STEEP STREAMS

Solid Transport Evaluation and Efficiency in Prevention: Sustainable Techniques of Rational Engineering and Advanced MethodS

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Water JPI
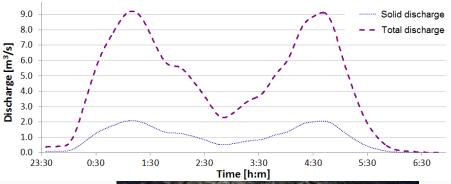WaterWorks2015 Cofunded Call
8 May 2018, Larnaca

STEEP STREAMS deals with

Debris Flows:

- **catastrophic events** affecting **small mountain basins;**
- causing **loss of lives and properties damage**.
- **The total volumes** mobilized is **several times larger that that of the actual rainfall** volume

- **Uncertain triggering conditions.**
- often the **after a long rain saturating the soil,** followed by a **intense rain** that **induces the collapse.**

- Most **effective defense structure** is the **deposition basin** combined with the **open check dam**, which acts by reducing the peak of solid discharge during extreme events.

Why STEEP STREAMS?

An **unresolved** problem: the **presence of wood**:

• that enhances **clogging of the protection struct**ures;

• increases the **destructive power of the flow.**

The Consortium of STEEP STREAMS

Coordination
University of Trento, Italy

Partners
Instito Superior Tecnico, Lisbon, Portugal University of Uppsala, Sweden

Main targets of STEEP STREAMS

- Better understanding of the **triggering condition in a scenario of climate change**

- Development of rational criteria for the design of **defense structures** against debris flows and driftwood **able to manage separately sediments and wood**.

- Design guidelines

- Dissemination of the results

Scientific progresses

WP Nr	WP Title	Trento	Uppsala	Lisboa
WP1	Project Coordination & Management	L	P	P
WP2	Climate change and hydrology	P	L	P
WP3	Mathematical models	L	P	P
WP4	Defence structure against sediments	L	P	P
WP5	Defence structure against driftwood	P	P	L
WP6	Design of the works in experimental basin	L	P	P
WP7	Dissemination	L	P	P

L=Leader, P=Partner

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WP1

- subscription the Consortium Agreement (no DESCA model but including all the required sections)

- Organization of the first meeting at Uppsala University on October 7th, 2016

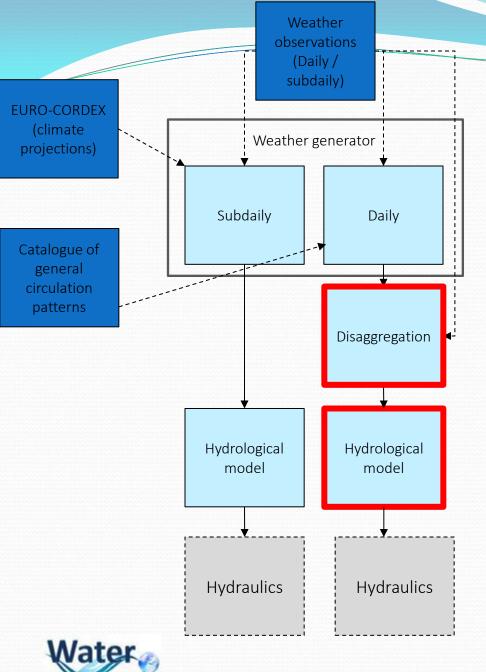- Organization of the second meeting at Lisbon University on October 6th , 2017.

