Characteristics to Enhance Image Velocimetry Performance in Rivers

Article Jun 2020

Silvano Fortunato Dal Sasso · Alonso Pizarro · Salvatore Manfreda

River flow monitoring is essential for many hydraulic and hydrologic applications related to water resource management and flood forecasting. Currently, unmanned aerial systems (UASs) combined with image velocimetry techniques... …

View 5 Recommendations · 218 Reads · 20 Citations



Refining image-velocimetry performances for streamflow monitoring: Seeding metrics to errors minimisation

Article Sep 2020

Alonso Pizarro · Silvano Fortunato Dal Sasso · Salvatore Manfreda

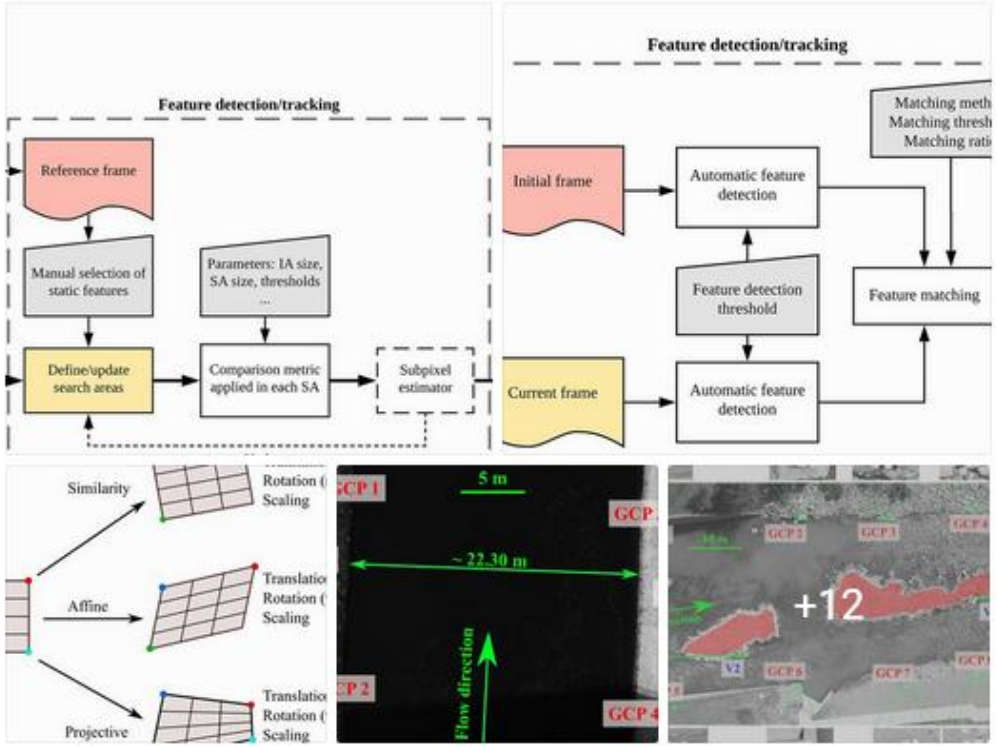
River streamflow monitoring is currently facing a transformation due to the emerging of new innovative technologies. Fixed and mobile measuring systems are capable of quantifying surface flow velocities and discharges, relying on... …

View 4 Recommendations · 84 Reads · 9 Citations

Main research topics (4)

Video stabilisation

- An STSM of Robert Ljubičić (Serbia) hosted by Salvatore Manfreda (Italy)
- An open source image stabilisation software SSIMS developed by Robert Ljubičić
- A paper by Ljubičić *et al.* (2021) on a comparison of tools and techniques for stabilising UAS imagery
- A book chapter by Peña-Haro *et al*. on geometric correction and stabilisation of images



A comparison of tools and techniques for stabilising unmanned aerial system (UAS) imagery for surface flow observations

Article Sep 2021

Robert Ljubičić · Dariia Strelnikova · Matthew Thomas Perks · [...] · Salvatore Manfreda

