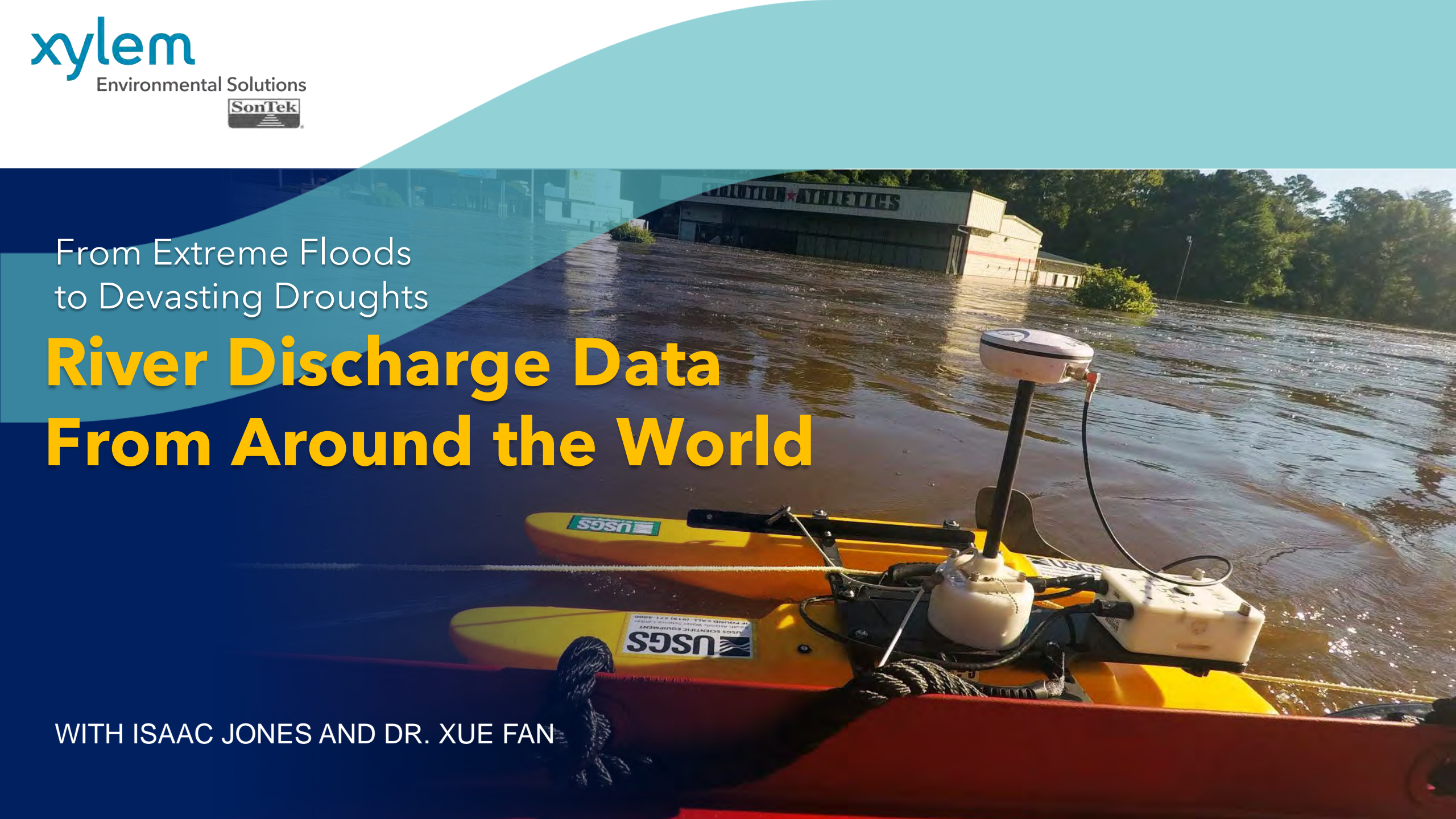


From Extreme Floods
to Devasting Droughts

River Discharge Data From Around the World

WITH ISAAC JONES AND DR. XUE FAN



Overview

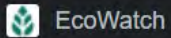
Drought Case Studies

- South Africa
- Southwest USA

Flood Case Studies

- Oregon, USA
- Eastern Australia
- United Kingdom

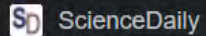




More Than 75% of the World Could Face Drought by 2050 ...

Droughts were also the deadliest natural disaster on a global scale; though they only represent 15 percent of natural disasters, they killed...

2 weeks ago



The European drought event from 2018 to 2020 was the most ...

An international team of researchers led by scientists from the Helmholtz Centre for Environmental Research (UFZ) has succeeded in categorizing...

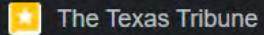
1 week ago



The New York Times

California Approves New Water Restrictions Amid Worsening Drought

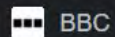
10 hours ago



Worsening Texas drought sparks wildfires, water restrictions, crop failures

Hundreds of wildfires have broken out this spring. More than a dozen areas are under voluntary or mandatory water use restrictions, and more...

14 hours ago

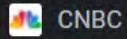


Why Africa couldn't get urgent global deal on drought

Africa has been hit by 14 extreme droughts in the past two years alone - more than any other continent.

1 day ago

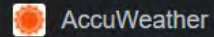




Photos: Bangladesh and India endure catastrophic floods

Severe floods in parts of Bangladesh and India have killed at least 24 people and left thousands displaced in recent weeks.

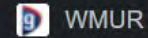
2 days ago



Frequent rounds of intense rainfall to raise flood risk in south-central US

Over 61 million people in the central and southern United States will be from a slow-moving storm capable of producing flooding and severe we.

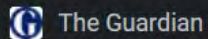
2 days ago



Flood risk expected to grow in New Hampshire as temperatures rise

Flooding is an ongoing worry in New Hampshire, causing more than half of all weather damage in the state, and there are concerns that...

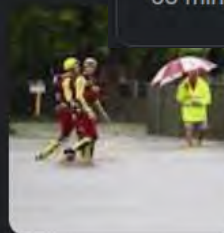
58 mins ago



More floods forecast for Australia's east as La Niña weather pattern lingers

Bureau of Meteorology climate report points to big wet in NSW and Queensland extending for months.

1 day ago



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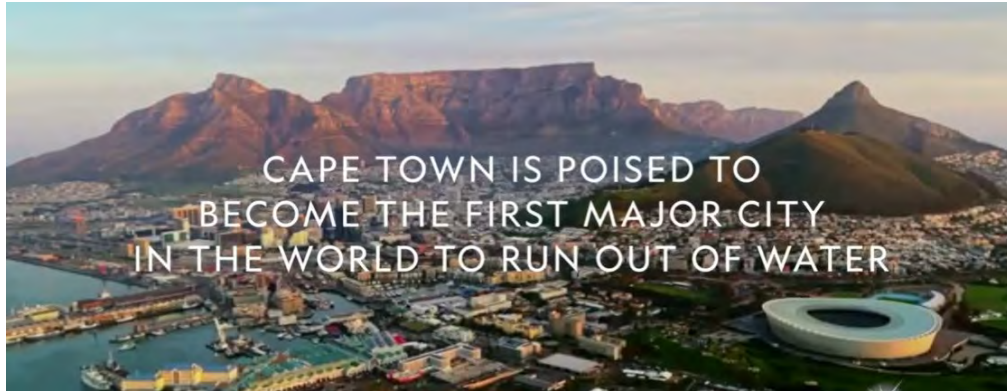
Environmental Solutions



Measuring Discharge in Drought-Stricken South Africa



South Africa Drought 2018-2021



(From National Geographic)

Headlines from 2018 – “Day Zero”

Each American uses an average of 82 gallons of water per day (372 liters)!

