# Prediction of logjam upstream backwater rise

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## How do jams generate an upstream backwater?

Region of slower, deepened water formed by water flowing through jam
Relate jam structure to backwater rise
Enables model representation, cross-catchment comparison

Common designs channel-spanning jam **(L)**, jam with lower gap **(R)**

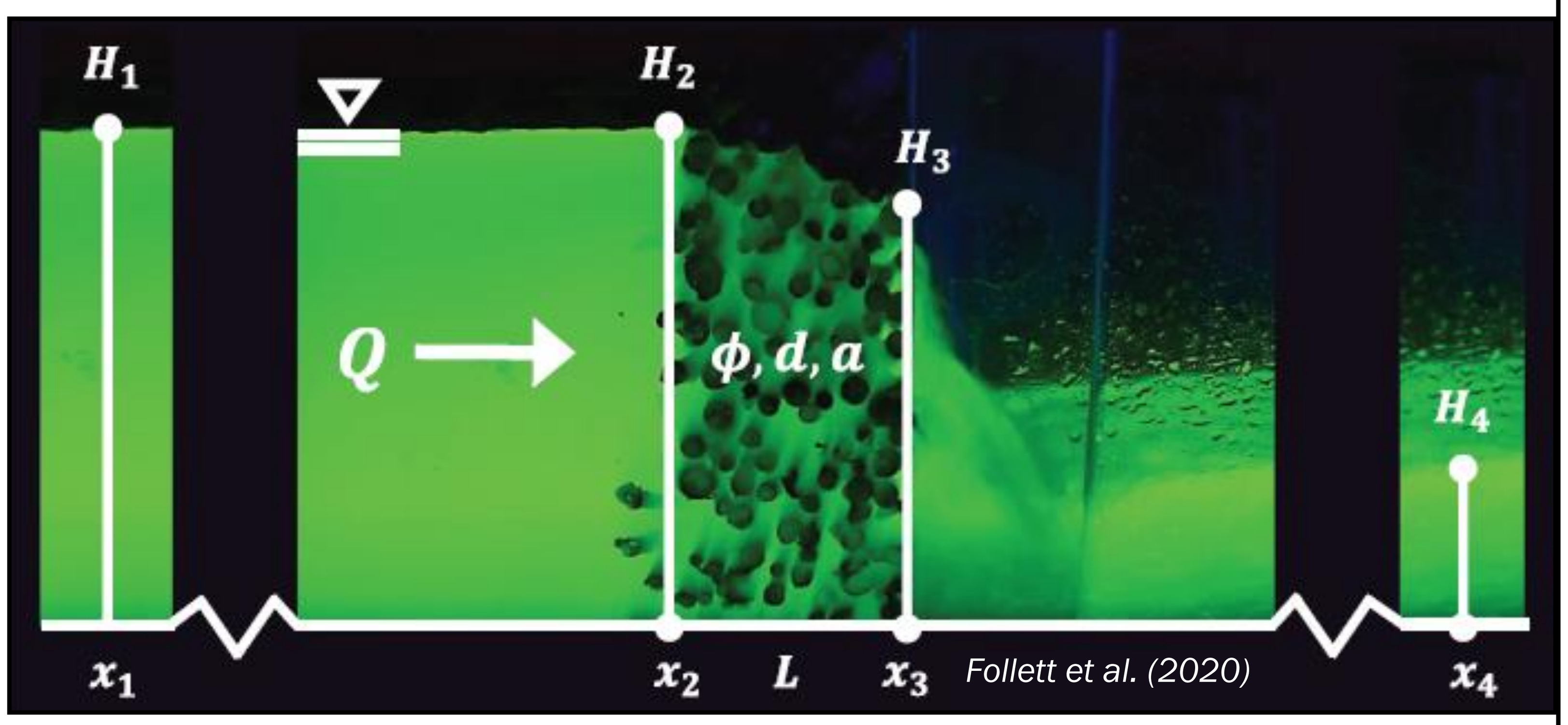
*Photo credit (R): Mr Geoff Smith/Shipston Area Flood Action Group*

## In-jam momentum loss represented by canopy model

584 flume experiments varied jam and flow conditions
Canopy drag model explained observed in-jam water surface profile

$$H_2^2 - H_3^2 - \underbrace{\frac{LC_Da}{(1-\phi)^3}}_{C_A}\frac{q^2}{gH_3} = 0$$

Dimensionless jam accumulation factor $C_A$ with jam length $L$, drag coefficient $C_D \approx 1$, frontal area per jam volume $a$ and solid volume fraction $\phi$




