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Naples, 31st July 2023

EGU - European Geosciences Union e.V.
Kastenbauerstraße 2
81677 Munich, Germany

Attn: Dr. Jane Roussak and Dr. Philippe Courtial

RE: 8th Galileo Conference (GC8-Hydro) – Report

1. Organizational aspects

The 8th Galileo Conference, titled "*A European Vision for Hydrological Observation and Experimentation*", was held in Naples (Italy) from 12 to 15 June 2023. Originally, this event was supposed to be held in early October 2020 but the spread since the beginning 2020 of the global pandemic of coronavirus disease 2019 (Covid-19) forced the Committee to postpone it twice. The reason for these shifts was the need to have the conference in presence, especially in view of the envisaged organizational aspects, without interfering with the sanitary measures.

The conference was jointly sponsored by the Interdepartmental Centre for Environmental Research (C.I.R.AM.) of the University of Naples Federico II (Italy) and Forschungszentrum Jülich (Germany), and organized by the University of Naples Federico II in the setting of the Historical Complex of Saints Marcellino and Festo that includes the historical cloister.

The organizational and scientific committee was chaired by Nunzio Romano (Univ. of Naples Federico II), co-chaired by Harry Vereecken (Forschungszentrum Jülich), and composed of the following members:

Roland Baatz (Zalf Müncheberg, Germany)
Günter Blöschl (TU Wien, Austria)
Isabelle Braud (INRAE Villeurbanne, France)
Gabrielle de Lannoy (KU Leuven, Belgium)
Karsten Høgh Jensen (University of Copenhagen, Denmark)
Laurent Pfister (LIST Luxembourg, Luxembourg)
Paolo Nasta, and Salvatore Manfreda (University of Naples Federico II, Italy)
Sonia Seneviratne (ETH Zürich, Switzerland)

Prof. Ing. Nunzio Romano
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Ana Maria Tarquis (Universidad Politécnica de Madrid, Spain)
Ilja van Meerveld (University of Zürich, Switzerland)
Heye Bogena, and Ralf Kunkel (Forschungszentrum Jülich, Germany)
Marc Voltz (LISAH Montpellier, France)
Yijian Zeng (Twente University, The Netherlands)

The conference program was designed to foster intense and fruitful discussions and interactions among the attendees throughout the event. However, this need also had to be combined with the relatively large number of abstracts received (more than 100) that requested oral presentations. A trade-off to meet these requirements was to fix, for each session, the orals at 10 minutes (but setting the invited talks at 15 minutes). Then, the discussion sessions were set as follows: nearly hour-long poster sessions (scheduled within the coffee/tea breaks), breakout groups, and open discussions during the lightning talks. A schematic of the program is reported below:

	From	To	[h:mm]	Activity
12 June 2023	08:00	09:00	1:00	Arrival and registration
	09:00	09:15	0:15	Conference Opening
	09:15	10:50	1:35	Session #1 (Key-note 15 min + 8 slots 10 min each)
	10:50	11:30	0:40	Posters #1 #2 + Coffee/Tea
	11:30	13:05	1:35	Session #2 (Key-note 15 min + 8 slots 10 min each)
	13:05	14:15	1:10	Lunch and free time for e-mails/business
	14:15	16:15	2:00	Break-out groups
	16:15	17:15	1:00	Posters #1 #2 + Coffee/Tea
	17:15	18:15	1:00	Lightning talk/Open discussions
				Dinner (self-organized)

	From	To	[h:mm]	Activity
13 June 2023 Geoscience excursion	8:00	10:00	2:00	Bus trip
	10:00	13:00	3:00	Paestum Archaeological site
	13:00	13:45	0:45	Bus to get to the Velia Bureau (dam)
	13:45	15:15	1:30	Lunch, posters, and free time
	15:15	16:00	0:45	Presentation of the Velia Bureau
	16:00	16:45	0:45	Presentation of the Alento CZ observatory
	16:45	17:30	0:45	Coffee/Tea + posters about the Alento Observatory
	17:30	18:30	1:00	Lightning talk/Open discussions
	18:30	22:30	4:00	Conference dinner and return to Naples

	From	To	[h:mm]	Activity
14 June 2023	8:30	10:05	1:35	Session #3 (Key-note 15 min + 8 slots 10 min each)
	10:05	10:40	0:35	Session #4 (Key-note 15 min + 2 slots 10 min each)
	10:40	11:30	0:50	Posters #3 #4 + Coffee/Tea
	11:30	12:30	1:00	Session #4 (6 slots, 10 min each)
	12:30	14:00	1:30	Lunch and free time for e-mails/business
	14:00	15:35	1:35	Session #5 (Key-note 15 min + 8 slots 10 min each)
	15:35	17:00	1:25	Break-out groups
	17:00	18:00	1:00	Posters #3 #4 + Coffee/Tea
	18:00	19:00	1:00	Lightning talk/Open discussions
	19:00			Dinner (self-organized)