South Africa Drought 2018-2021



Source: Wikipedia

Gauteng province draws its water from the Integrated Vaal River System that includes a huge water transfer via the Lesotho Highlands Water Project. Last October, Johannesburg residents were hit with precautionary water restrictions when the Vaal Dam levels dropped to 53 percent, and planned maintenance stopped Lesotho's water transfers for two months. To many, this highlighted the fragility of their water supply. Gauteng's population is increasing rapidly, with domestic supply the fastest-growing sector, but its available water won't increase until the Polihali Dam is completed in 2026. To avoid a water crisis, Gauteng must reduce water use in order to deal with population growth—cutting it by three percent per person per year. Last October's heatwaves saw daily consumption rise by 264 million gallons (1,000 million liters), and compounded by infrastructure problems, suburban faucets ran dry in the capital. Without the certainty of six years of good rains, Johannesburg and Pretoria need to follow Cape Town's lead and actively cut their water use.

South Africa Drought 2018-2021

- Lesotho Highlands Water Project – transfer water from Lesotho via tunnel system to Vaal Dam (south of Johannesburg)
- Water used to augment supply for Gauteng, the economic heartland of South Africa

The gauging weir in the Liebenbergsvlei River at Fredriksdal consists of a compound Crump structure with a measuring capacity of 110 m³/s.



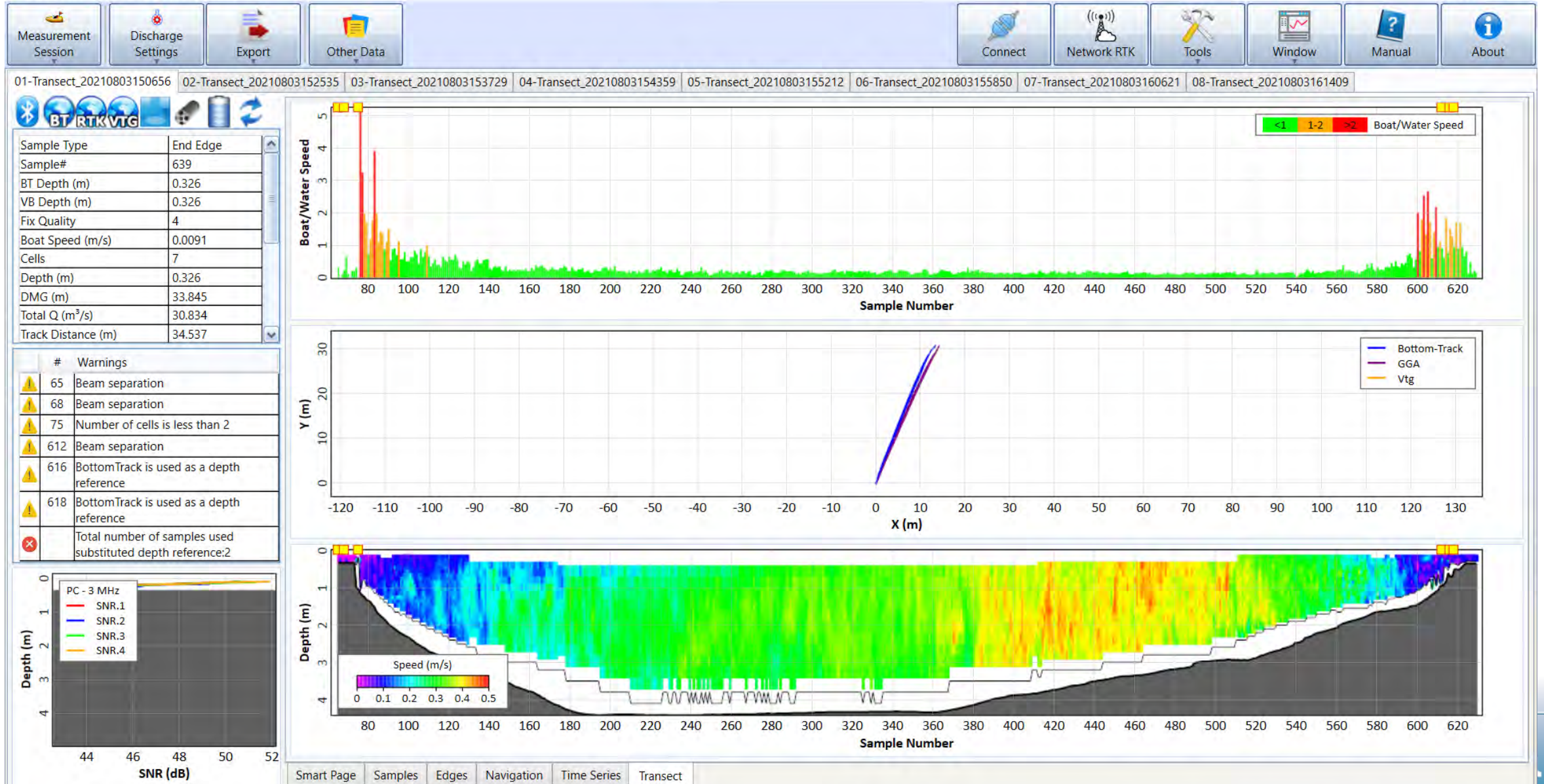
South Africa Drought 2018-2021



- RTK super critical at several gauging sites in this river system - <75m wide and flows range between 20 -30 cms. Accuracy of RTK makes measurements reliable and repeatable.
- Flood events create moving bed here (low discharge bias) so GNSS ship track helpful
- Several gauging stations along this river system - many large farms that using water for irrigation. Accurate measurement of water critical in this region

South Africa Drought 2018-2021



RSQ - C8H026_20210803_161926.rsqmb



Field Tip: Check your extrapolations

Default extrapolation configuration (RSQ)

Extrapolation Configuration Change

Top Extrapolation:
Extrapolation Method: Power Fit
Profile Part: Entire Profile
Coefficient: 0.1667

Bottom Extrapolation:
Extrapolation Method: Power Fit
Profile Part: Entire Profile
Coefficient: 0.1667

Bottom Discard:
Profile Part: Percentage of Profile
Percentage of Profile: 10 %

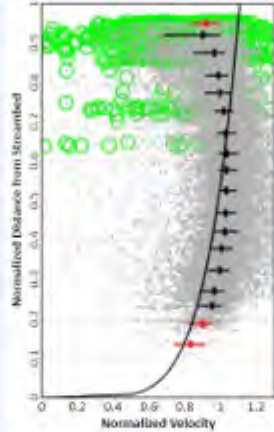
Q = 31.0440 cms (1096.31 cfs)

Q = 31.3223 cms (1106.14 cfs)

Extrap Method

Extrap method fit type: Measurement

Z	Points
0.9532	207
0.9221	1079
0.8773	3133
0.8195	2971
0.7755	2015
0.7294	3127
0.6731	2972
0.6215	2623
0.5795	2502
0.5269	3109
0.4705	2959
0.4230	2206
0.3802	2778
0.3251	2883
0.2717	2076
0.2349	963
0.1883	397
0.1364	32
0.0744	1
NaN	0



Fit: Manual

Top: Power Fit

Bottom: Power Fit

Exponent: 0.1667

Discharge Sensitivity

Top	Bottom	Exponent	% Difference
Power Fit	Power Fit	0.1667	0.00
Power Fit	Power Fit	0.0500	3.38
Constant	No Slip	0.1667	0.10
Constant	No Slip	0.1246	0.90
3-Point Fit	No Slip	0.1667	-0.30
3-Point Fit	No Slip	0.1246	0.70
Power Fit	Power Fit	0.1667	Reference

Depth Cell: Data Surface Cells

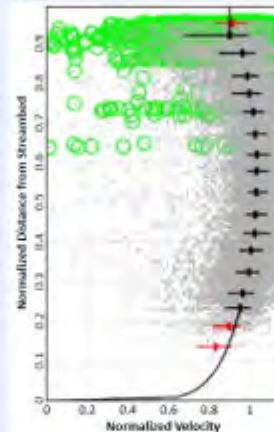
Measurement: Medians Fit

Apply to All Apply to Selected Close

Extrap Method

Extrap method fit type: Measurement

Z	Points
0.9532	207
0.9221	1079
0.8773	3133
0.8195	2971
0.7755	2015
0.7294	3127
0.6731	2972
0.6215	2623
0.5795	2502
0.5269	3109
0.4705	2959
0.4230	2206
0.3802	2778
0.3251	2883
0.2717	2076
0.2349	963
0.1883	397
0.1364	32
0.0744	1
NaN	0