While the availability and affordability of unmanned aerial systems (UASs) has led to the rapid development of remote sensing applications in hydrology and hydrometry, uncertainties related to such measurements must be quantified an... …

View 2 Recommendations · 113 Reads · 1 Citation

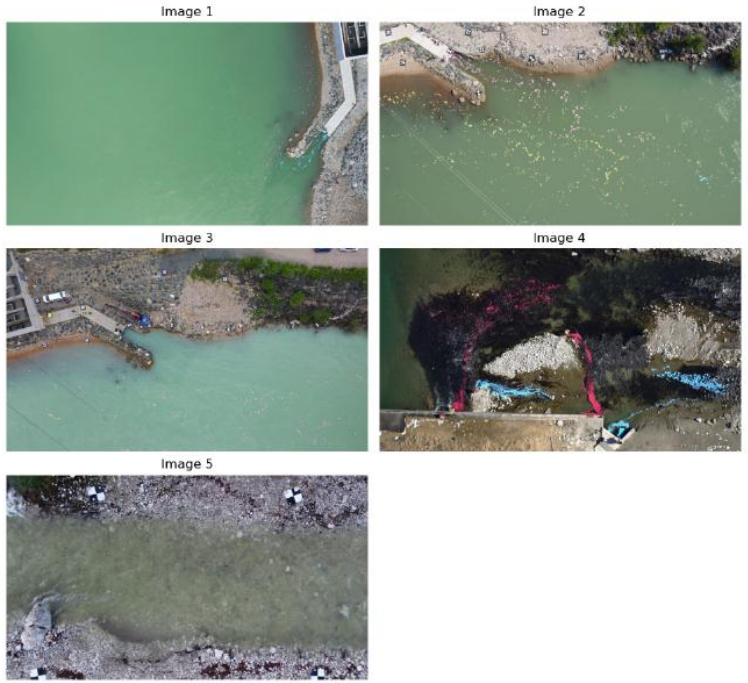
Main research topics (5)

Image enhancement

- An STSM of Robert Ljubičić (Serbia) hosted by Dariia Strelnikova (Austria) and a series of Jupiter Notebooks with hands-on image enhancement examples
- Jupiter notebooks with code snippets for testing will be published online in April 2022 and linked to the HARMONIOUS website
- Image enhancement functionality, including filter stacking, was added to the SSIMS software previously developed for stabilisation

Image enhancement (1)

- Image formats
  - JP(E)G
  - PNG
  - WebP
  - TIFF
  - BMP
  - GIF
- Image colorspaces
  - RGB/BGR
  - Grayscale
  - HSV
  - L*a*b*



- Image filtering
  - Image negative
  - Conversion to grayscale
  - Adjustment of brightness and contrast
  - Gamma adjustment
  - Histogram equalisation
  - Contrast-limited adaptive histogram equalisation (CLAHE)
  - Highpass filter
  - Intensity capping
  - Denoising
  - Removal of image background
  - ROI masking
- Filter stacking – reasonable filter combinations

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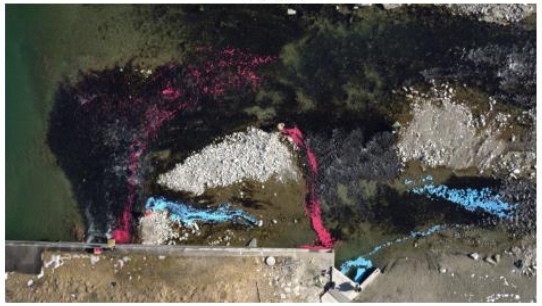
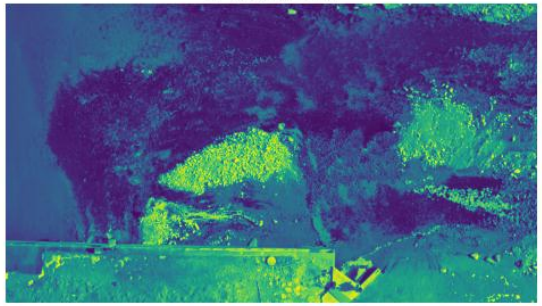
Image enhancement (2)

