From Drones to Phones to Satellites: The Latest Tools to Measure River Flow

Nick Everard
Senior Hydrometric Scientist, UKCEH
Hydro-Jules, July 9th 2024

UK Centre for Ecology & Hydrology

UK Centre for
Ecology & Hydrology

Nick Everard. Still excited after

36 years

....measuring rivers

Senior Hydrometric Scientist
River flow technologies
and techniques

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Nick Everard. Still excited after...

17 years

Dunking sensors

(Leading on ADCP technology at the Environment Agency)

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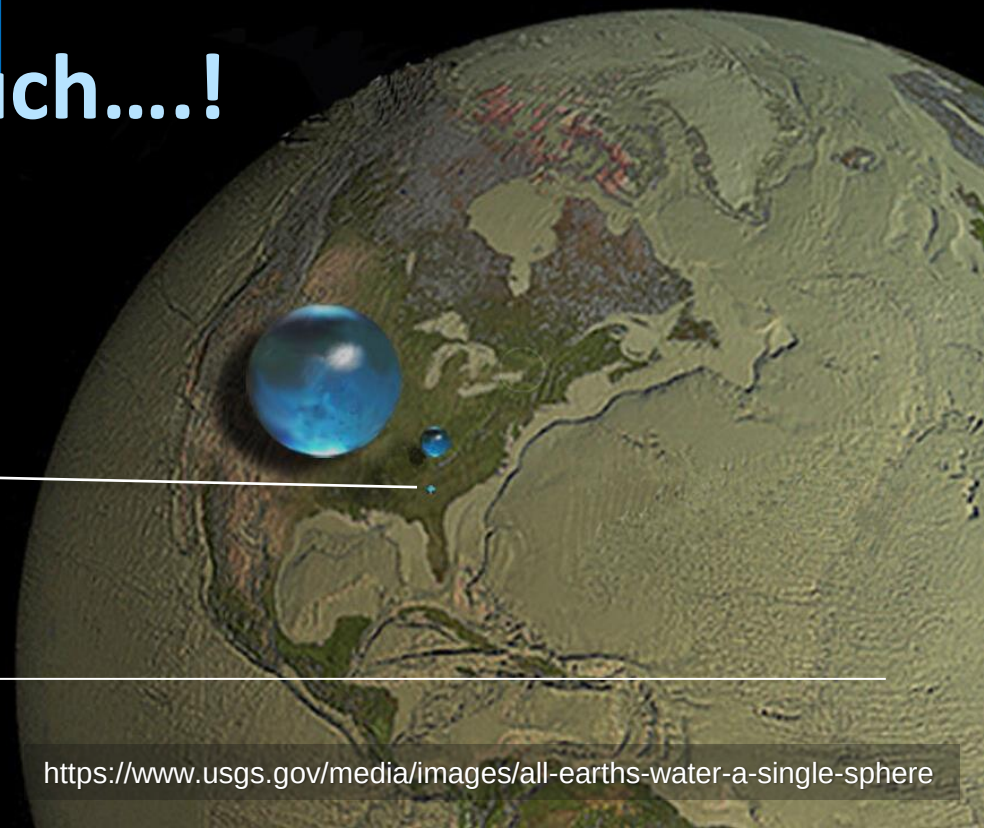
Water

There isn’t very much….!



Water in rivers and lakes

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https://www.usgs.gov/media/images/all-earths-water-a-single-sphere

Climate Water

Impacts (for many) will be felt most strongly through

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Ed Hawkins Climate Stripes
Global temperature series

