Large wood (LW) and sediment (dis-)connectivity in river systems

Introducing LW **(dis-)connectivity and sediment retention potential indices** and their application in river management contexts

C. Übl, 2015

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Introduction

In-stream large wood **(LW)** can have significant **effects on** channel hydraulics and thus **water and sediment connectivity (incl. sediment storage)** (e.g. Keller and Swanson, 1979; Gregory et al., 1985; Wallerstein and Thorne, 1997; Pfeiffer and Wohl, 2018)

Relationship between in-stream LW structures and their hydraulic function is generally quantified through **drag force** (cf. Abbe and Montgomery, 1996)

Drag analyses, however, are **data-demanding,** time-consuming and often not straightforward (and therefore **not practicable**, esp. in river management contexts)

Here, we introduce a **simple LW dis-connectivity as well as a LW sediment retention potential index** calculated based on visually estimated field-derived LW parameters

LW disconnectivity index (ID_{LW})

$$ID_{LW} = \frac{\sum A_{LW}}{River\ length\ (m)}$$

A_{LW} = degree of in-stream LW channel blockage (in % of the channel cross-sectional area filled by the LW accumulation, perpendicular to the flow direction) – visually estimated in the field (cf. Dixon et al., 2016)

LW sediment retention potential index (IR_{LW})

$$IR_{LW} = \frac{\sum RP_{LW_{(f)}}*}{River\ length\ (m)}$$

RP_{LW} = sediment retention potential of LW (no (0), low (1), moderate (2), high (3), based on LW acc. type** and A_{LW})

* For the calculation of fine (f) sediment retention potential of LW ($RP_{LW(f)}$), only LW accumulations exhibiting significant backwater effects are taken into account

LW sediment retention potential index (IR_{LW})

LW acc. type**	RP_{LW} class (0-3)
Single pieces	
Bridge	0 (no bed contact)
Collapsed bridge	1 (A_{LW} < 50%), 2 (A_{LW} > 50%)
Ramp	1 (A_{LW} < 50%), 2 (A_{LW} > 50%)
Log step	2 (A_{LW} < 50%), 3 (A_{LW} > 50%)
Partial log step	1 (A_{LW} < 50%), 2 (A_{LW} > 50%)
Debris jams	
Underflow jam	0 (no bed contact)
Dam jam	2 (A_{LW} < 50%), 3 (A_{LW} > 50%)
Partial dam jam	1 (A_{LW} < 50%), 2 (A_{LW} > 50%)
Other jams	0 (no bed contact), 1 (A_{LW} < 50%), 2 (A_{LW} > 50%)