- Organization of the third meeting at Trento University on 15th June 2018

WP2

G. Di Baldassarre & K. Brail (Uppsala)
R. Rigon: (Trento)

Weather observations (Daily / subdaily)

EURO-CORDEX (climate projections)

Catalogue of general circulation patterns

Weather generator

Subdaily

Daily

Disaggregation

Hydrological model

Hydrological model

Hydraulics

Hydraulics

1. Development of a space time weather generator to simulate precipitation patterns and temperature fields and fill the observational gaps at daily time scale
2. Development of a space time algorithm to disaggregate **from daily into hourly values** (precipitation and temperature)
3. Tested at **small scale** (Trentino) and at **large scal**e (Sweden)
4. Implementation of **weather forecast models**
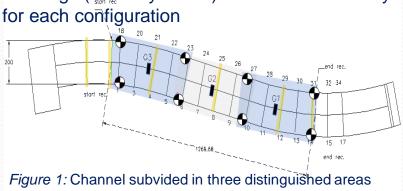5. Implementation of the existing model **JGrass-NewAGE**

Water JPI

Eulerian description of driftwood

**Methods:
experiments
and
simulations**

Experimental campaign in a bended channel: Three synchronized GoPro Cameras + 50 logs (wood cylinders) released individually for each configuration

Figure 1: Channel subvided in three distinguished areas covered by three different cameras.

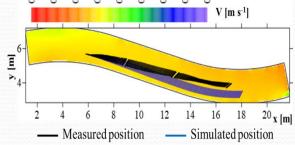### Numerical code: ORSA2D_WT: Eulerian solution of the Shallow Water Equation + dynamic Lagrangian module

Figure 2: Simulated trajectories compared to the measured ones.

Preliminary Results

The analysis of the experimental data allows the determination of an Eulerian diffusion coefficient for driftwood and the Determination of a advection-diffusion equation for the wood volume fraction.

A. Armanini , G. Rossi (Trento)

- The device analyzed in this study is a suitable inclined barrier located upstream the slit of the check;

- Firstly, the investigation allowed the **definition of objective parameters** to measure the **efficiency of wood retraining devices**, against the capacity of the check dam to laminate the solid volume; $Trapping\ efficiency\ [\%] = TE = \dfrac{N_{hold}}{N_{imp}}$

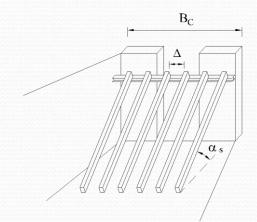 <u>Controlled quantities:</u> $T_{clog,solid}$ $Q_s = 0 \text{ m}^3/\text{s}$

 <u>Aims</u>:   1. *increase TE*   2. *increase* $T_{clog,solid}$

 <u>Parameters of devices</u>

- $a_s = 30°, 60°$

- Coefficient $I = \dfrac{\Delta}{L}$)   L = length of logs)

- <u>Coefficient of recover</u> $= \dfrac{(Nr+1)\Delta}{B_c}$

A.Cardoso; S. Meninno; R. Canelas; J. Matos (Lisbon)

Best strategy to intercept wood before a check dam

Research question	1. Analysis and performance of retaining structure for wood under clear water conditions 2. Performance of the devices with intense sediment transport
Methods	Experimental apparatus: • Physical model under Froude similarity (λ=30); corresponding to a natural stream with nearly Width = 13 m; Slope = 0.01 Q_{200}= 100 m^3/s • Width of the slit b= 9 cm (2.7 m) • Grid with longitudinal bars before the check dam • Different wood discharge and geometry
Preliminary results	

Rack

Check dam

Slit check dam, and of the rack from the transparent side-wall

Trapping efficiency versus bar inclination and distance for different wood discharge and characteristics.

Experimental basin: Torrente Meledrio

Basin located in the Province of Trento, in Val di Sole, North-West of Trento

BACINO DEL TORRENTE MELEDRIO: VISTA AEREA 3D

DIMARO

Fig. 1 – Vista aerea 3D del bacino del Torrente Meledrio

Some data:

Parameter	Data
Area of the basin	52.8 km^2
Length	15.5 km
Minimum height	816 m a.s.l.
Average slope	56.3%
Average phi	-
Flood Discharge (Tr=100)	101 m^3/s
d_{50}	0.15 m

Existing check dams on Meledrio torrent

New specific structures will be constructed according to the SteepStreams project