Floods…

…are getting worse

Mytholmroyd, England, December 2015

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So we *really*

Need Accurate Measurements

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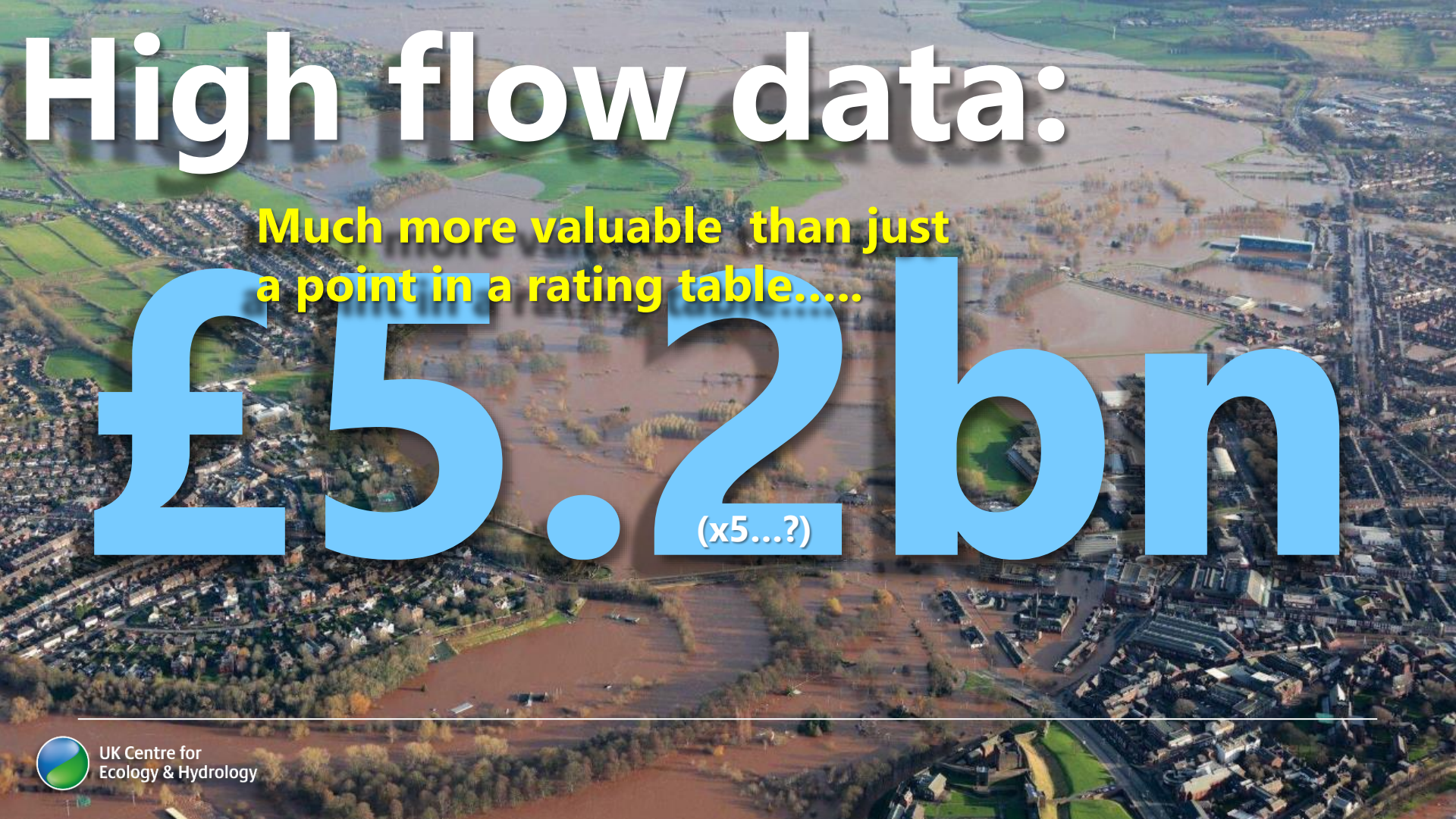
High flow data:
Much more valuable than just a point in a rating table.....
£5.2bn
(x5...?)
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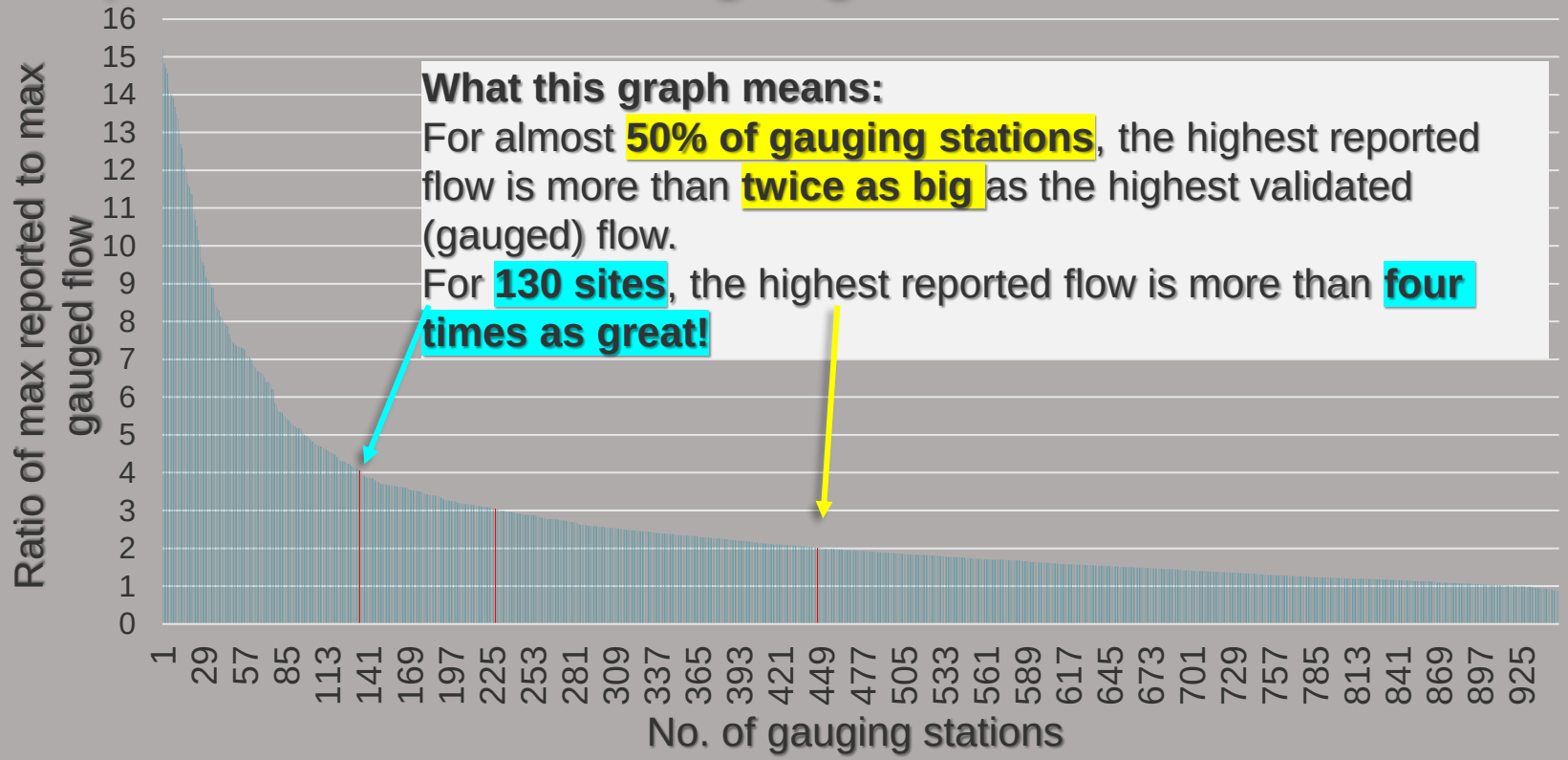
The problem – Measuring big floods is difficult!!!



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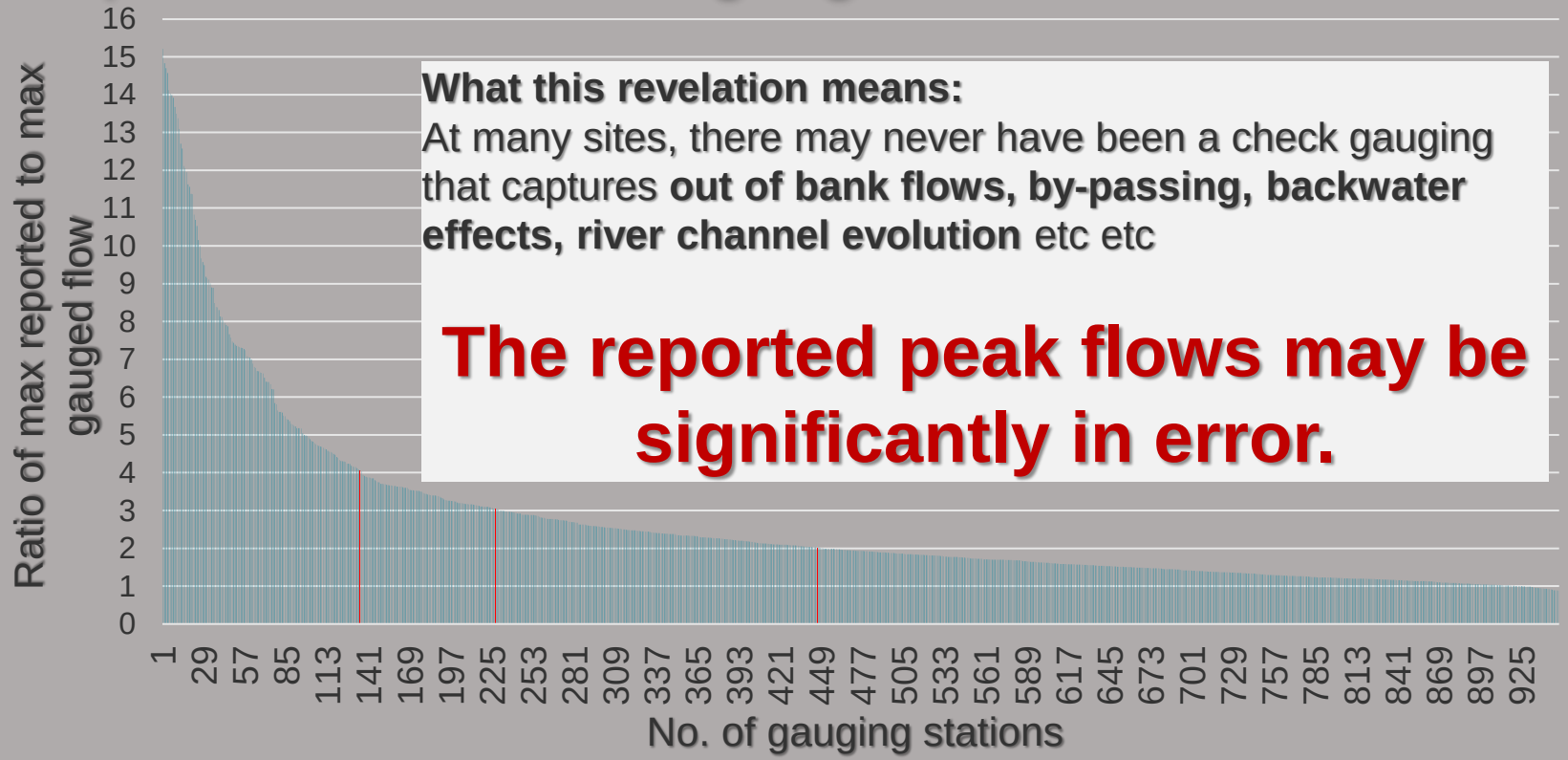

What this revelation means:
At many sites, there may never have been a check gauging that captures **out of bank flows, by-passing, backwater effects, river channel evolution** etc etc

The reported peak flows may be significantly in error.