Fit: Automatic

Top: Constant

Bottom: No Slip

Exponent: 0.1246

Discharge Sensitivity

Top	Bottom	Exponent	% Difference
Power Fit	Power Fit	0.1667	-0.89
Power Fit	Power Fit	0.0500	2.46
Constant	No Slip	0.1667	-0.79
Constant	No Slip	0.1246	Reference
3-Point Fit	No Slip	0.1667	-0.98
3-Point Fit	No Slip	0.1246	-0.20

Depth Cell: Data Surface Cells

Measurement: Medians Fit

Apply to All Apply to Selected Close

increased by 0.9%

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Environmental Solutions



Managing Drought in the Southwest USA

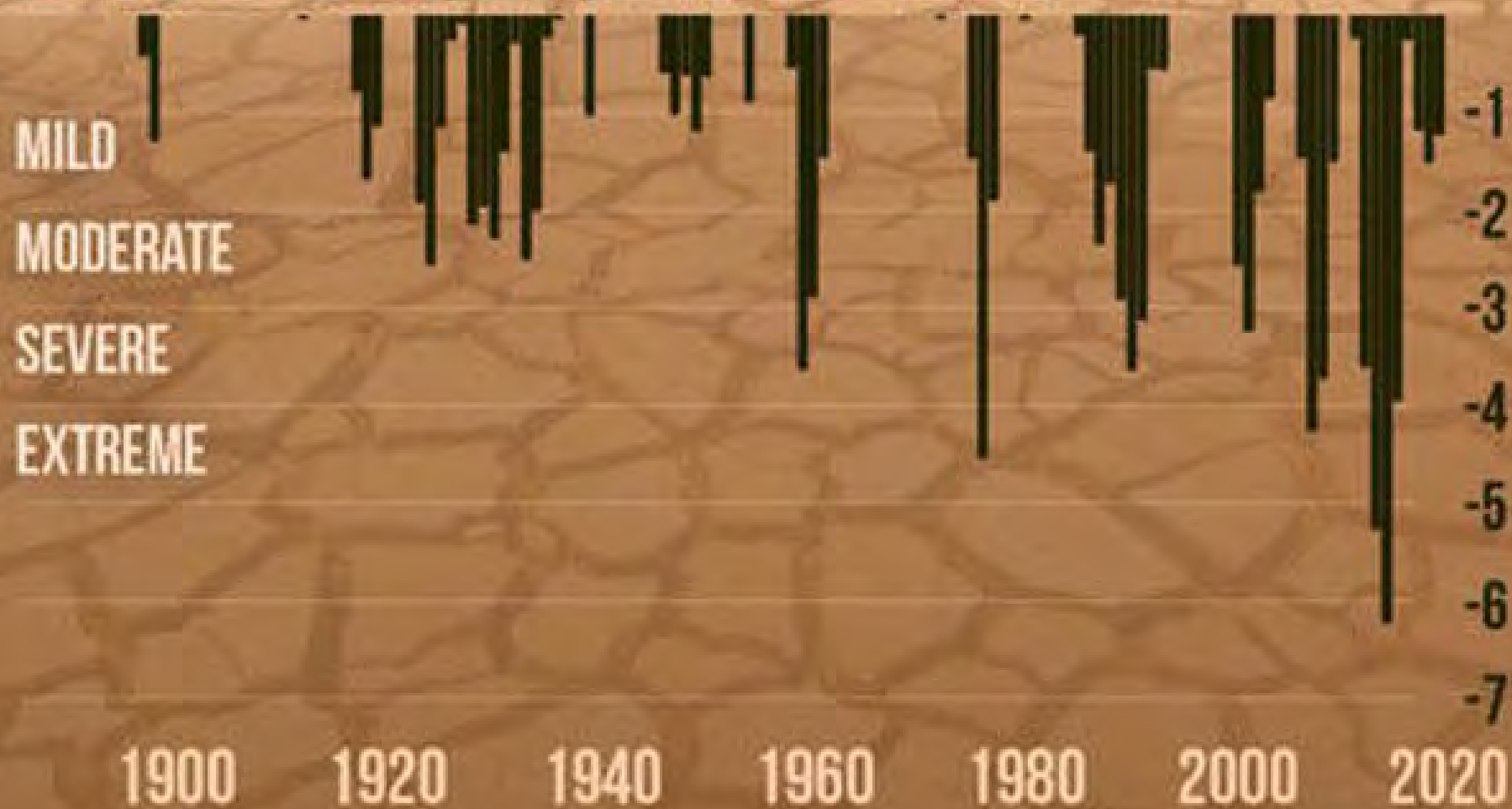


Colorado River Basin



- Colorado River supplies water to 7 western US states
- Colorado River compact divides up water rights
- Based on yearly average of 16.4M acre-ft (641cms) per year – actual 13.2 – 14.3 M acre-ft per year (516-559cms)