	From	To	[h:mm]	Activity
15 June 2023	9:00	10:45	1:45	Session #6 (Key-note + 6 slots, 15 min each)
	10:45	11:30	0:45	Posters #5 #6 + Coffee/Tea
	11:30	11:40	0:10	The WATSON COST Action - A brief report
	11:40	12:30	0:50	Plenary session, Chairs present working group results; Conference wrap-up, decide engagement, deliverables, on-going commitments
	12:30			End of Conference

The scientific sessions (with conveners and key-note speakers) were the following:

1) Innovative geophysical sensing methods in hydrological and critical zone research (conveners: Paolo Nasta and Karsten Høgh Jensen; key-note speaker: Yann Kerr, Centre d'Etudes Spatiales de la Biosphere, CESBIO, France);
2) Environmental monitoring and modeling with the support of UAS and satellites (conveners: Nunzio Romano and Yijian Zeng; key-note speaker: Monica Garcia, Univ. Politécnica de Madrid, Spain);
3) Data assimilation, artificial intelligence, and hydrological observations (conveners: Gabriëlle De Lannoy and Roland Baatz; key-note speaker: Christian Massari, CNR-IRPI, Italy)
4) Using O-H stable isotopes for studying hydrological process understanding and the history of flowing waters (conveners: Laurent Pfister and Ilja van Meerveld; key-note speaker: Adrià Barbeta Margarit, Universitat de Barcelona, Spain);
5) Quantifying regional hydrological change impacts (conveners: Salvatore Manfreda and Marc Volt; key-note speaker: Florence Habets, CNRS, France)
6) Big data science in hydrological research (conveners: Ana Maria Tarquis and Ralf Kunkel; key-note speaker: Steffen Zacharias, UFZ Helmholtz Centre for Environ. Res., Germany).

The way the breakout group sessions were organized is shown in the following tables:

CONFERENCE DAY #1, Monday 12 June.	
1a) What are the hypothesis-driven science questions to establish new hydrological observatories? *Chairpersons: Karsten Hogh Jensen, Günter Blöschl, Ilja van Meerveld, Yijian Zeng, Nunzio Romano.*	**1b) A virtual tracer experiment to assess the temporal origin of water balance components in Hydrus-1D.** *Chairperson: Paolo Nasta.*
Topic presentation; split attendees into 4 sub-groups and discussion; short break (10 min); general presentation of the session outcome and wrap-up.	Training.

CONFERENCE DAY #3: Wednesday 14 June.		
2a) Design and requirements of hydrologic observatories. *Chairpersons: Heye Bogena, Marc Voltz*	**2b) Establishing a European network of observatories and governance.** *Chairpersons: Harry Vereecken, Roland Baatz*	**2c) Use of unmanned aerial systems for hydrological monitoring.** *Chairperson: Salvatore Manfreda*
S. Zacharias's short presentation on LTER; split attendees into 4 subgroups and discussion; short break (10 min); internal presentation of the session outcome and wrap-up.	Topic presentation; split attendees into 4 subgroups and discussion; short break (10 min); internal presentation of the session outcome and wrap-up.	Training.

The committee invited three renowned scientists to give lighting presentations, which were intended to be sort of *illuminating but provocative talks*, with the main aim of triggering reactions from the audience, even contrasting ones, on the general topic of the talk, and stimulating comparisons between different viewpoints and experiences. The schedule and titles of these talks were the following:

- Monday 12th June - prof. Bill Kustas (USDA-ARS, USA) with a provocative talk on hydrological fluxes from remote sensing for large-scale applications;
- Tuesday 13th June - prof. Xin Li (Chinese Academy of Sciences, China) with a provocative talk on hydrological observatory network, titled "*Linking IoT, edge computing, and social sensing for ecohydrological observation in extreme environments*";
- Wednesday 14th June - prof. Günter Blöschl (T.U. Wien, Austria) with a provocative talk on hydrology and what's new to do in the next 10 years, titled "*The future of hydrology - nature or nurture?*".

We allotted one hour to each lightning presentation, which was split into 40 minutes for the keynote speech and 20 minutes for question&answer.

On Tuesday, 13th June, a whole day was devoted to the geoscience excursion at the seat of the "Velia" Bureau of Reclamation and Irrigation, located just downstream of the earthen dam (Piano della Rocca) on the Alento River (https://www.consorziovelia.com/). The location of the "Velia" bureau was selected to present the activities that the UniNA group is carrying out at the "Alento" critical zone observatory (https://blogs.egu.eu/divisions/hs/2020/12/02/featured-catchment-the-alento-hydrological-observatory-in-the-middle-of-the-mediterranean-region/; awarded in 2020 as EGU Best Blog Post).