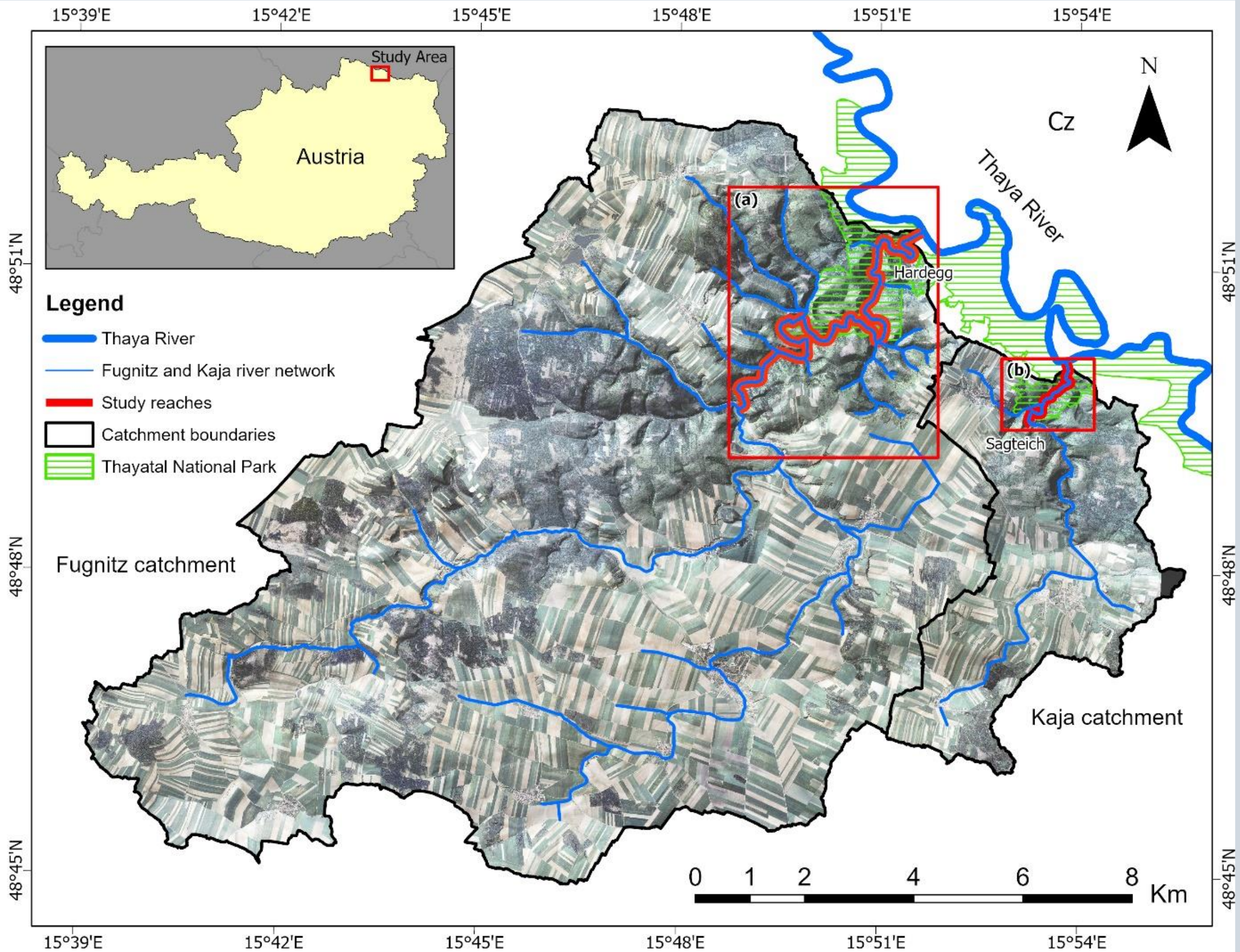
Log step

Collapsed bridge

Dam jam

Partial dam jam

Application of the indices



Poeppl et al., in prep.

Lower (forested) reaches of **two medium sized mixed-load perennial streams in the Thayatal National Park, Austria**:

<u>Fugnitz:</u>

-) Third-order stream
-) Catchment size: 138.4 km²
-) Total length: 29.7 km

<u>Kaja:</u>

-) Second-order stream
-) Catchment size: 21.3 km²
-) Total length: 10.5 km

Bohemian Massif (Crystalline mid-mountain range)
500-600 mm mean ann. precipitation
~8°C mean ann. temperature

Application of the indices

Field survey of in-stream LW in spring 2021:

-) LW classification (span, position, orientation, type)
-) Visual estimation of A_{LW} cf. Dixon et al., 2016
-) Backwater effects
-) Sediment storage (volume) cf. Welling et al., 2021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Management contexts:

-) Flood/water and sediment retention
-) Habitat quality/diversity


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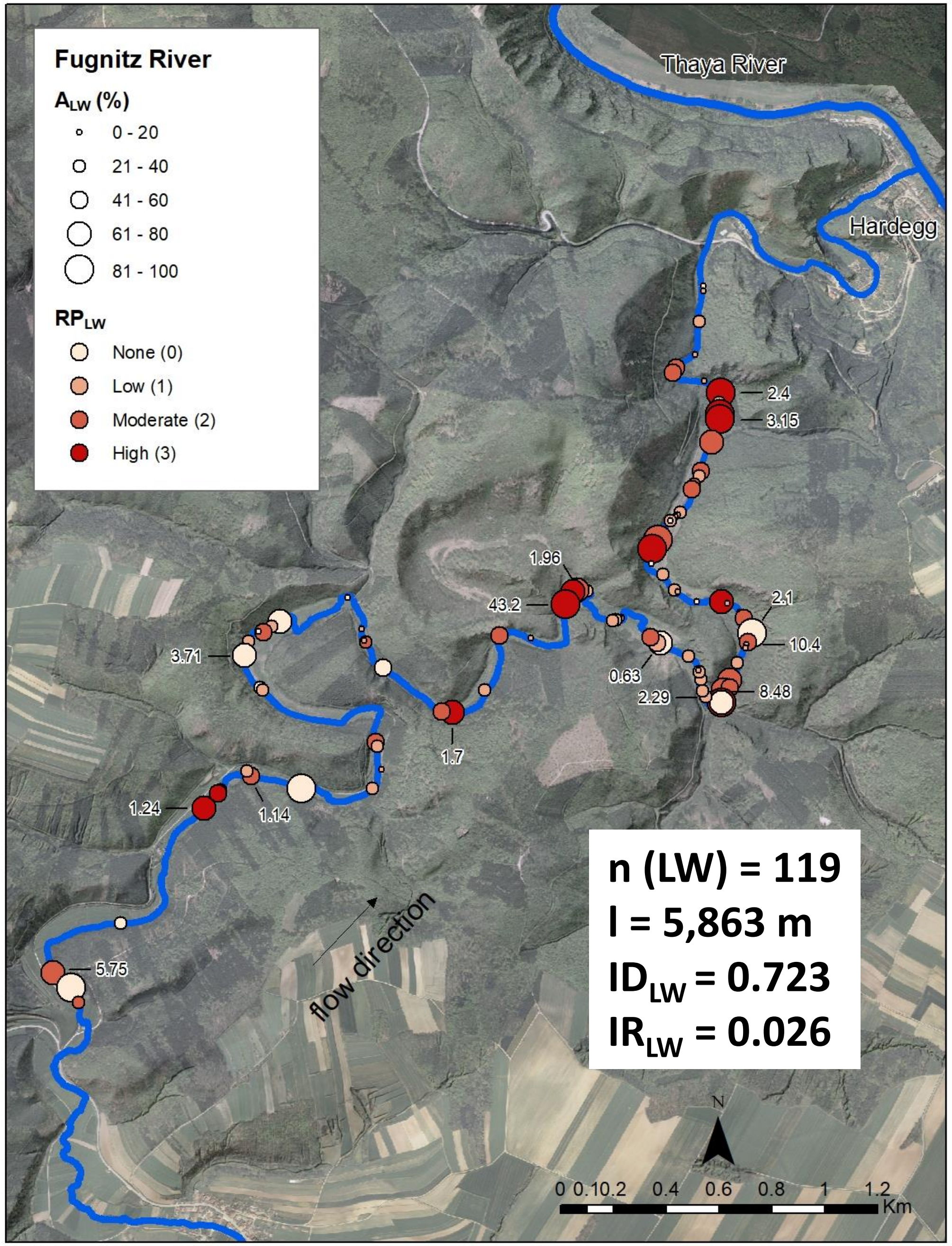
Results

FUGNITZ RIVER				
LW type	Quantity	Avg. A_{LW} (%)	Avg. RP_{LW} (0-3)	Avg. sediment storage (m^3)
Single pieces				
Bridge	7	13.5	0	0
Collapsed bridge	3	33.33	1.33	0
Ramp	11	21.36	1	0
Partial log step	10	17.5	1	0
Log step	2	2	2	0
Debris jams				
Underflow jam	11	63.18	0	0
Dam jam	12	**79**	**2.92**	**4.307**
Partial dam jam	23	47.83	**1.57**	**1.305**
Other jams	30	28.62	1.17	0

Poeppl et al., in prep.

Total sediment storage = 88.7 m^3 (= 15.13 m^3/km)