WESTERN U.S. DROUGHT INDEX



Lake Mead @ Hoover Dam



1983



2022

Lake Mead @ Hoover Dam



Before



2021

Lake Mead 2000-2021

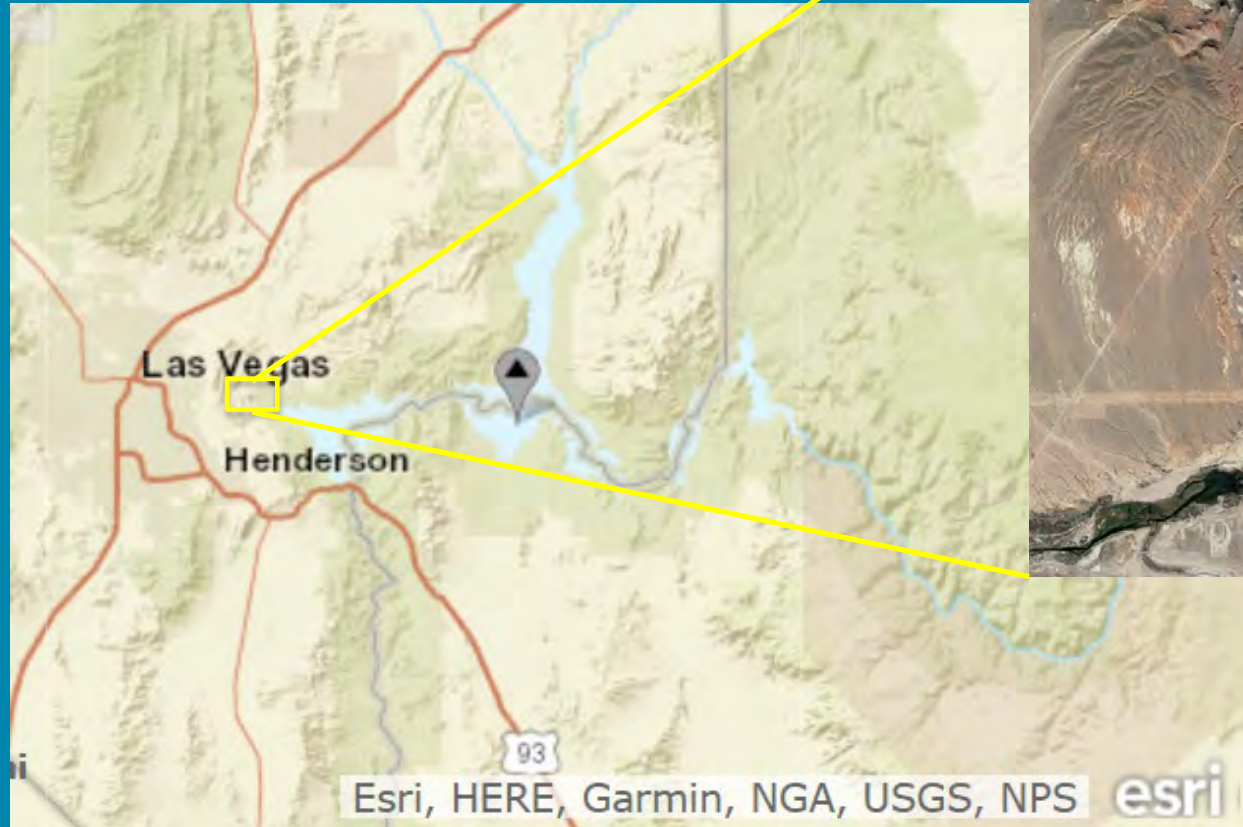


August 2000



August 2021

Las Vegas Wash

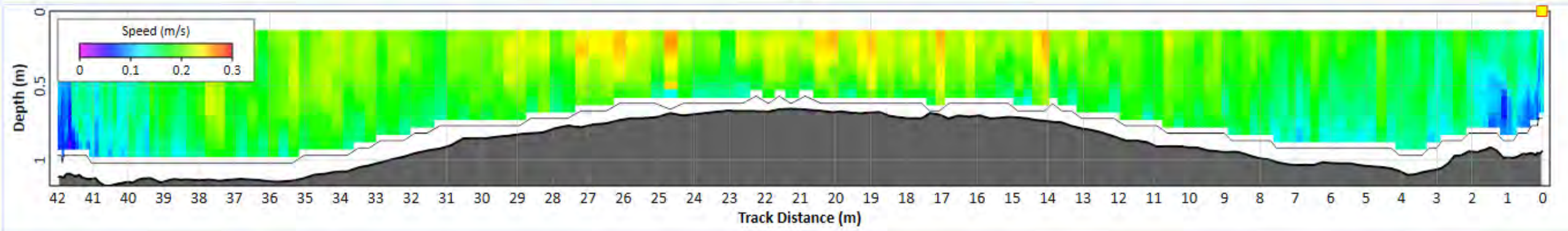
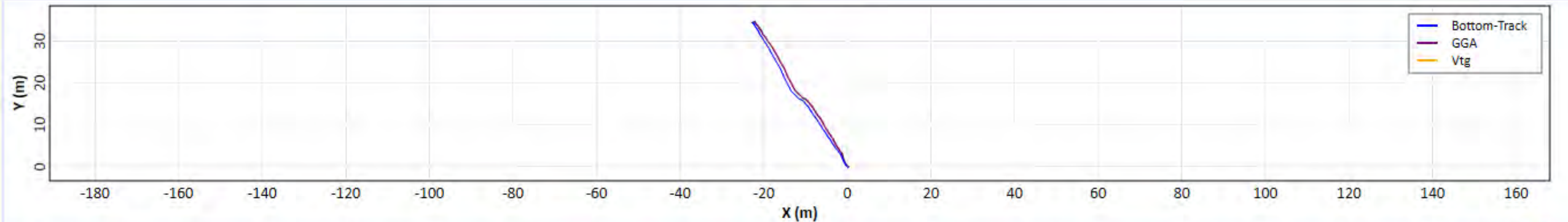
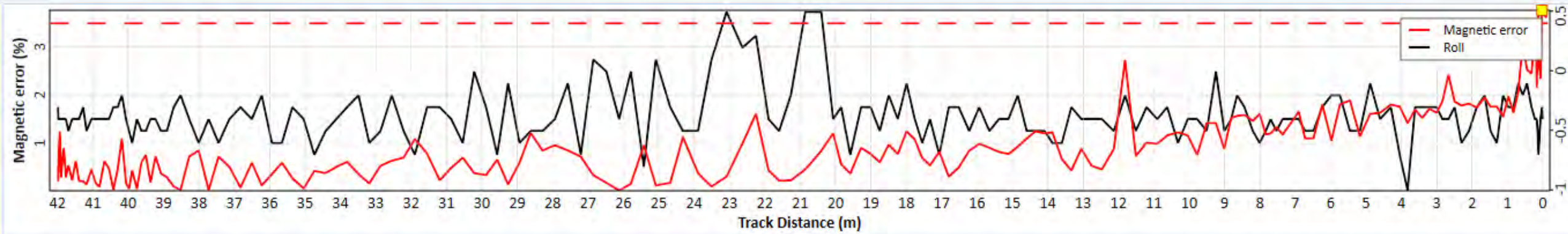


- Drains Las Vegas valley
- Tributary to the Colorado River

Las Vegas Wash

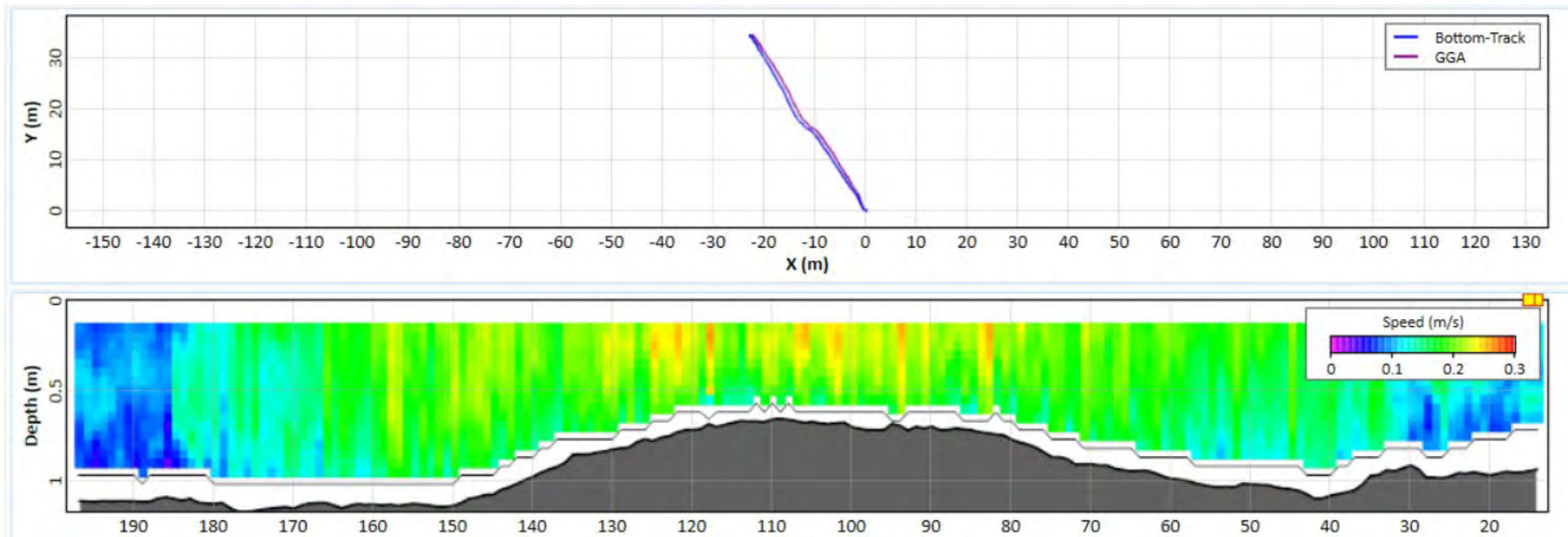


Las Vegas Wash – USGS Site: Three Kids



Field Tip: Don't forget to calibrate the compass

- You must have a valid compass calibration and magnetic declination when using GNSS!
- A compass calibration adjusts for any magnetic interference at the site and puts your track and velocity vectors in the right direction
- Seeing a slight offset between bottom track and GNSS ship track? Look at GC-BC. If value is SMALL, this is OK