Prof. Xin Li gave his lightning talk in the conference room of the Velia Bureau. Participants then visited the posters illustrating the different activities conducted at the Alento CZ observatory. Before leaving this place, participants went to the crest of the dam and here Ing. Giovanni La Barbera (from Velia Bureau; see the pictures below) provided information about the earthen dam, its construction, and the relevant hydraulic works (spillway, outlet works, riprap slope protection, stilling basin, etc.). During the journey from Naples, a stop was made at Paestum (province of Salerno) to visit the archaeological site, while we had the conference dinner at the Bellelli family farm on our way back.

Monitoring plate Piano Della Rocca (PDR) reservoir
(as of June 13, 2023)

Reservoir level altitude (water level; m a.s.l.)

Reservoir volume (m^3)

Total derived flow rate (l/s)

Flow rate derived for hydroelectric use (hydropower generation; l/s)

Flow rate derived for irrigation use (l/s)

Flow rate derived for environmental use (l/s)

To summarize, a total of 117 individuals have registered to participate in GC8-Hydro, with 44 ECSs and 73 seniors. The subdivision by country is reported in the table below:

Country	No. of participants
Austria	3
Belgium	1
Canada	1
China	1
Denmark	2
France	6
Germany	13
Hungary	2
Israel	1
Italy	21
Luxembourg	1
Netherlands	6
Spain	3
Switzerland	3
Türkiye	1
United Kingdom	1
United States of America	7

Two moments of the conference are depicted in the photographs below: (left) people attending a session in the Saints Marcellino and Festo church, and (right) discussions in the cloister after the lunch break.

2. Conference actions for scientific progress beyond the state of the art

GC8-Hydro provided the opportunity of addressing at the international level both the state of the art and novel development of methods and technology in the fields covered by the six sessions. Also, this conference highlighted the interdisciplinary approach for monitoring environmental variables and fluxes, designing research infrastructures, using the latest developments in machine learning for parameter estimation, and merging all this information in eco-hydrological models of different complexities.

Especially during the breakout group sessions and the lightning talks, the discussants provided feedback about the future need for different and more effective methods related to the scales of interest, improvements in techniques and devices, efficient strategies for (big) data analysis, as well as best practices on the prevention and mitigation of hydroclimatic extreme events.

The main outcomes from the breakout group sessions held on Day #1 were the following:

- Sub-group 1a.1 (led by G. Blöschl) discussed the importance of using non-invasive, non-destructive, and cost-efficient measurements and stressed the need to enhance the measurements of water fluxes rather than state variables.
- Sub-group 1a.2 (led by I. van Merveeld) discussed the way to enhance interdisciplinary work and the importance of expanding hydrological research beyond hydrology. There was a debate over whether to begin with a research question or begin with observations and then the question will arise.
- In sub-group 1a.3 (led by Y. Zeng) the following main issues emerged: it helps establish integrated multidisciplinary earth observatories, like eLTER; the time has come to treat measurement noises as gold because "noises" can be used to detect vegetation water content and biomass.
- Sub-group 1a.4 (led by K. Jensen) extensively discussed the issue of measuring accurately the basic hydrological fluxes at the target scale, and highlighted the need for measurements of deeper subsurface processes. Regarding the global network of permanent and sustainable hydrological observatories:

measurements according to standardized protocols, easy access to data and metadata. Machine learning and physically-based models in tandem may make better use of big data and may lead to new hydrological discoveries including new process equations.

- For Group 1b, Paolo Nasta presented the assessment of the temporal origin of drainage, evaporation, and root water uptake (RWU), which is an indicator of ecosystem functioning and provides insights into the impact of natural and anthropogenic disturbances on plant resilience and aquifer vulnerability. A virtual tracer experiment was carried out in HYDRUS-1D by using data taken from a soil lysimeter planted with winter rye in Austria. The RWU (τ_R), evaporation (τ_E), and drainage (τ_D) transit times (τ) were determined by identifying the arrival times when a prescribed percentage of the tracer mass breakthrough curves was reached.

The main outcomes from the breakout group sessions held on Day #2 were the following:

- Group 2a was split into three theme-specific sub-group: River (led by H.R. Bogena), Lake (led by M. Voltz), and Observatories (led by S. Zacharias).
- Group 2b raised the following critical points: self-organized as a community addressing specific questions or hypotheses with a limited set of observatories and own funding acquisition; to engage, in the current ongoing eLTER, initiative and benefit from the momentum (DEIMS site registry). Group 2b discussed the following questions: Securing long-term funding (instrumentation); bringing the relevant and interested people in Europe together behind a research agenda (efficiency & results); being a multi-scale observatory (transferrable) and interacting with authorities (visibility & funding).
- For Group 2c, Salvatore Manfreda and his collaborator Ruodan Zhuang organized the session as follows: introduction on the use of drones for Digital Surface Models (DSM) generation; basic issues on uncrewed aerial systems (UASs) for environmental monitoring; the COST-Action HARMONIOUS; presentation of the Elsevier Book titled "*Unmanned Aerial Systems for Monitoring Soil, Vegetation, and River Systems*" and the video courses series.

Prof. Ing. Nunzio Romano
Chairman of the
Organizational and Scientific Committee