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Extreme Floods

Established methods

May not be very safe…

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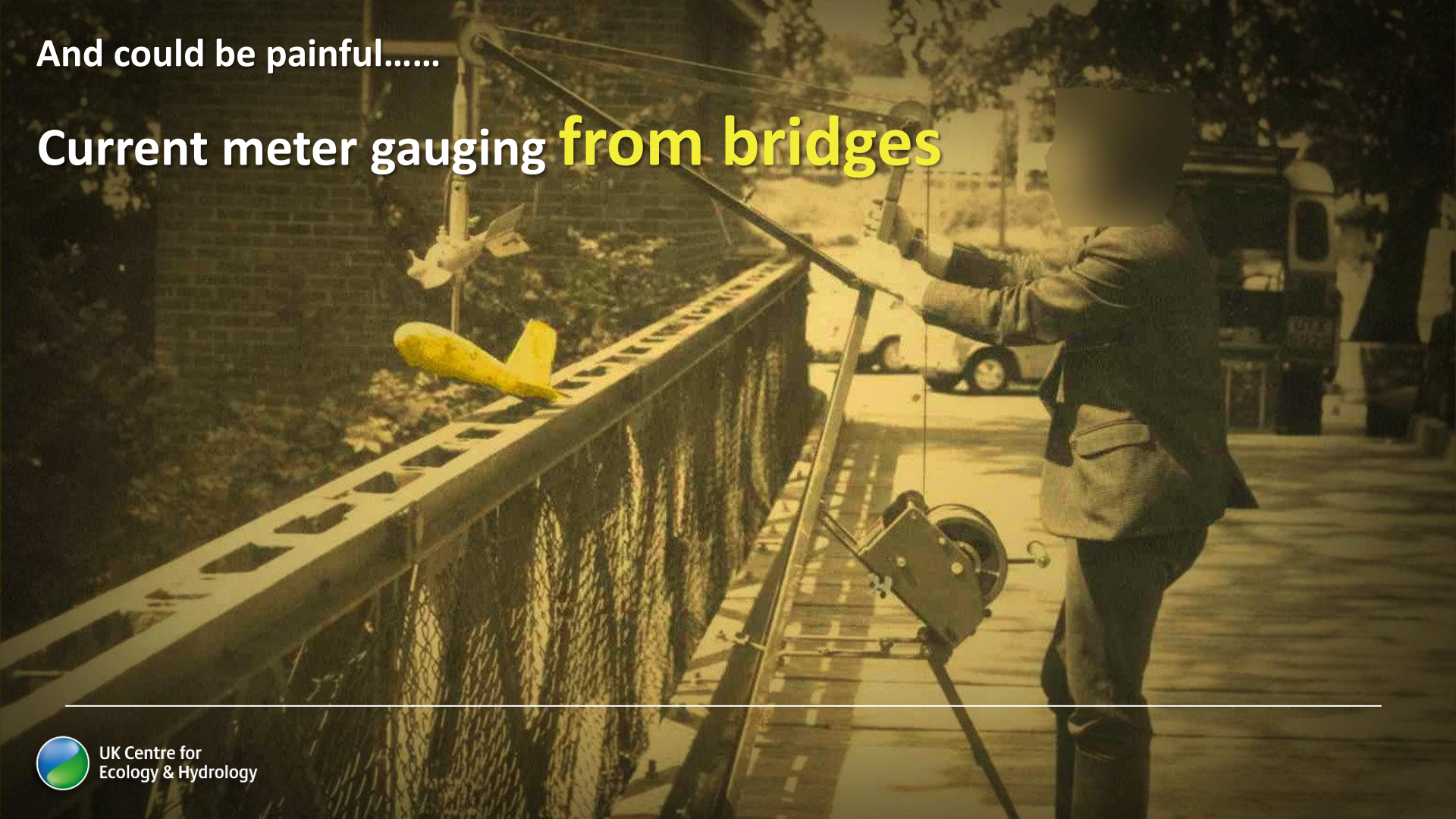
Picture: USGS surface water calendar


And could be painful……
Current meter gauging from bridges

And hazardous……

Current meter gauging with Crewed boats

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ARCboat & ADCP

Perfect solution for lowland rivers

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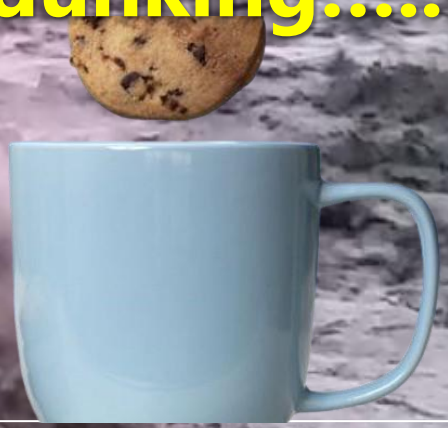
If the water wants to destroy your sensors….

…it's time to **stop dunking…..!**



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Glacial outburst flood, Iceland.
[Very brave Icelander….]