WEBSITE:

Dissemination of the results 1/2

7 Articles in peer-reviewed journals

- Breinl, K., Di Baldassarre, G., Lopez, M. G., Hagenlocher, M., Vico, G., & Rutgersson, A. (2017). Can weather generation capture precipitation patterns across different climates, spatial scales and under data scarcity? _Scientific Reports,_ 7(1), 5449. (WP2)
- Breinl, K, Di Baldassarre, G (2017, submitted). A new non-parametric method for the space-time disaggregation of rainfall and temperature. _Water Resources Research._ (WP2)
- Gravity-driven, dry granular flows over a loose bed in stationary and homogeneous conditions. S. Meninno, A. Armanini and M. Larcher. _Physical Review Fluids_ 3, 024301 (2018). (WP4-WP5)
- Nucci, Armanini, Larcher, The interphase forces in submerged granular flows, _under review_, June 2017. (WP4)
- Dynamic impact of a water and sediments surge against a rigid wall. A. Armanini, G. Rossi and M. Larcher, under review of _J. Hydraulic Research_ (WP4)
- R.B. Canelas, M. Brito, O. García-Feal, J.M. Domínguez, A.J.C. Crespo, 2018. Extending DualSPHysics with a Differential Variational Inequality: modeling fluid-mechanism interaction, _Applied Ocean Research,_ under review (WP5)
- Abera, W; Formetta, G.; Borga, M.; Rigon, R.; Estimating the water budget components and their variability in a Pre-Alpine basin with NewAge-JGrass, _Advances in Water Resources_, 2017 (WP2)
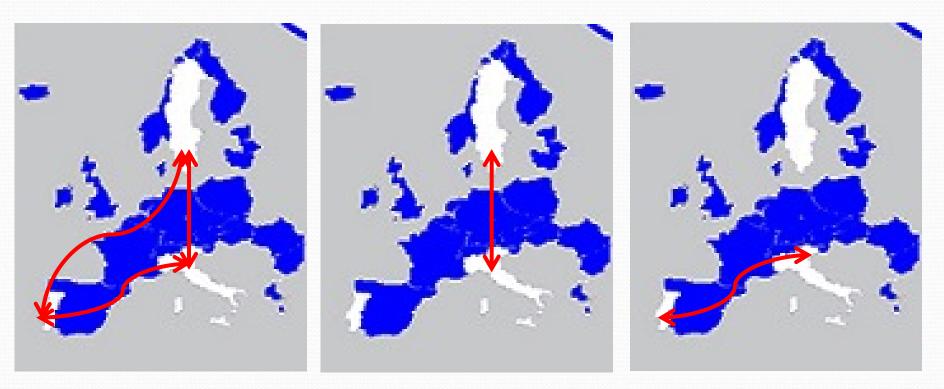
16 Proceedings paper, presentations, and posters