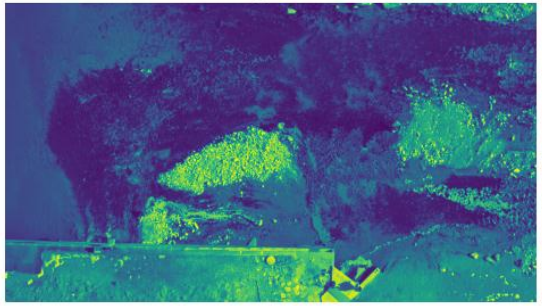
Original



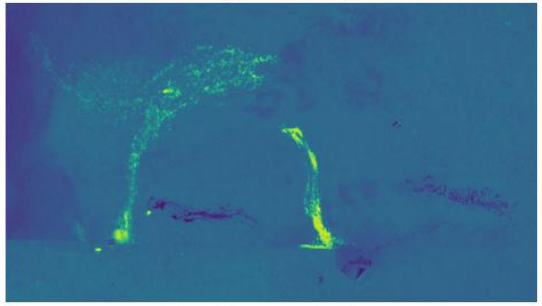
L* (lightness)



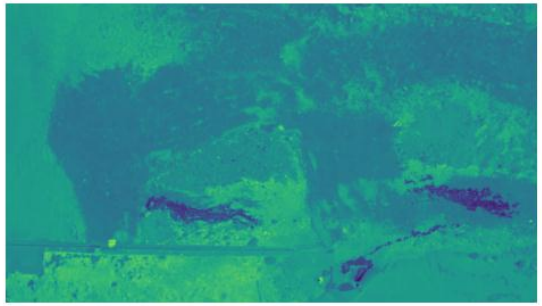
Grayscale

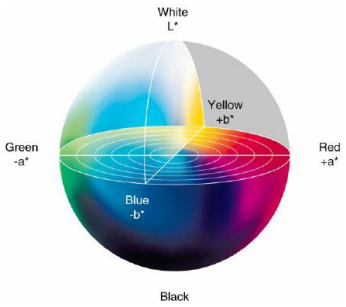


a* (green to red)



b* (blue to yellow)