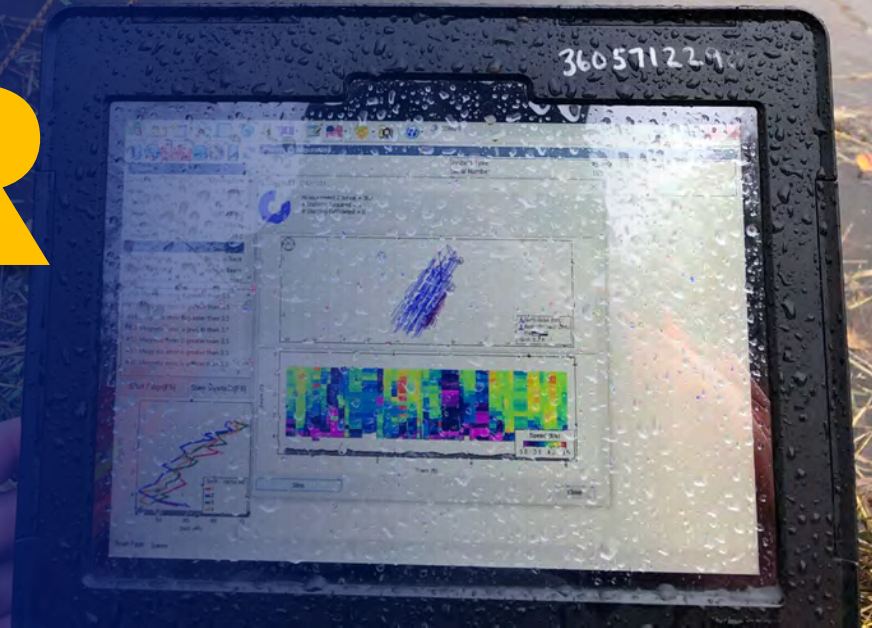
01-Transect_20220331092938 02-Transect_20220331095020	
DMG (m)	43.559
Total Q (m ³ /s)	6.4321
Track Distance (m)	45.204
Battery Voltage (V)	4.02
Temperature (°C)	21.53
Speed in Last Cell (m/s)	0.0614
Number of Satellites	29
D(BT)/D(GPS)	1.02619
Boat/Water Speed	0
Sample Time (DC Time)	09:58:37
GC-BC (deg)	1.55

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Environmental Solutions



Historic 2012 Floods in Salem, OR



Salem, OR

During the most recent event in January 2012, some areas of south Salem received over nine inches of rain within a five-day period. Heavy rainfall combined with melting snow caused substantial flooding in the Battle Creek, Mill Creek, Pringle Creek, and Croisan Creek basins. Approximately 300 people were evacuated from their homes, and 64 city streets were closed due to high water.

While the 1996 event was devastating to the entire region, the floods of 1861, 1890, and 1964 exceeded the 1996 events in terms of velocity and volume of water. These four major historical floods and the recent 2012 flood have been estimated to be nearly 100-year events, or base floods, and all within a time frame of about 150 years.



Salem, OR

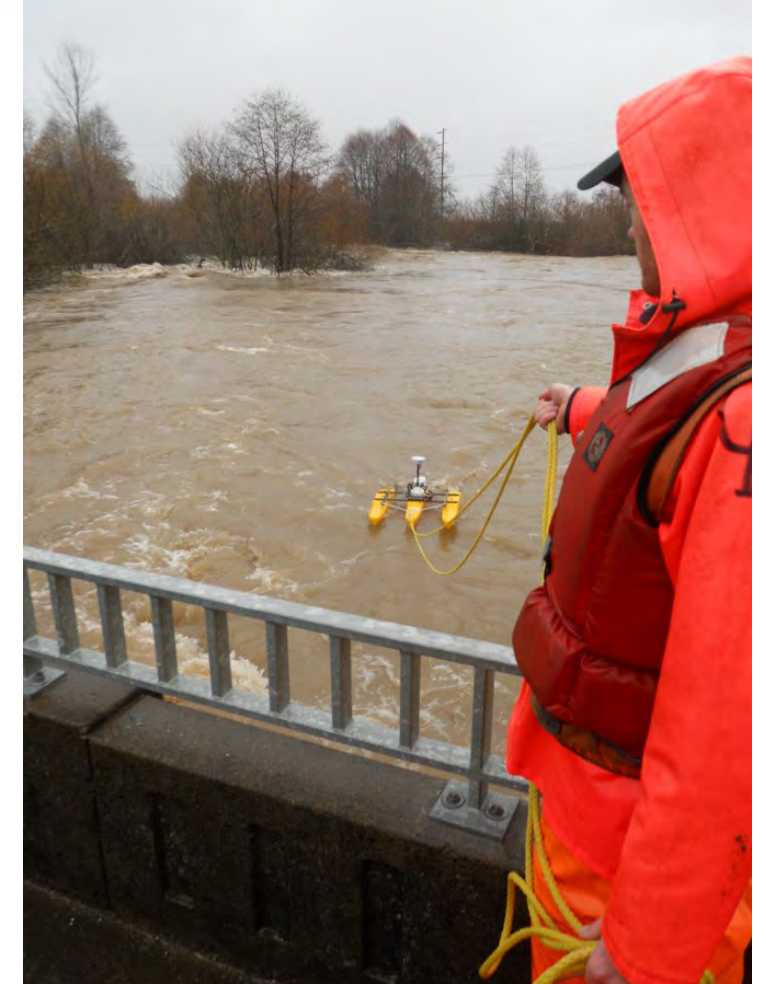


Water Environmental Sedimentation Technology

Data and images from Salem 2012 storm thanks to Jeff Budnick of West Consultants, Inc.

Measurements as part of contract with City of Salem – measurements develop and update rating curves. Curves are used to calculate flow in flood models developed by West for the city.

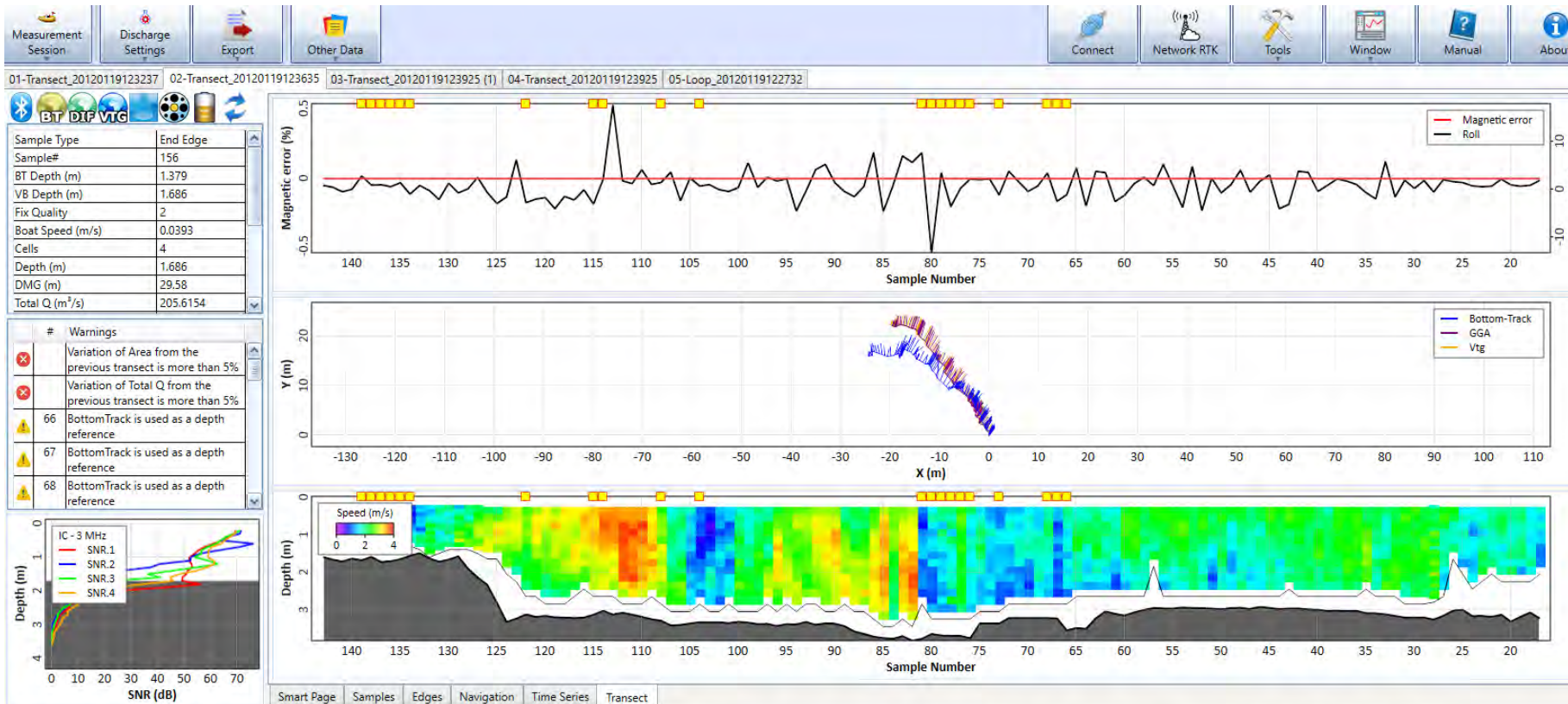
Many sites with high sediment load due to runoff during flood event – if moving boat not possible, try stationary. If not, find a new cross section or switch to AA meters.