## Predict upstream depth from flow, jam structure

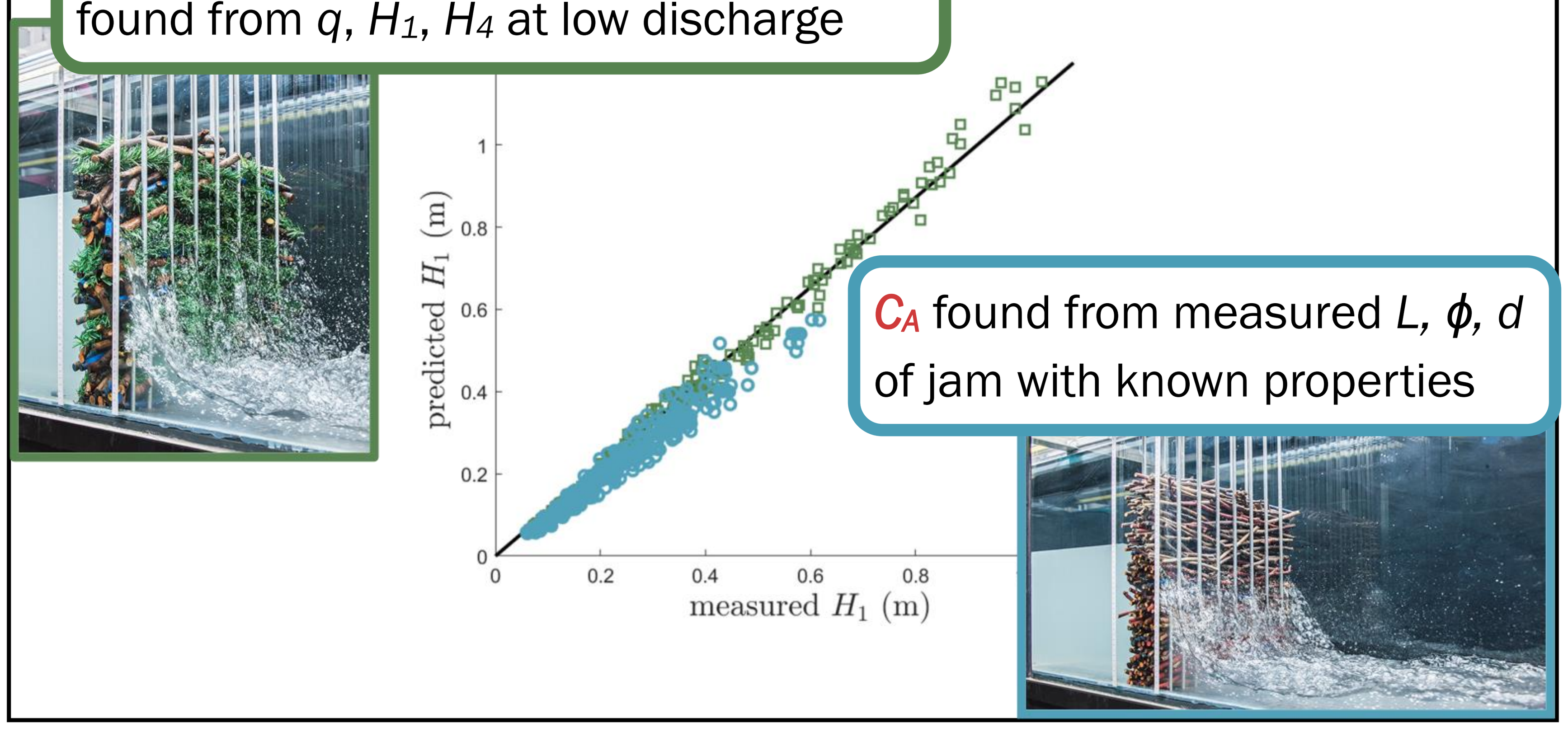
Water rises to minimum possible upstream depth, reducing in-jam losses and generating fall at downstream end of jam

$$q = \left[\frac{2gH_1^3}{3\sqrt{3}C_A}\right]^{1/2}$$

Backwater stores energy to compensate for in-jam losses, returning water to unobstructed depth far downstream of jam

For preexisting complex jams with fine material, $C_A$ may be identified from flow measurements

Effective $C_A$ for preexisting, complex jam found from $q$, $H_1$, $H_4$ at low discharge