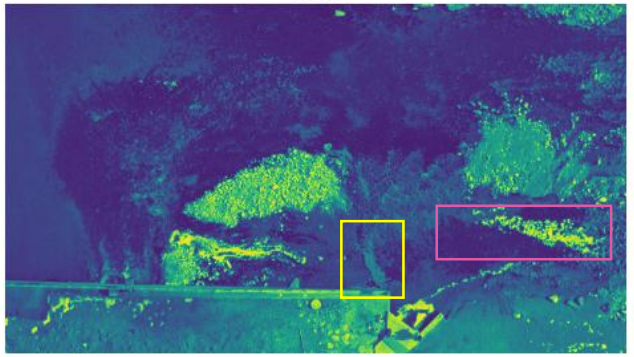




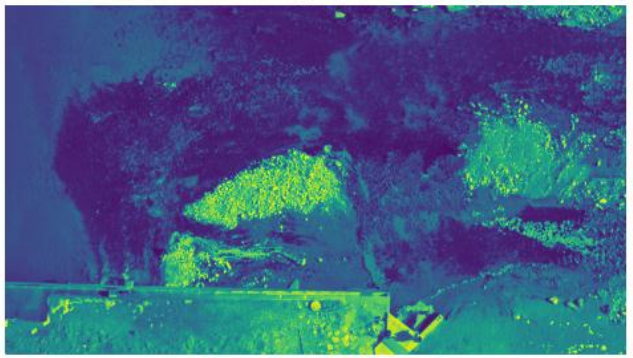
L*a*b*

Original

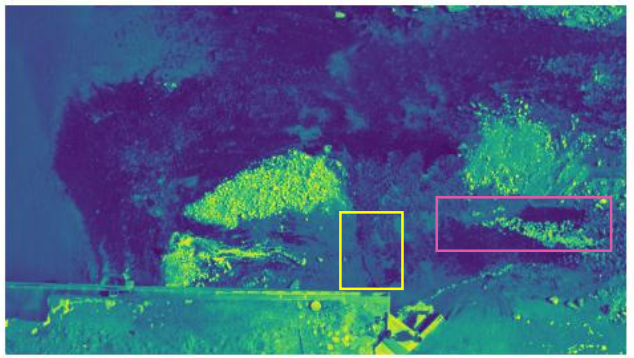
Blue



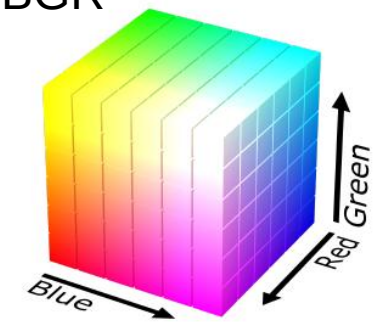
Grayscale



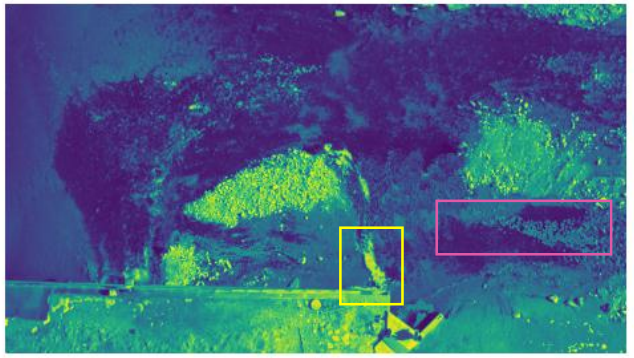
Green



RGB/BGR



Red



WG4 Meetings

Total of 6 meetings:

- Belgrade, Serbia 2018 (a workshop and a field experiment)
- Prague, Czech Republic 2019 (as a part of General Assembly)
- Rome, Italy 2019 (Belgrade data analysis and comparison of image velocimetry algorithms)
- Coimbra, Portugal 2019 (as a part of General Assembly)
- Villach, Austria 2020 (work on video stabilisation, recording of a promotional video)
- Magdeburg, Germany 2022 – held online (river monitoring with cameras)

STSMs (1)

A total of **8 STSMs** organized

#	Topic	Applicant	Host
1	UAVs for flow monitoring: • Assessment of changes in UAV camera angle/height and the accuracy of image-velocimetry results • Assessment of different image-velocimetry algorithms including: PTV, OTV, LSPIV and KLT-IV	Sophie Pearce, the UK	Flavia Tauro, Italy
2	Cooperation with STSM #1. Preparation and analysis of ADCP data for benchmarking different image velocimetry algorithms.	Robert Ljubičić, Serbia	Matthew Perks, the UK
3	Review and comparison of different image stabilization algorithms for UAV image velocimetry purposes. Preparation of Dissemination #8.	Robert Ljubičić, Serbia	Salvatore Manfreda, Italy
4	Construction of video series to promote the scientific activities of the COST Action HARMONIOUS	László Bertalan, Hungary	Salvatore Manfreda, Italy

STSMs (2)

#	Topic	Applicant	Host
5	Develop an understanding of soil erosion and rill/gully volume estimations using Unmanned Aerial Vehicles (UAVs)	Josie Lynch, the UK	Anette Eltner, Germany
6	Overview of image enhancement techniques for UAV image velocimetry	Robert Ljubičić, Serbia	Dariia Strelnikova, Austria
7	A template of an Operations Manual for the use of UAS in environmental applications based on the European Aviation Safety Agency (EASA) requirements	Dariia Strelnikova, Austria	Sorin Herban, Romania
8	Data collection for fluvial geomorphology: Image velocimetry methods	Martin Jolley, the UK	László Bertalan, Hungary

