I.S.RIVERS
LYON 2018

PASSIVE ACOUSTIC MONITORING OF BEDLOAD DISCHARGE

Objective

- Bedload measurement with physical samplers is heavy, expensive and sometime dangerous
- We develop an indirect measurement method based on underwater 'microphones' which record the sound generated by bedload particles impacting the river bed.

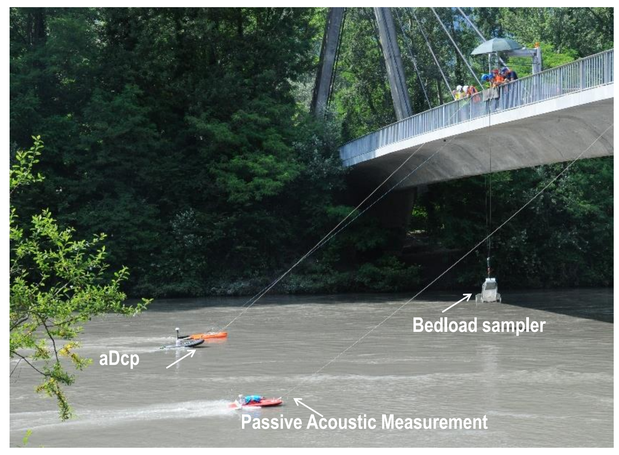

Figure 1 : Bedload sampler, aDcp and Passive Acoustic Measurements deployed in the Isère River (France).

Method 1 : acoustic profiles

- This method gives information on total bedload discharge and spatial distribution over the entire cross-section. Bedload measurements can be performed in a reduced time (typically an hour) and do not require heavy operational means.
- Experiments conducted on 7 rivers suggest that passive acoustic profiles are a rather reliable surrogate of bedload discharge measurements

River	Local Slope (%)	River Width (m)	Label on graph	Date	Sample number	Discharge (m^3/s)	Bedload [D_{50};D_{84}] (mm)
Arve	0.75	14	A1	2017-06-27	11	38	[1; 4]
			A2	2017-06-28	15	29	[1; 3]
Grand Buëch	0.70	13	GB	2017-05-15	23	13	[39; 63]
Isère	0.05	60	I	2017-06-06	47	237	[2 ;13]
Romanche	0.13	33	R	2017-06-14	38	55	[1 ;3]
Séveraisse	1.00	13	S1	2017-05-17	54	14	[5 ;48]
			S2	2017-05-30	28	16	[12 ;52]
Moselle	0.1	16	M	2018-01-28	25	80	[20 ;47]
Selves	1.3	10	Sel	2017-09-19	60	15	[2 ;4]

Table 1 : bedload sampling characteristics in the 7 rivers where the experiences were conducted

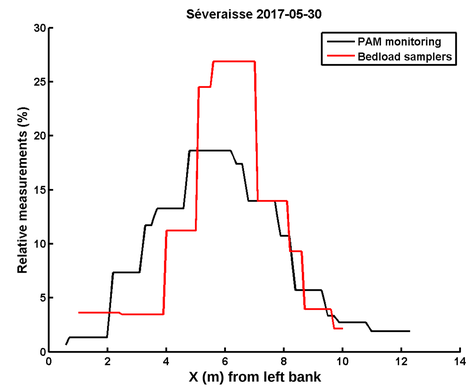

Figure 2 : Cross-sectional comparison between Passive Acoustic Measurements (PAM) and bedload sampling in the Séveraisse River (France)

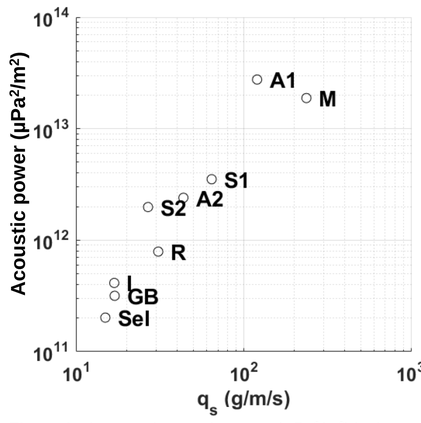

Figure 3 : Averaged acoustic power ($\mu Pa^2/m^2$) in the cross-section, in function of averaged specific flux (g/m/s). Acoustic power is corrected according to sound propagation attenuation effects in each river.

Method 2 : continuous monitoring from the riverside

- Provides long-term observations of bedload processes
- Operational use of this method requires further methodological developments

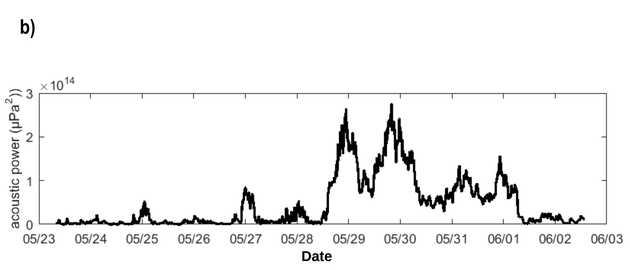

Figure 4 : Continuous monitoring from the riverside (Isère River, France) : a) the monitoring station ; b) example of temporal evolution in 2017 (time step = 1 hour)

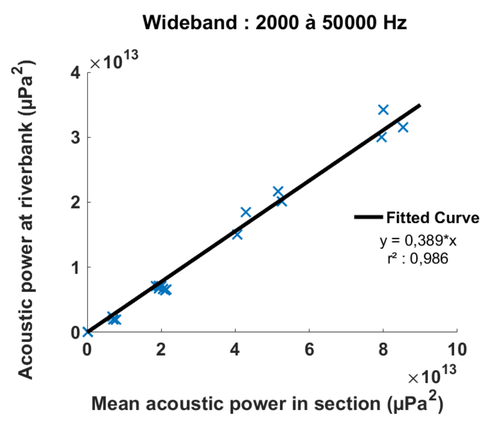

Figure 5 : Acoustic power at riverbank (μPa^2) in function of Averaged acoustic power in the cross-section (μPa^2) (Isère River – Grenoble, France)

Perspectives

- Well-adapted to large piedmont or plain rivers
- Research or River Management applications : estimate of critical shear stress and bedload discharge ; impact of an event (flood, hydraulic flush) ; monitoring after river restoration works

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