1. Armanini, A., et al. STEEP STREAMS-Solid Transport Evaluation and Efficiency in Prevention: Sustainable Techniques of Rational Engineering and Advanced MethodS. In: EGU General Assembly Conference Abstracts. 2017. p. 17261.
2. Armanini A., Larcher, M. (2017) "Slit-check dams for the control of debris flow". EGU General Assembly 2017, Vienna, 08-13 April 2017.
3. Dry granular flows rheology: experimental investigation and particles simulations. G. Rossi and A. Armanini, Sorrento _AERC-European Society of Rheology_ 2018. (WP4)
4. G. Rossi, A. Armanini and M. Larcher. Dynamic impact of granular material on a vertical obstacle. EGU General Assembly. Vienna, April 2017.
5. G. Rossi, A. Armanini A depth integrated model for dry geophysical granular flows. EGU General Assembly. Vienna, April 2017.
6. M. Larcher, A. Armanini, Schlitzsperren zur hydrodynamischen Kontrolle der Sedimente. Stand der Technik im Naturgefahren-Ingenieurwesen, Vienna, 21-23 February 2018.
7. Breinl, K., Di Baldassarre, G., Müller, H.. Extreme flows in small alpine catchments under current and future climate conditions: impact of temporal rainfall disaggregation In: López-Tarazón, J. A., Bronstert, A., Thieken, A., & Petrow, T. (2017). International symposium on the effects of global change on floods, fluvial geomorphology and related hazards in mountainous rivers.
8. Breinl, K. (2017, April). Single-site vs. multi-site rainfall generation and the role of parametric rainfall distributions in lumped hydrological modelling. In EGU General Assembly Conference Abstracts (Vol. 19, p. 4935).
9. Breinl, K., & Di Baldassarre, G. (2017, April). Flash floods in small Alpine catchments in a changing climate. In EGU General Assembly Conference Abstracts (Vol. 19, p. 5231).
10. Breinl, K., Di Baldassarre, G., & Girons Lopez, M. (2017, April). Reduced-complexity multi-site rainfall generation: one million years over night using the model TripleM. In EGU General Assembly Conference Abstracts (Vol. 19, p. 3065).
11. Gozzi, D, Breinl, K, Di Baldassarre, G. (2018, submitted) Hydro-meteorological extremes in the Adige river basin, Italy. 5th IAHR Europe Congress, Trento, June 2018.
12. Armanini Rossi 5th IAHR Europe Congress, Trento, June 2018.
13. Larcher M., Jenkins J.T., 5th IAHR Europe Congress, Trento, June 2018
14. R. B. Canelas, D. Conde, O. Garcia-Feal, M. J. Telhado, R. M.L. Ferreira, 2017. A 2D-3D strategy for resolving tsunami-generated debris flow in urban environments, European Geosciences Union, Vienna
15. R.B. Canelas, J.M. Domínguez, A.J.C. Crespo, M. Gómez-Gesteira, R.M.L. Ferreira, 2017. Resolved simulations of a granular-fluid flow through a check dam with a SPH-DCDEM model, European Geosciences Union, Vienna
16. D. Zugliani, M. Pasqualini, G. Rosatti, Dynamic transition between fixed- and mobile-bed: mathematical and numerical aspects.

Collaboration, coordination and mobility

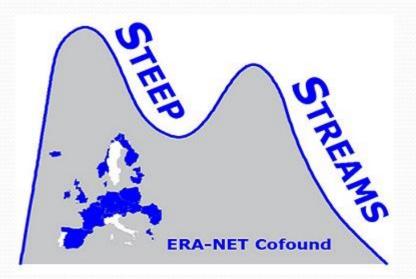**WP1+WP6+WP7** **WP2** **WP3+WP4+WP5**

- Meetings (Uppsala, Lisbon, Trento)
- Several skype calls
- Dr. K. Brain (Sweden partner) stayed one month in Trento
- Dr. S. Mennino (Portuguese partner) is supervisor of a master student in Trento

Stakeholder/industry engagement

- The collaboration with the Torrent Control Authority of the Province of Trento **ASM** started immediately with the definition of the experimental basin for the field test.

- The Italian partner is collaborating with a private company, i.e. **M.I.C.** (**Maccaferri Innovation Center**) of Bozen Italy on an the extensive use of nets based on the use of iron nets, lighter and cheaper respect to the traditional solutions.

- Joint project between **ASM**, **M.I.C.** and the **University of Trento**.

Identified problems or specific risks

1. The idea behind the JPI project is **certainly positive**: the direct **involvement of the member states and the national agencies.**

2. However, the different **methodologies** adopted by the States members to **elect the funding** risked **jeopardising the success** of the project.

3. In particular, it would have **compromised** the effective **collaboration** among **partners.** In our case this collaboration has been **partially recovered** thanks to a work of substitution carried out by **the individual universities.**

4. However, an **extension of the deadline** of the project will be **necessary** to allow completion of **final reports** and to better enable the **transfer of the results to stakeholders.**

Thank you

for listening