Publications

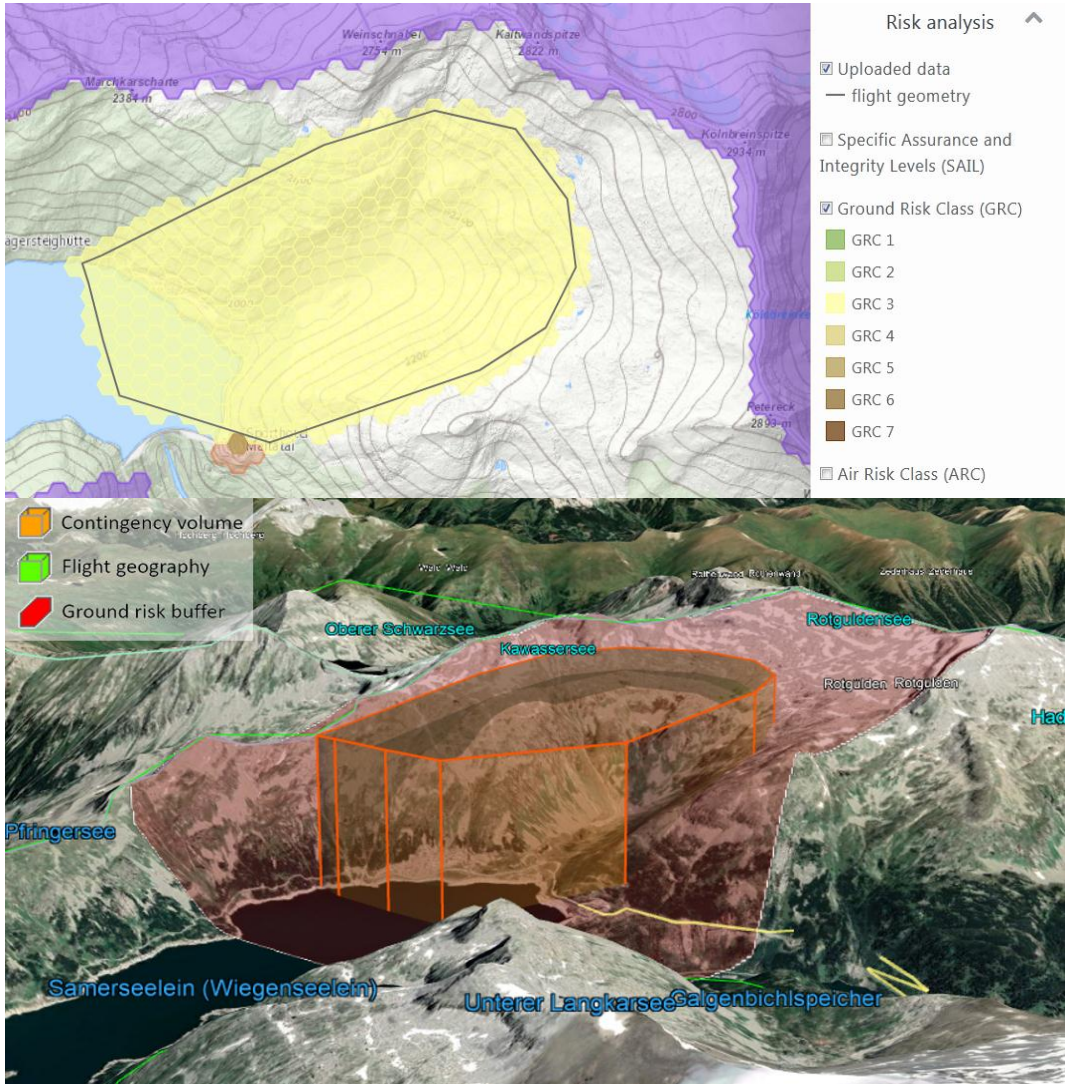
- 9 conference contributions:
  - All 9 created in collaboration within the network that resulted from the HARMONIOUS Action
  - 2 funded by the HARMONIOUS Action
- 12 scientific papers:
  - 8 direct deliverables of the HARMONIOUS Action
  - 3 created in collaboration within the network that resulted from the HARMONIOUS Action
  - 10 funded by the HARMONIOUS Action
- 4 book chapters:
  - 3 direct deliverables of the HARMONIOUS Action
  - 1 created in collaboration within the network that resulted from the HARMONIOUS Action

Full list available in Appendix A

Cooperation with WG1 (1)

Development of a template of an Operations Manual for the use of UAS in environmental applications based on the European Aviation Safety Agency (EASA) requirements:

- Operations Manual (OM) with pre- and post-flight checklists
- An example of Concept of Operations (ConOps) with risk assessment according to SORA
- An Emergency Response Plan (ERP)



Cooperation with WG1 (2)

The developed OM, ConOps and ERP are going to be published on the HARMONIOUS website + through EASA or elsewhere.