Salem, OR



Water Environmental Sedimentation Technology



Loop Method

Loop Method Files: 05-Loop_20120119122732

Distance Made Good (m): 12.666

Loop Time (seconds): 215

Moving Bed Velocity (m/s): 0.0589

Flow Velocity (m/s): 2.3275

Moving Bed Direction (deg): 209.99

Flow Direction (deg): 29.58

Estimated Percent Correction (%): 2.53

Percent Bad Bottom Track (%): 28.84

Warning: Percentage of bad bottom track value exceeds 5. Loop may not be accurate. Please review your data.

Error: Due to the errors noted above this loop is not valid. Please consider the suggestions offered.

Close

Field Tip: Be prepared to measure the shallow banks

Although you might measure the main channel with a boat-mounted ADCP, make sure to take equipment to measure overflow. Significant overflow in the Salem 2012 event meant that overflow measurements had to be taken on the street using a FT2/other wading techniques!

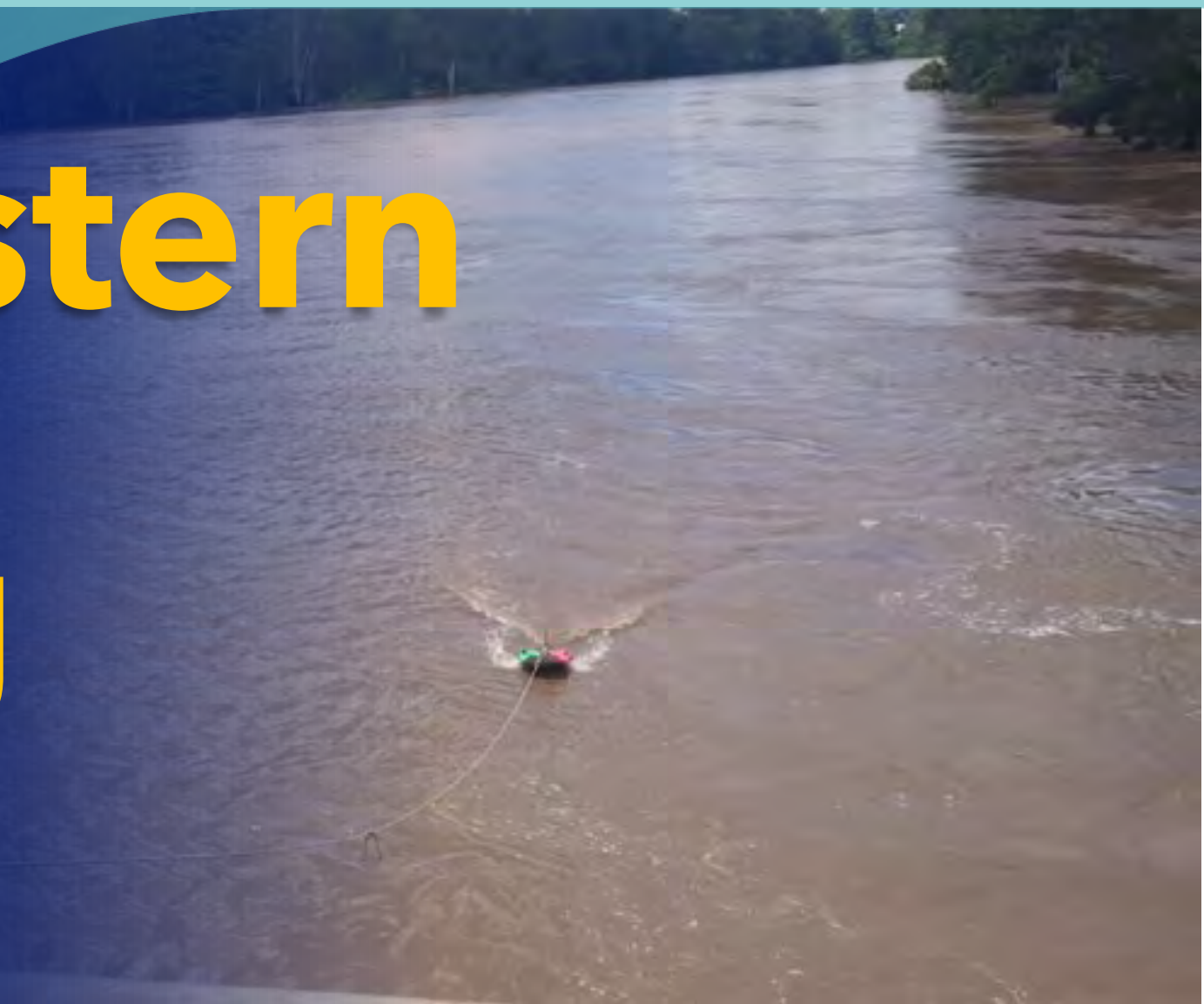


xylem