Site access

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Surface velocity methods

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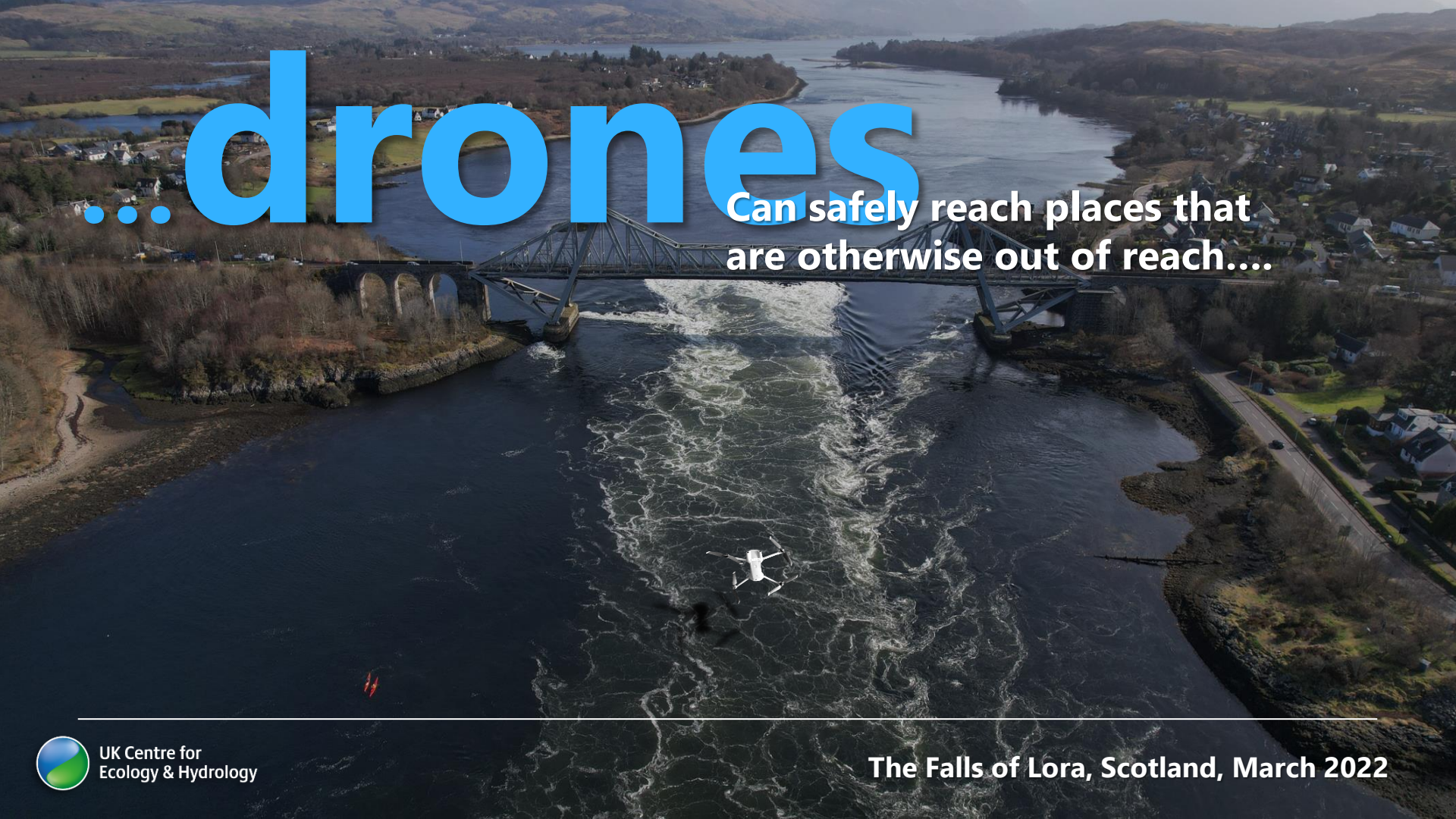
A velocities
4.0 m/s
2.51
0.00
Measuring surface water speeds
With drones…
…Phones…
…Radars…
SVR
UK Centre for Ecology & Hydrology

Video velocimetry

Short videos (20 sec)

Motion of **visible features** on water's surface **tracked** through time

River Feshie, Scotland, March 2022


...drones
Can safely reach places that are otherwise out of reach....
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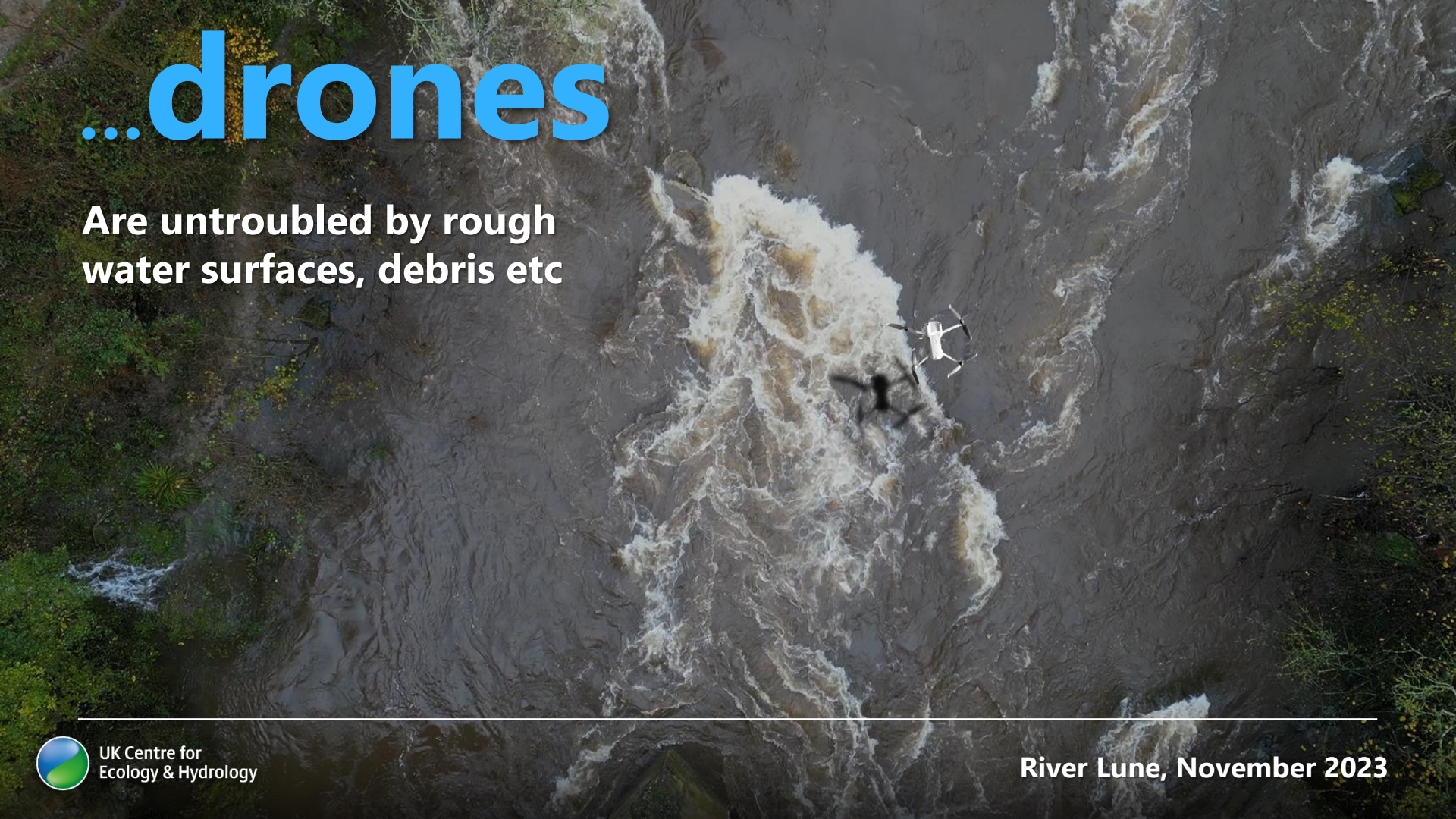
The Falls of Lora, Scotland, March 2022

...drones

Are untroubled by rough water surfaces, debris etc



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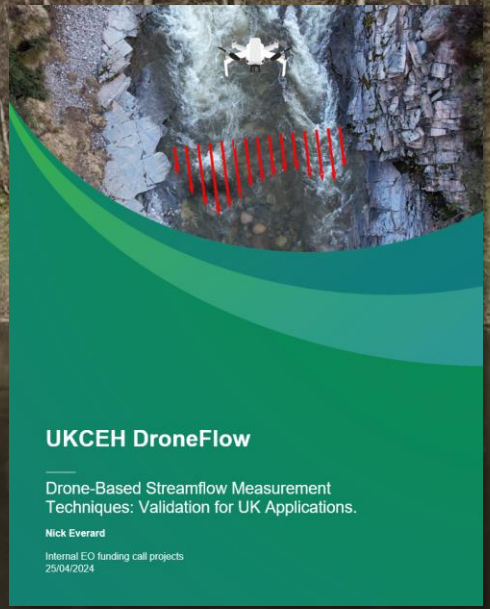
River Lune, November 2023

Aerial velocimetry: How accurate is it?