SITE SURVEY			Picture/video documented
Does the reality on the ground correspond to the information in the preliminary site survey?		Yes/No	☐
If not, are there significant difference that affect the safety of the operation?		Yes/No	☐
Have all obstructions been identified and documented (power lines, high trees, towers, migratory birds, terrain peculiarities, etc.)?		Yes/No	☐
Details:			

WEATHER			Picture/video documented
Is there enough visibility to safely execute the operation?		Yes/No	☐
Wind speed (m/s):			☐
Is the wind speed within the operational limitation of the UAS?		Yes/No	☐
Temperature (°C):			☐
Is the temperature within the operational limitation of the UAS?		Yes/No	☐
Is there precipitation (rain, snow, sleet, rain, icy rain, etc.)?		Yes/No	☐
Is the precipitation level within the operational limitation of the UAS?		Yes/No	☐
Given the weather conditions, is it safe to fly?		Yes/No	☐

SAFETY MEASURES		Picture/video documented
Is a first aid kit stocked, readily accessible and visible to everyone in the area?	Yes/No	☐
Is fire extinguisher available and its location known to all the involved persons?	Yes/No	☐
Are telephone numbers of emergency organisations known or readily available?	Yes/No	☐
Is a cell phone and necessary coverage available?	Yes/No	☐
Is the nearest landline phone location known?	Yes/No	☐
Has a call-out of ERP procedures been performed?	Yes/No	☐
Has everyone in the flight area been notified about the upcoming UAS operation?	Yes/No	☐
Have uninvolved people in the operation area been notified to vacate the area?	Yes/No	☐
Are there nearby properties and if so, have their owners been notified about the upcoming UAS operation?	Yes/No	☐
Have any NOTAMs been issued in the operation area? If so, have they been taken into account?	Yes/No	☐
Can a visible line of sight towards the UAV be maintained at all times by the RP?	Yes/No	☐
Can a visible line of sight towards the UAV be maintained at all times by the RP and VOs?	Yes/No	☐
Are personnel wearing the proper protective equipment?	Yes/No	☐

Summary of activities of WG4: River monitoring

Dariia STRELNIKOVA[1], Matthew T. PERKS[2]

[1] School of Geoinformation, Carinthia University of Applied Sciences, Villach, Austria,
[2] School of Geography, Politics and Sociology, Newcastle University, Newcastle Upon Tyne, United Kingdom

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Appendix A: Publications (1)

#	Title	Type	Relation to HARMONIOUS*
1	Acharya, B.S., Bhandari, M., Bandini, F., Pizarro, A., Perks, M., Joshi, D.R., Wang, S., Dogwiler, T., Ray, R.L., Kharel, G., Sharma, S., 2021. Unmanned Aerial Vehicles in Hydrology and Water Management: Applications, Challenges, and Perspectives. Water Resources Research 57, 37. 10.1029/2021WR029925.	scientific paper	C
2	Bertalan, L., Eltner, A., Maddock, I., Pizarro, A., 2022. Monitoring of river channel dynamics by UAS, in: Manfreda, S., Ben-Dor, E. (Eds.), Unmanned Aerial Systems in Monitoring. Elsevier.	book chapter	D
3	Bertalan, L., Nagy, B., Szopos, N.M., Eltner, A., Sardemann, H., Mader, D., 2019. UAV/UWV applications for the detailed assessment of channel morphodynamics. A case study of Sajó River, Hungary., in: Workshop on standardization of procedures in using UAS for environmental monitoring, Coimbra, Portugal. 6-8 November.	conference contribution	C
4	Bertalan, L., Sardemann, H., Mader, D., Szopos, N.M., Nagy, B., Eltner, A., 2020. Geomorphological and hydrological characterization of a meandering river by UAV and UWV applications, in: EGU General Assembly 2020. EGU2020-18069, Vienna, Austria. May 2020.	conference contribution	C
5	Dal Sasso, S.F., Pizarro, A., Manfreda, S., 2020. Metrics for the Quantification of Seeding Characteristics to Enhance Image Velocimetry Performance in Rivers. Remote Sensing 12, 1789. 10.3390/rs12111789.	scientific paper	D
6	Dal Sasso, S.F., Pizarro, A., Manfreda, S., 2020. On the characterisation of open-flow seeding conditions for image-velocimetry techniques using UASs, in: EGU General Assembly 2020. EGU2020-18069, Vienna, Austria. May.	conference contribution	C F