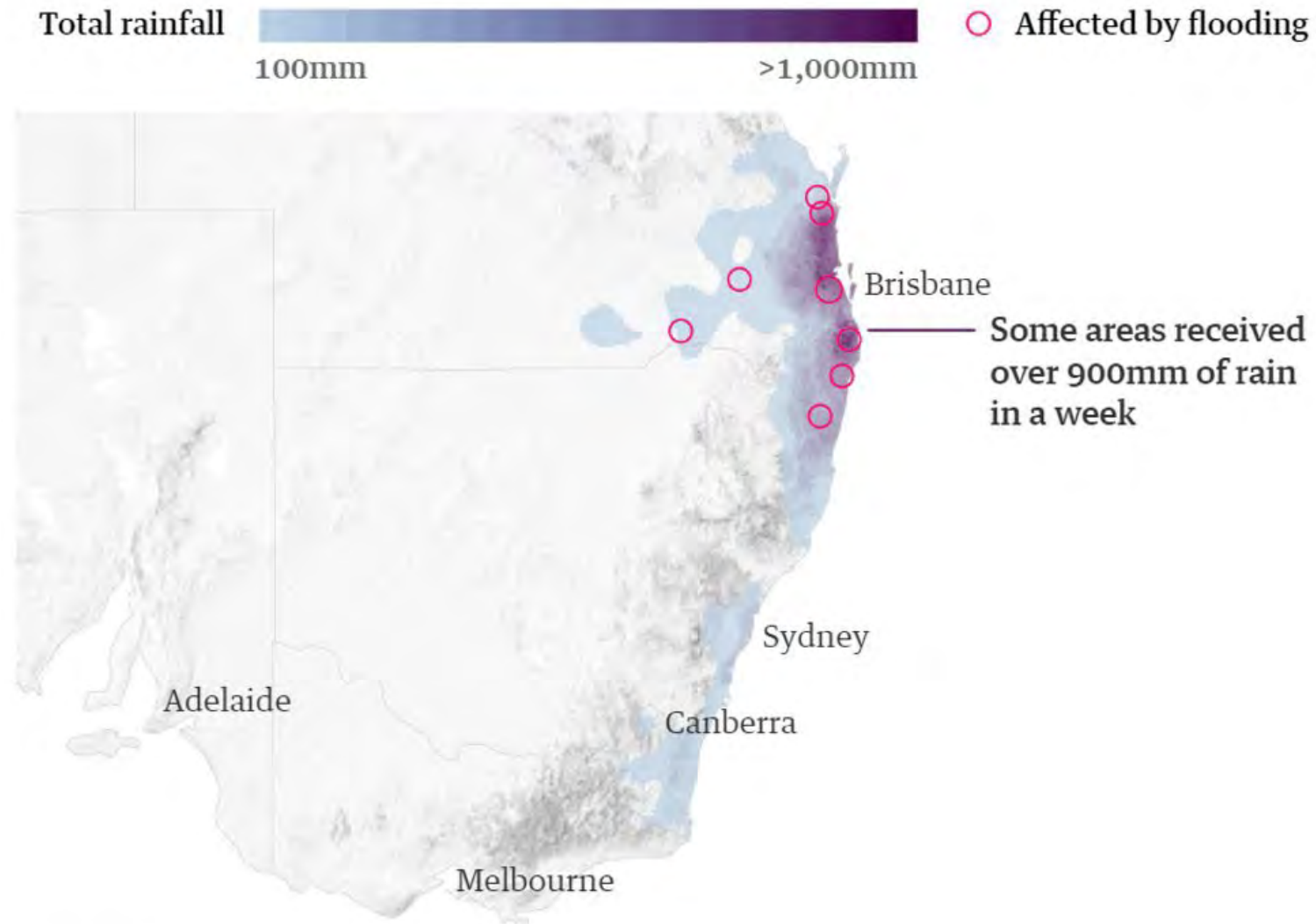
Environmental Solutions



2022 Eastern Australia Flooding



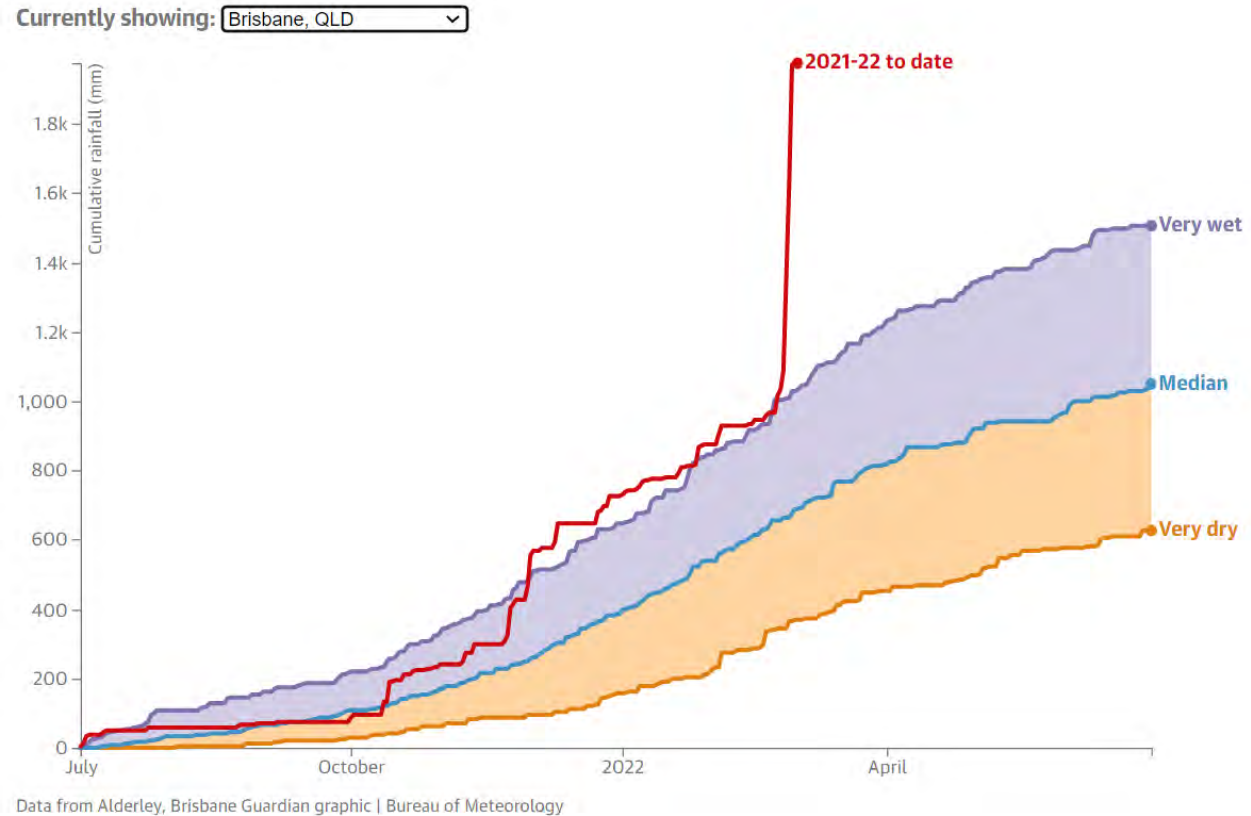
2022 Eastern Australia Flooding



Guardian graphic. Source: Bureau of Meteorology

2022 Eastern Australia Flooding

- 676.8 mm (26in) rain in 3 days in late February.
- Brisbane's wettest three days on record
- Largest 3 and 7 day total ever recorded in Brisbane topping 1974 records
- Damage from floods is expected to reach almost \$1.5 billion



Impact - Brisbane

- 20,000 homes inundated
- 51,000 without power
- Wivenhoe Dam peaked at 183.9%
 - Inflows of 2.2 million Megaliters
 - Released 150,000 Megaliters



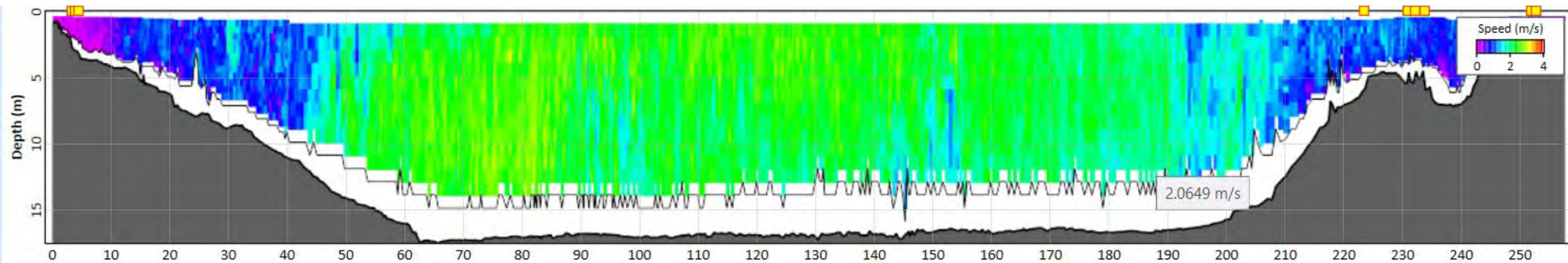
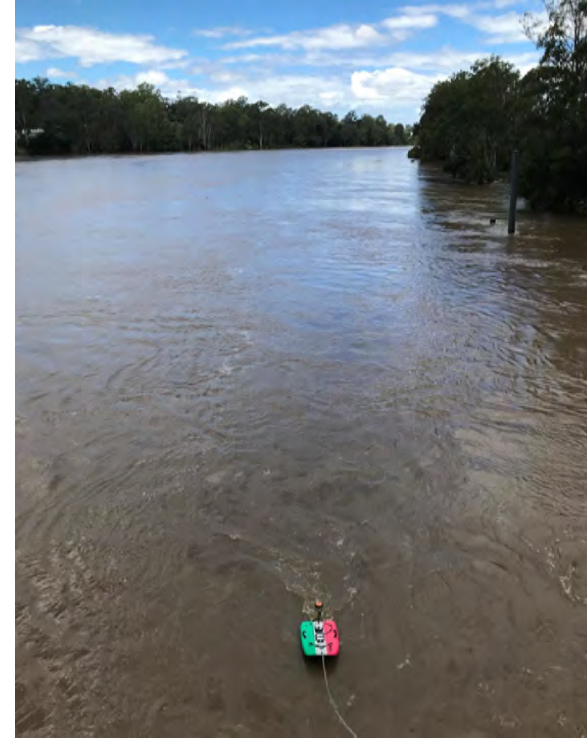
Prof Stuart Khan, an expert on water management at the University of New South Wales, says Wivenhoe gained about 1,450 billion litres of water, “which all came in under three days”. That is about three Sydney Harbours’ worth of water.