116.43 m^3/sec

116.61 m^3/sec

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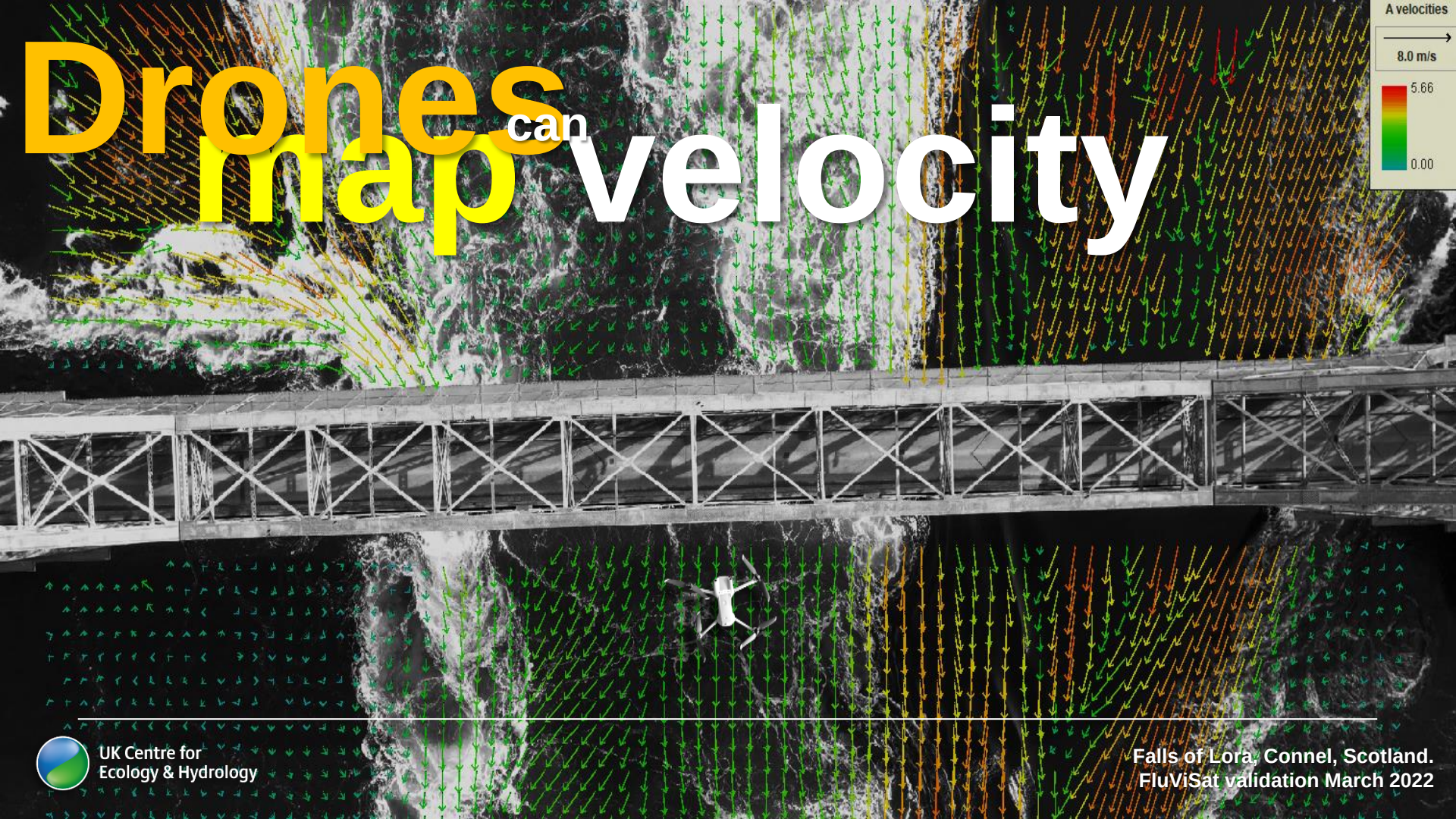
River Tweed at Norham, March 16th 2022

Drones can map velocity



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Falls of Lora, Connel, Scotland.
FluViSat validation March 2022

Fixed camera installations

Resilient, low-cost monitoring

Newcastle University

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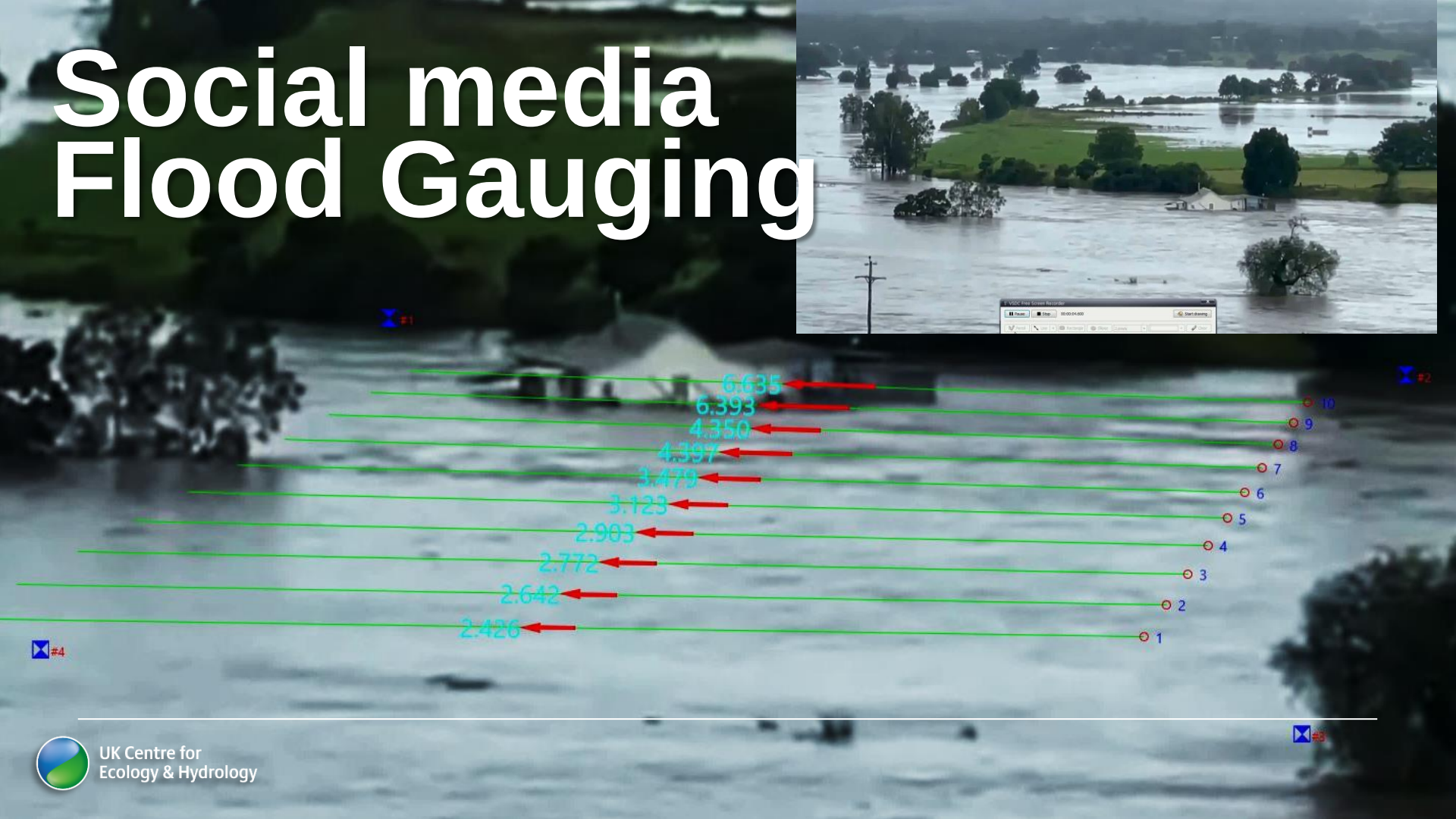
Social media Flood Gauging