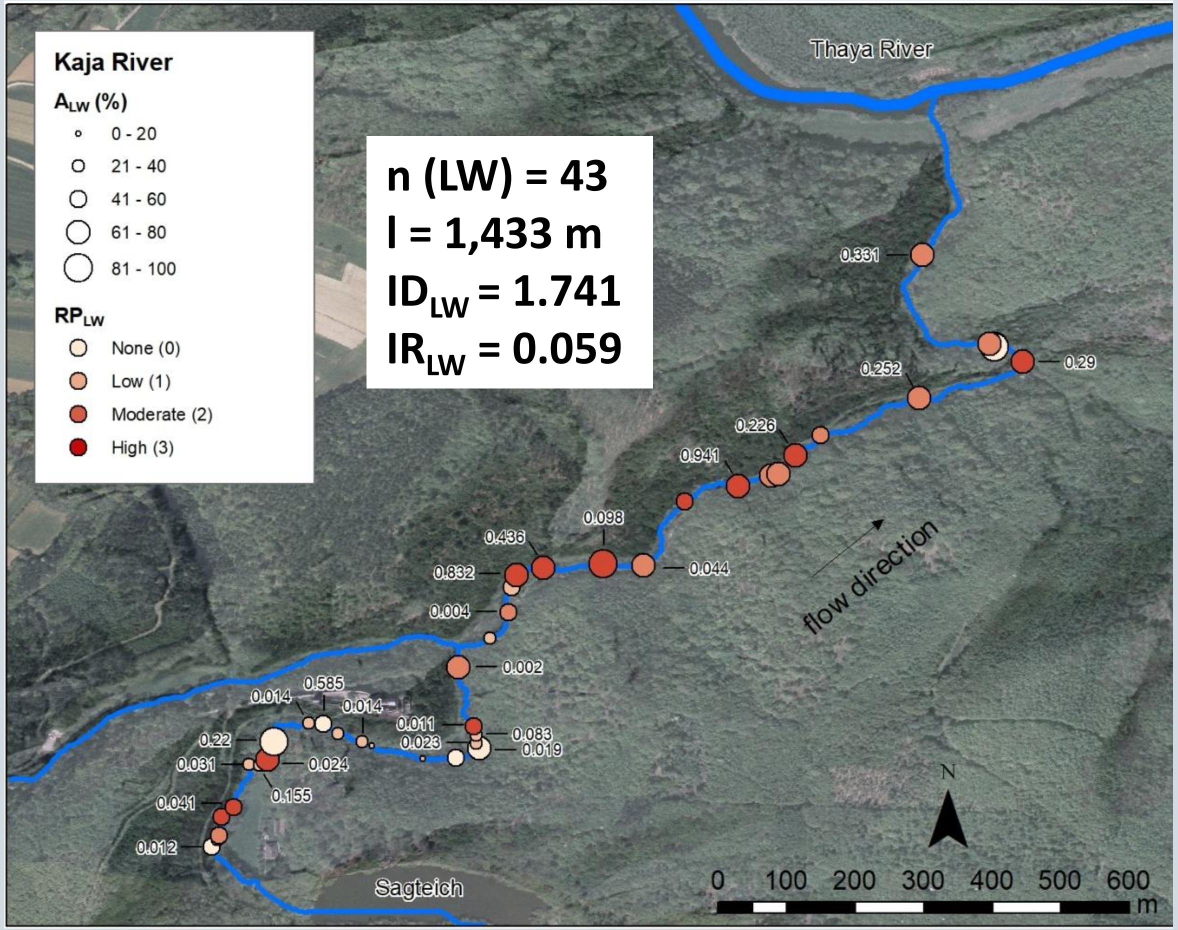
Poeppl et al., in prep.

Results

KAJA RIVER				
LW type	Quantity	Avg. A_{LW} (%)	Avg. RP_{LW} (0-3)	Avg. sediment storage (m^3)
Single pieces				
Bridge	1	85	0	0
Collapsed bridge	2	30	1	0
Ramp	5	22	1	0.017
Partial log step	-	-		-
Log step	-	-		-
Debris jams				
Underflow jam	7	76	0	0
Dam jam	11	**70.45**	**3**	**0.263**
Partial dam jam	10	**58.82**	**1.82**	**0.011**
Other jams	7	**53.57**	**1.42**	**0.109**

Poeppl et al., in prep.

Total sediment storage = 4.7 m^3 (= 3.28 m^3/km)



Poeppl et al., in prep.

Conclusion (short)

The newly developed indices have shown to provide a **straightforward and valuable tool** to assess the effects of LW on **water and sediment (dis-)connectivity**, especially in a river management context where often **simple assessment** approaches are needed to get a system-wide overview on location, type and potential effects of LW accumulations.

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