* D – direct deliverable of the Action, F – research/publication funded by HARMONIOUS, C – created in collaboration within the network that resulted from the HARMONIOUS Action

Appendix A: Publications (2)

#	Title	Type	Relation to HARMONIOUS*
7	Dal Sasso, S.F., Pizarro, A., Manfreda, S., 2021. Recent Advancements and Perspectives in UAS-Based Image Velocimetry. Drones 5, 81. 10.3390/drones5030081.	scientific paper	D
8	Dal Sasso, S.F., Pizarro, A., Pearce, S., Maddock, I., Manfreda, S., 2021. Increasing LSPIV performances by exploiting the seeding distribution index at different spatial scales. Journal of Hydrology 598, 126438. 10.1016/j.jhydrol.2021.126438.	scientific paper	D
9	Dal Sasso, S.F., Pizarro, A., Vuono, P., Colombaroli, M., 2021. PTV and LSPIV optical techniques for river monitoring: an application to the Basento River., in: XXXVII Congress of Hydraulics and Hydraulic Constructions, Reggio Calabria. June 2021.	conference contribution	C
10	Eltner, A., Bertalan, L., 2020. Hydromorphologische Charakterisierung einzelner Flussabschnitte mittels einer low-cost UAV – Messung von Bathymetrie und Fließgeschwindigkeit. Arbeitskreis Geomorphologie 2020	conference contribution	C
11	Eltner, A., Bertalan, L., Grundmann, J., Perks, M.T., Lotsari, E., 2021. Hydro-morphological mapping of river reaches using videos captured with UAS. Earth Surf. Process. Landforms 46, 2773–2787. 10.1002/esp.5205.	scientific paper	C
12	Eltner, A., Mader, D., Szopos, N.M., Nagy, Bálint, Grundmann, Jens, Bertalan, L., 2021. Using thermal and RGB UAV imagery to measure surface flow velocities of rivers. ISPRS International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XLIII-B2-2021, 717–722. 10.5194/isprs-archives-XLIII-B2-2021-717-202.	conference contribution	C

Appendix A: Publications (3)