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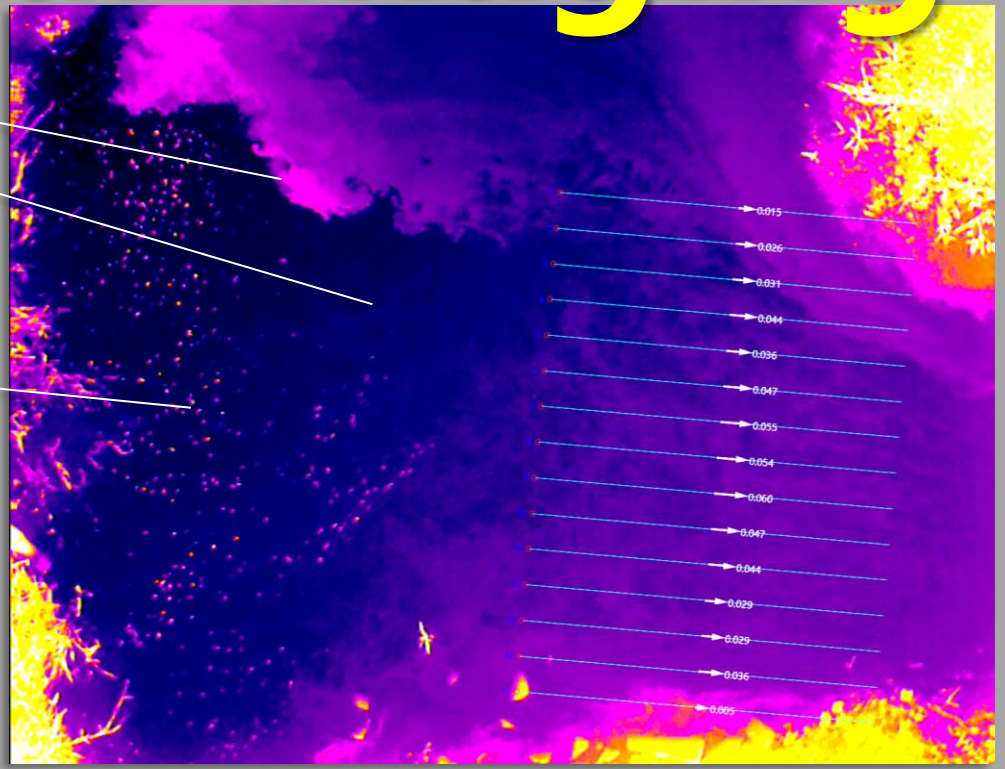
Thermal imaging

Warmer water

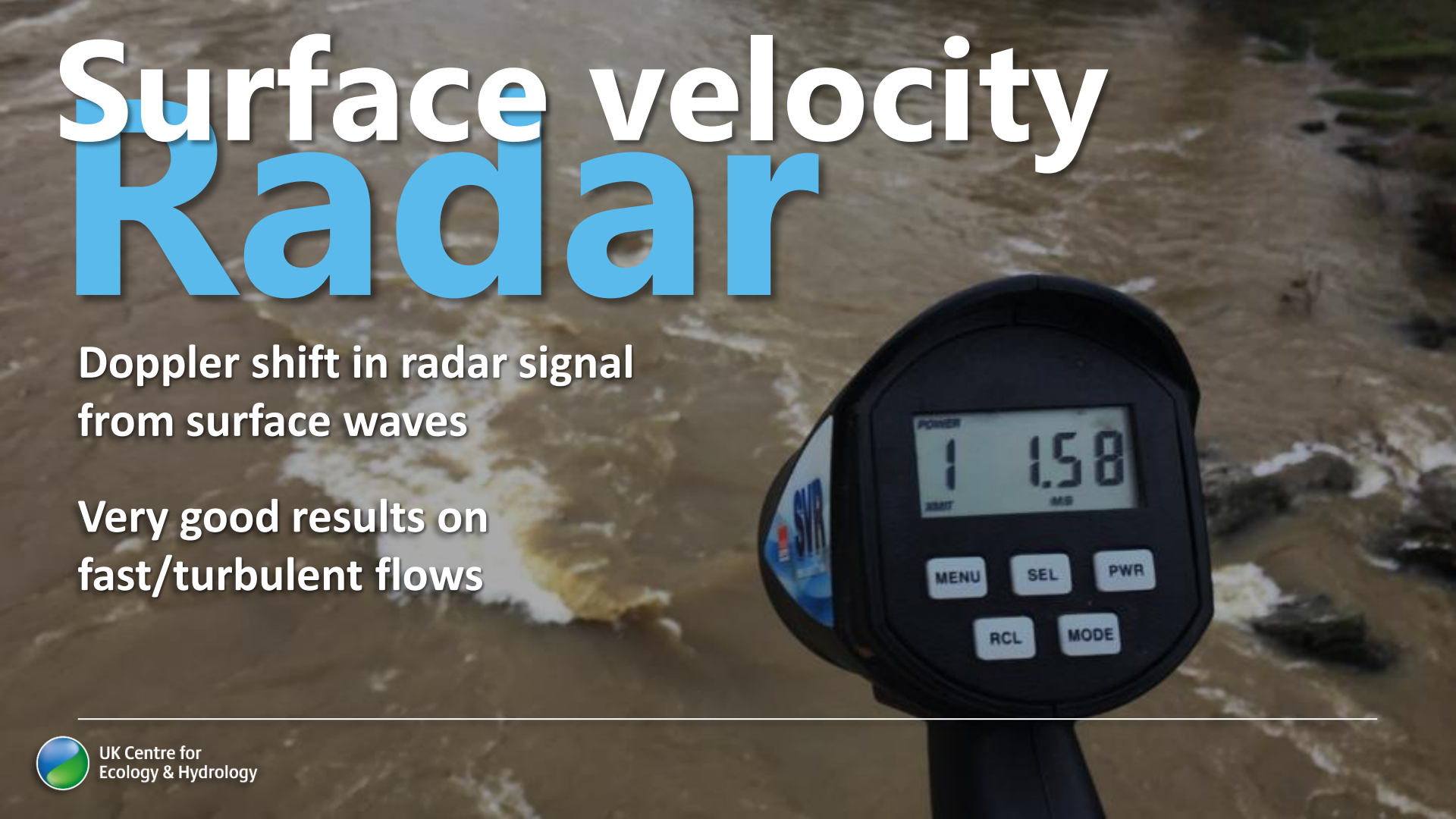
Cooler water

Rice Krispies
(visual tracer)