$C_A$ found from measured $L$, $\phi$, $d$ of jam with known properties

## Jams with a lower gap: flow redistribution & upstream depth

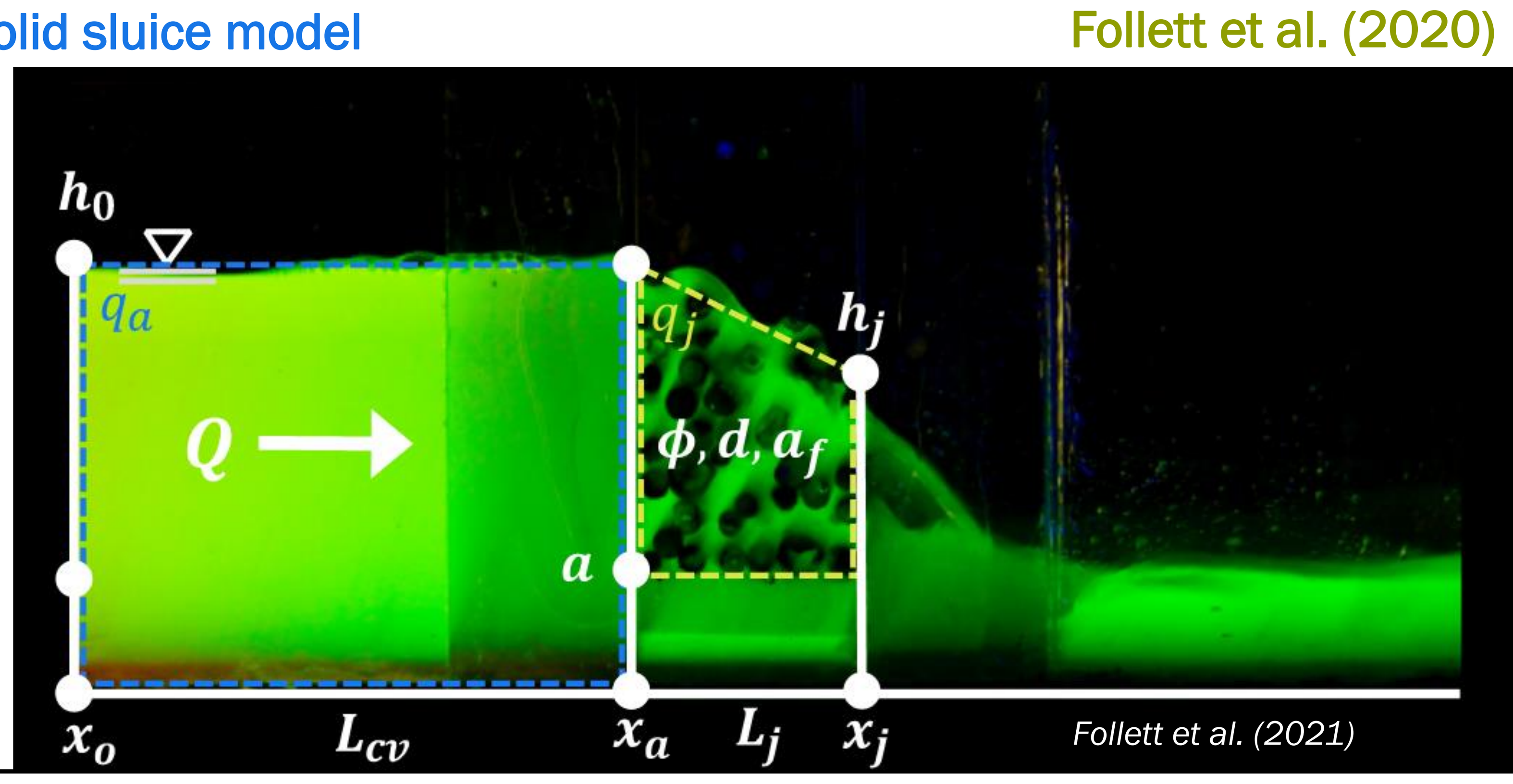
Two-box model constrained by in-jam drag, momentum loss in lower gap, and net pressure force

Validated by bulk velocity measurements and video analysis of spatial average velocity through gap

$$q = \left[\frac{C_{p0}}{\left(1 + C_b\frac{a}{h_0}\right)} g a^2 h_0\right]^{1/2} + \left[\frac{2g(h_0 - a)^3}{3\sqrt{3}C_A}\right]^{1/2}$$

$q_a$ discharge through gap, solid sluice model

$q_j$ discharge through jam, Follett et al. (2020)




### Acknowledgements

This project was supported by the Royal Academy of Engineering under the Research Fellowships scheme

Royal Academy of Engineering

This project has received funding from the European Regional Development Fund through the Welsh Government Sêr Cymru programme 80762-CU-241

### References

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