#	Title	Type	Relation to HARMONIOUS*
13	Eltner, Anette; Bertalan, László; Lotsari, Eliisa. (2021): Hydromorphological monitoring of individual river reaches with UAV-data – image-based measurement of bathymetry and flow velocity, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-14276, https://doi.org/10.5194/egusphere-egu21-14276, 2021.	conference contribution	C
14	Ljubičić, R., Strelnikova, D., Perks, M.T., Eltner, A., Peña-Haro, S., Pizarro, A., Dal Sasso, S.F., Scherling, U., Vuono, P., Manfreda, S., 2021. A comparison of tools and techniques for stabilising unmanned aerial system (UAS) imagery for surface flow observations. Hydrol. Earth Syst. Sci. 25, 5105–5132. 10.5194/hess-25-5105-2021.	scientific paper	D
15	Manfreda, S., Dal Sasso, S.F., Pizarro, A., Tauro, F., 2019. New Insights Offered by UAS for River Monitoring, in: Sharma, J.B. (Ed.), Applications of small unmanned aircraft systems. Best practices and case studies, 1st ed. CRC Press Taylor & Francis, Boca Raton.	book chapter	C
16	Pearce, S., Ljubičić, R., Peña-Haro, S., Perks, M.T., Tauro, F., Pizarro, A., Dal Sasso, S.F., Strelnikova, D., Grimaldi, S., Maddock, I., Paulus, G., Plavšić, J., Prodanović, D., Manfreda, S., 2020. An Evaluation of Image Velocimetry Techniques under Low Flow Conditions and High Seeding Densities Using Unmanned Aerial Systems. Remote Sensing 12, 232. 10.3390/rs12020232.	scientific paper	D
17	Peña-Haro, S., Ljubičić, R., Strelnikova, D., 2022. Geometric correction and stabilisation of images collected by UAVs in river monitoring, in: Manfreda, S., Ben-Dor, E. (Eds.), Unmanned Aerial Systems in Monitoring. Elsevier.	book chapter	D
18	Perks, M.T., Dal Sasso, S.F., Hauet, A., Jamieson, E., Le Coz, J., Pearce, S., Peña-Haro, S., Pizarro, A., Strelnikova, D., Tauro, F., Bomhof, J., Grimaldi, S., Goulet, A., Hortobágyi, B., Jodeau, M., Käfer, S., Ljubičić, R., Maddock, I., Mayr, P., Paulus, G., Pénard, L., Sinclair, L., Manfreda, S., 2020. Towards harmonisation of image velocimetry techniques for river surface velocity observations. Earth Syst. Sci. Data 12, 1545–1559. 10.5194/essd-12-1545-2020.	scientific paper	D
19	Pizarro, A., Dal Sasso, S.F., Manfreda, S., 2020. Image-velocimetry techniques under particle aggregation for streamflow monitoring: A numerical approach, in: EGU General Assembly 2020. EGU2020-18069, Vienna, Austria. May.	conference contribution	C F

Appendix A: Publications (4)

#	Title	Type	Relation to HARMONIOUS*
20	Pizarro, A., Dal Sasso, S.F., Manfreda, S., 2020. Refining image-velocimetry performances for streamflow monitoring: Seeding metrics to errors minimization. Hydrological Processes 34, 5167–5175. 10.1002/hyp.13919.	scientific paper	D
21	Pizarro, A., Dal Sasso, S.F., Perks, M.T., Manfreda, S., 2020. Identifying the optimal spatial distribution of tracers for optical sensing of stream surface flow. Hydrol. Earth Syst. Sci. 24, 5173–5185. 10.5194/hess-24-5173-2020.	scientific paper	D
22	Strelnikova, D., Paulus, G., Anders, K.-H., Käfer, S., Mayr, P., Schneeberger, R., Mader, H., 2019. Towards a standard approach to UAS based data collection for optical monitoring of heterogeneous flow, in: Workshop on standardization of procedures in using UAS for environmental monitoring, Coimbra, Portugal. 6-8 November.	conference contribution	C
23	Strelnikova, D., Paulus, G., Käfer, S., Anders, K.-H., Mayr, P., Mader, H., Scherling, U., Schneeberger, R., 2020. Drone-Based Optical Measurements of Heterogeneous Surface Velocity Fields around Fish Passages at Hydropower Dams. Remote Sensing 12, 384. 10.3390/rs12030384.	scientific paper	F
24	Strelnikova, D., Perks, M.T., Dal Sasso, S.F., Pizarro, A., 2022. River flow monitoring with UAS, in: Manfreda, S., Ben-Dor, E. (Eds.), Unmanned Aerial Systems in Monitoring. Elsevier.	book chapter	D
25	Strelnikova, D., Perks, M.T., Paulus, G., Käfer, S., Anders, K.-H., Mayr, P., Mader, H., Scherling, U., Schneeberger, R., 2022. Rapid Detection of the Change in Surface Flow Patterns Near Fish Passages at Hydropower Dams With the Use of UAS Based Videos Under Controlled Discharge Conditions. Frontiers in Remote Sensing 3. 10.3389/frsen.2022.798973.	scientific paper	C F