River Beane,
Hertfordshire,
October 2023

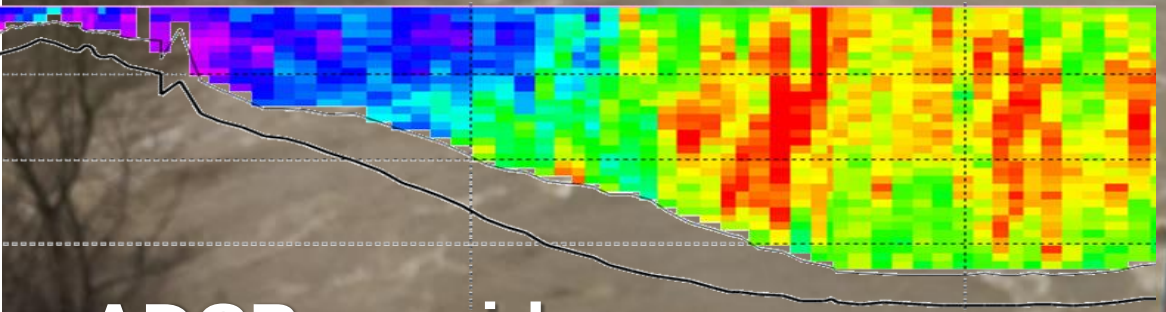
Surface velocity Radar

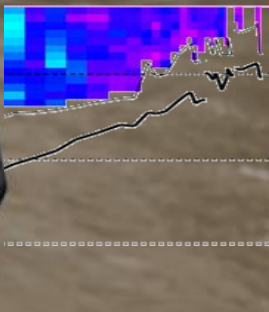


Doppler shift in radar signal from surface waves

Very good results on fast/turbulent flows

Surface Velocity Radar (SVR)





ADCP provides cross-section and velocity profile

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Reading the surface…

These surface features are there for a reason.

Can they be ‘read’ to provide depth and velocity profiles? (we think so!)

What if we could measure floods from space?

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FluViSat
Hydrological Flow Measurement
from Satellite Video
Shot from space.
0.8m pixel size.
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Background image courtesy Planet Labs PBC

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SAR

Synthetic
Aperture
Radar

(Can see through clouds....)
((16cm pixels now possible!))
(((....And video!!!)))

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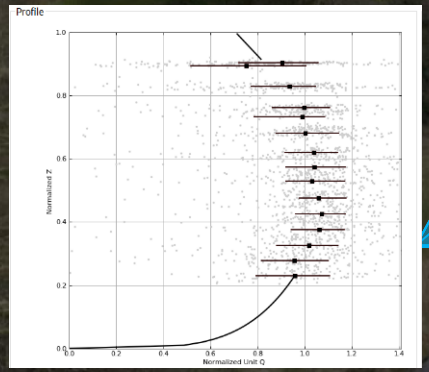
All these methods (currently) need ADCP data!

ADCP data needed for :

- **Cross-section**
- **Velocity profile**



Satellite video

Drone video

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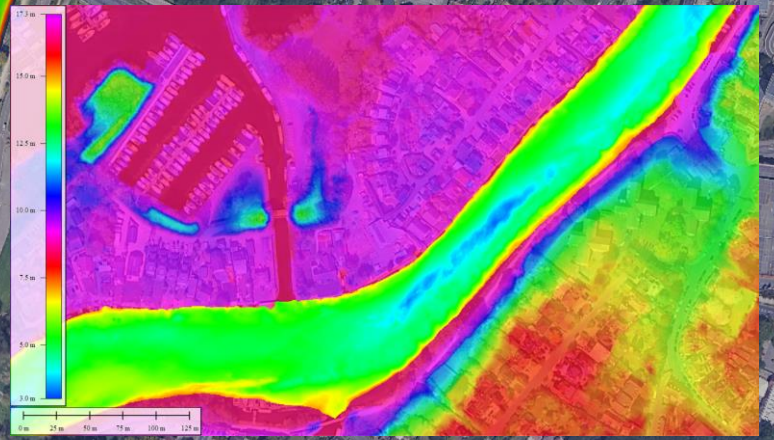
River bathymetry

....and floodplain DEM

Environment Agency multi-beam bathymetry and LiDAR open data



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150 m 250 m 350 m

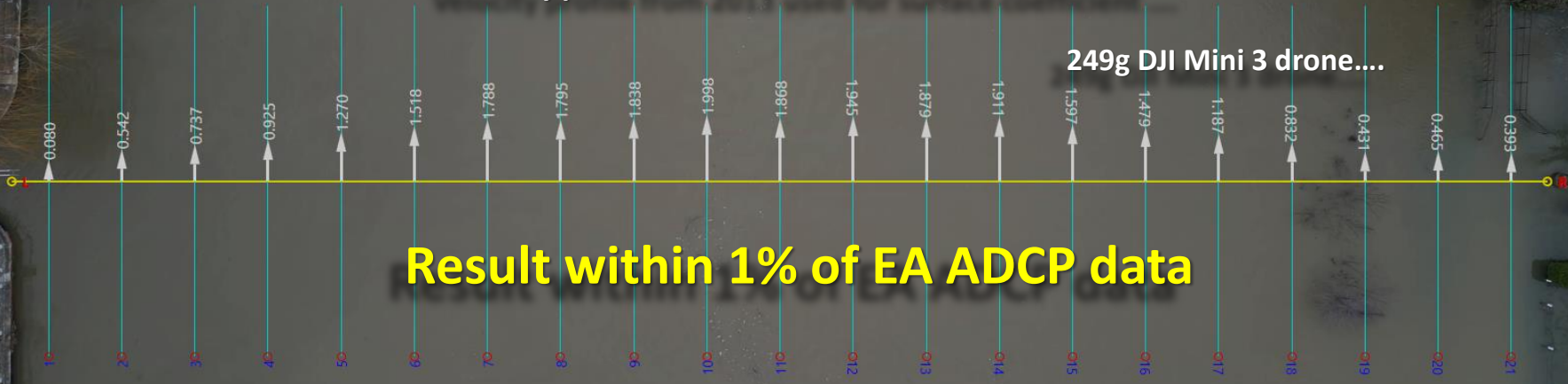
River bathymetry

….and floodplain DEM

Environment Agency multi-beam bathymetry and
LiDAR open data used to determine cross-section

Velocity profile from 2013 used for surface coefficient ….

249g DJI Mini 3 drone….



Result within 1% of EA ADCP data

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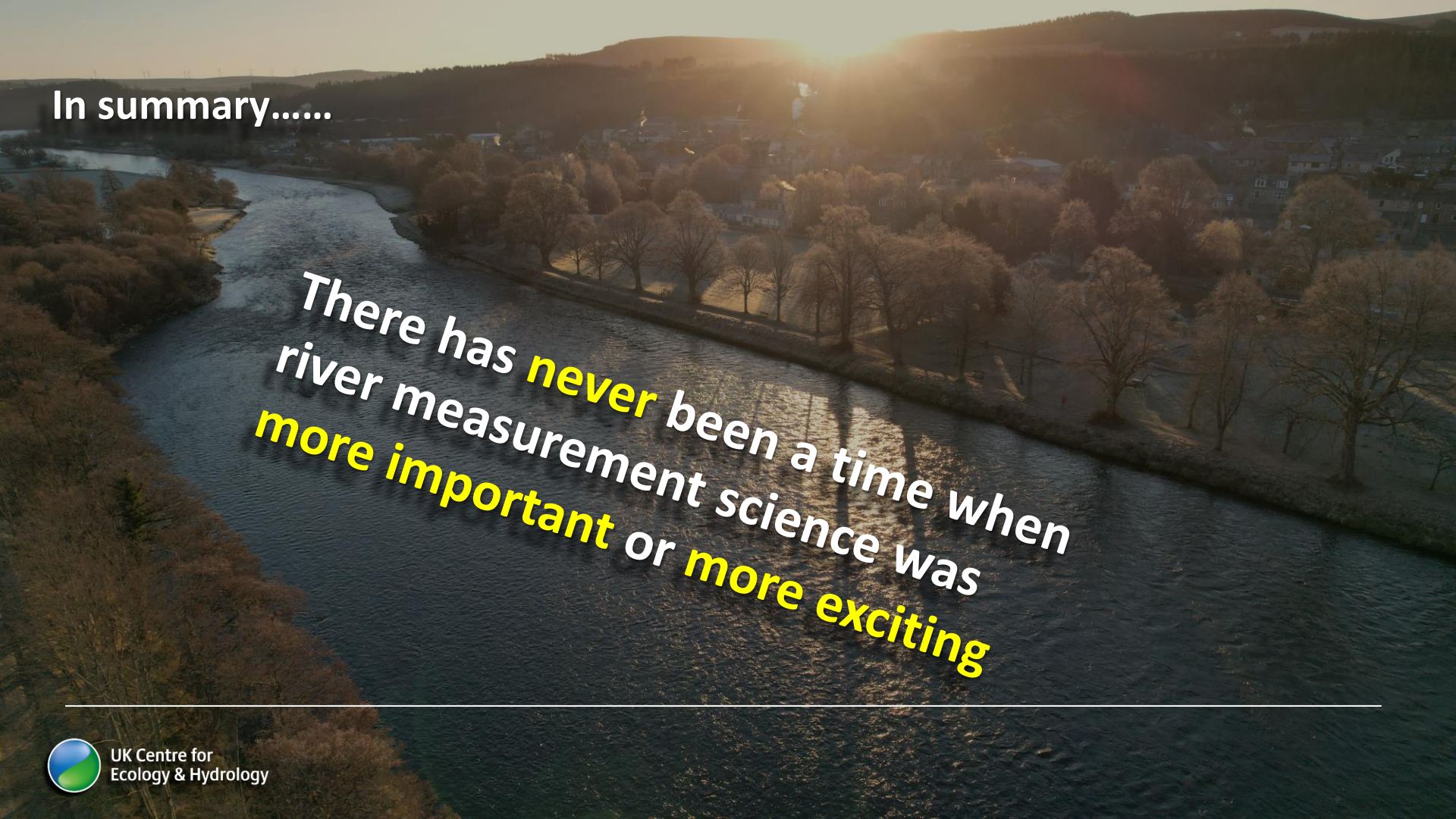

In summary……

There has never been a time when river measurement science was more important or more exciting

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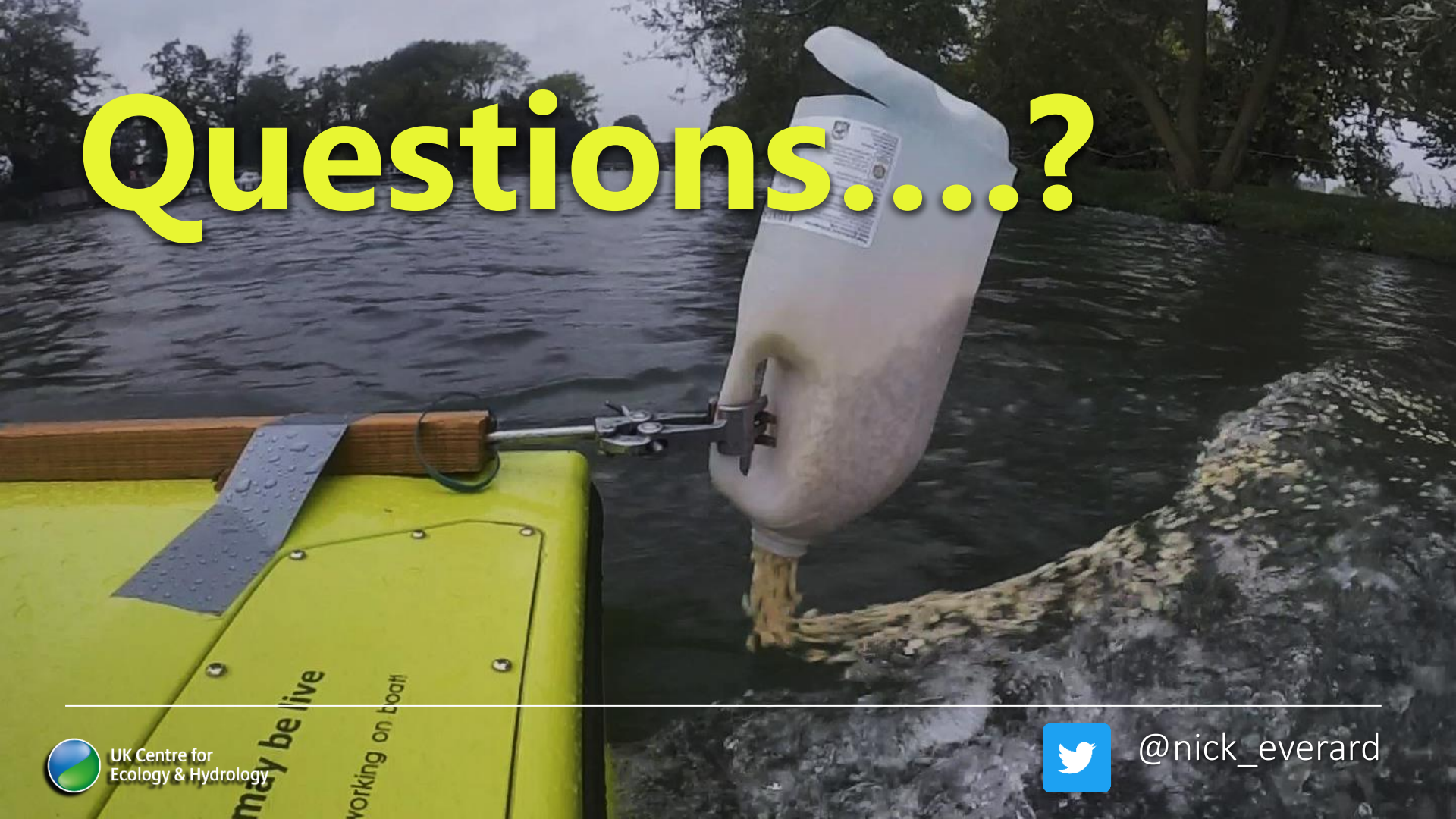
Questions....?
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@nick_everard