Brisbane flooding



ADCP – Brisbane River Gauging

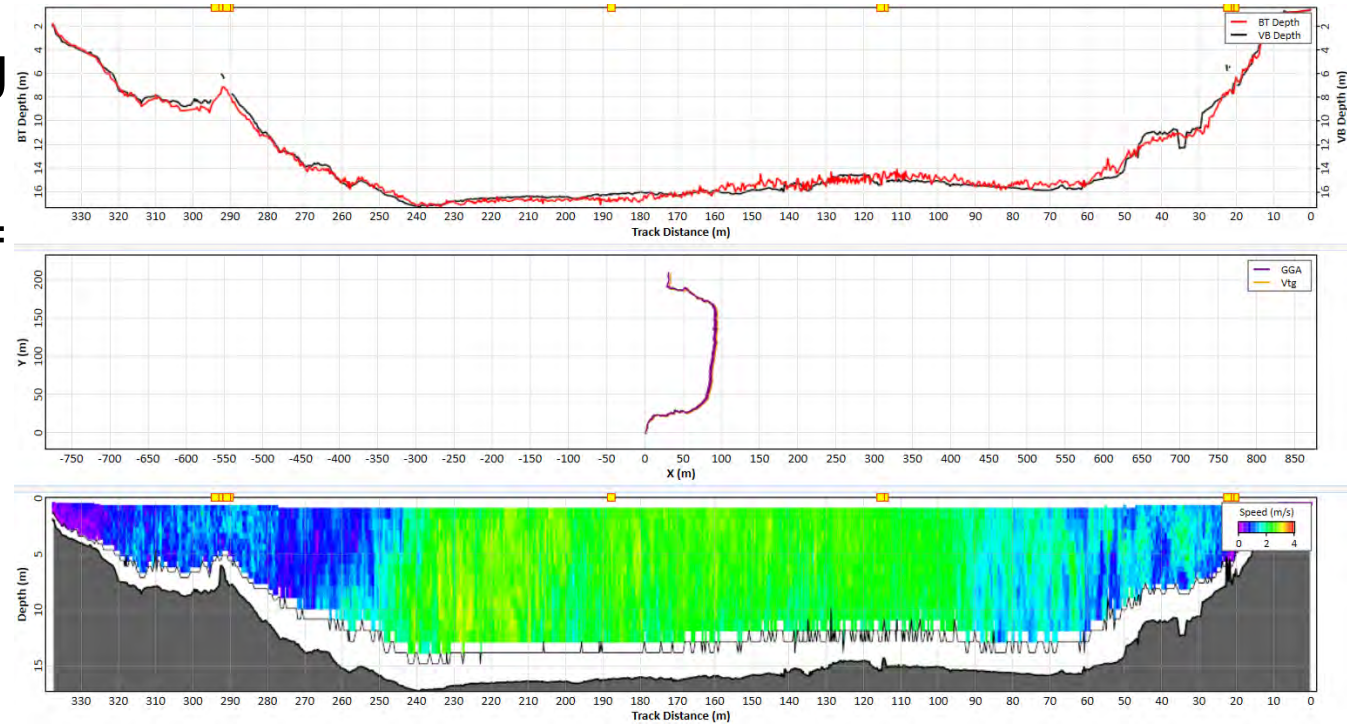
- Water level: 8.01 m
- Mean velocity: 2.01 m/s
- Max velocity: 3.34 m/s
- Discharge: 5,591 m³/s



Field Tip: Check for moving bed

Tools: Loop Method and Stationary Moving Bed Analysis (SMBA)

1. No moving bed and good bottom track = bottom-track track reference
2. Moving bed and good GNSS = GGA track reference
3. Moving bed and bad GNSS coverage = Stationary method.



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Environmental Solutions



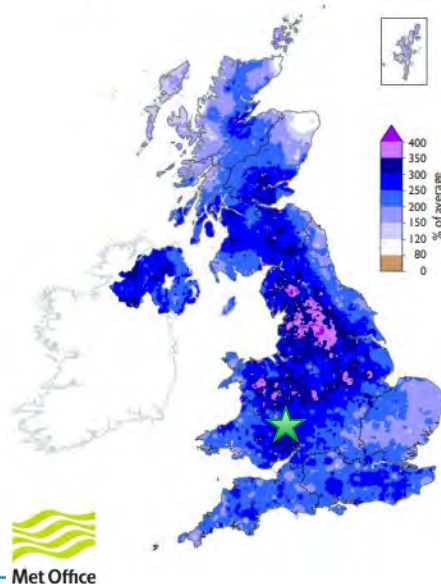
Widespread UK Flooding 2020



February 2020 – a “remarkable” month (in hydrological terms)

- 4th wettest month on record (since 1910)
- 3 different storms (‘Ciara’, ‘Dennis’, and ‘George’)
- Greatest rainfall anomalies (350% over average) in northern/central England

February 2020 rainfall
as % of 1981-2010 average



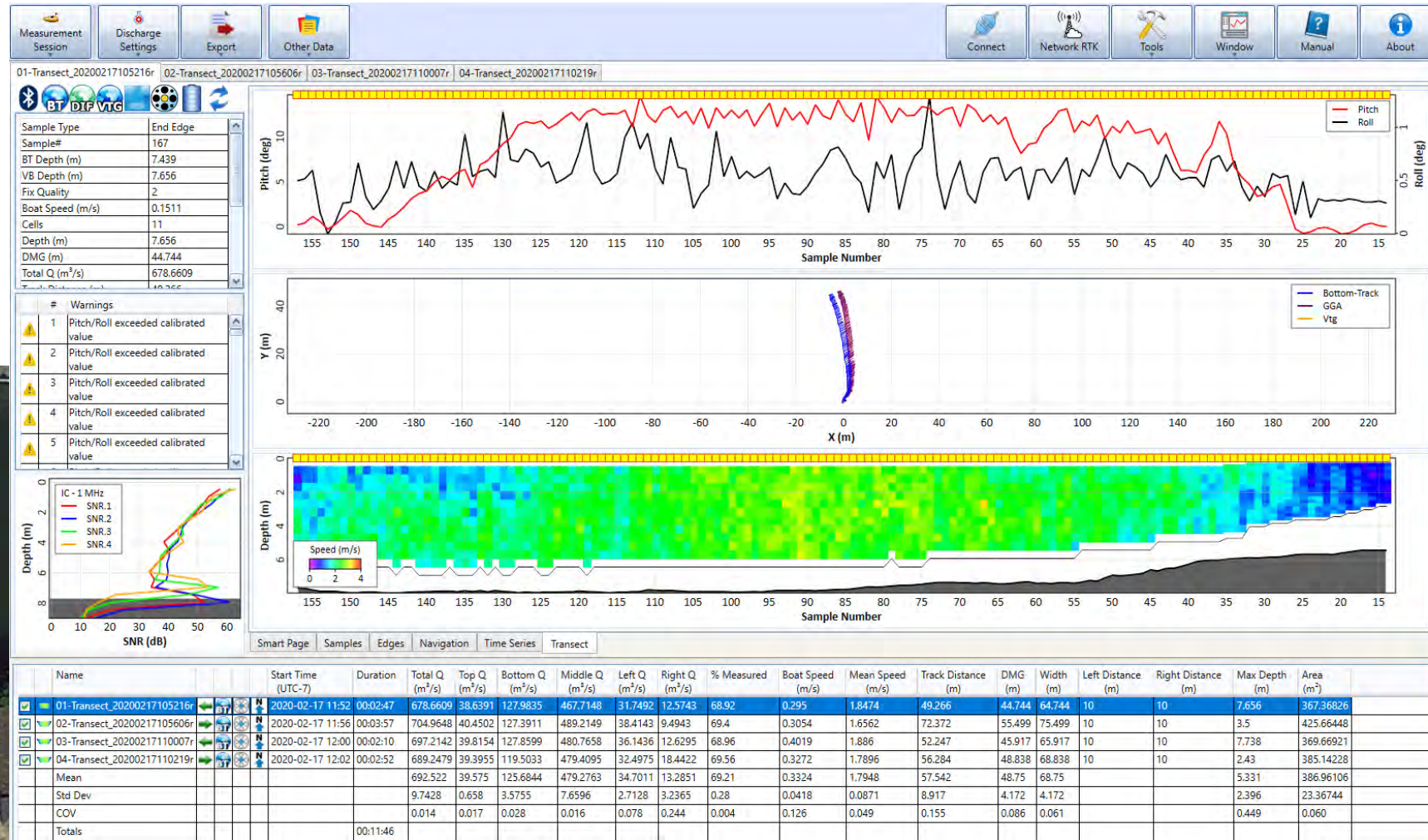
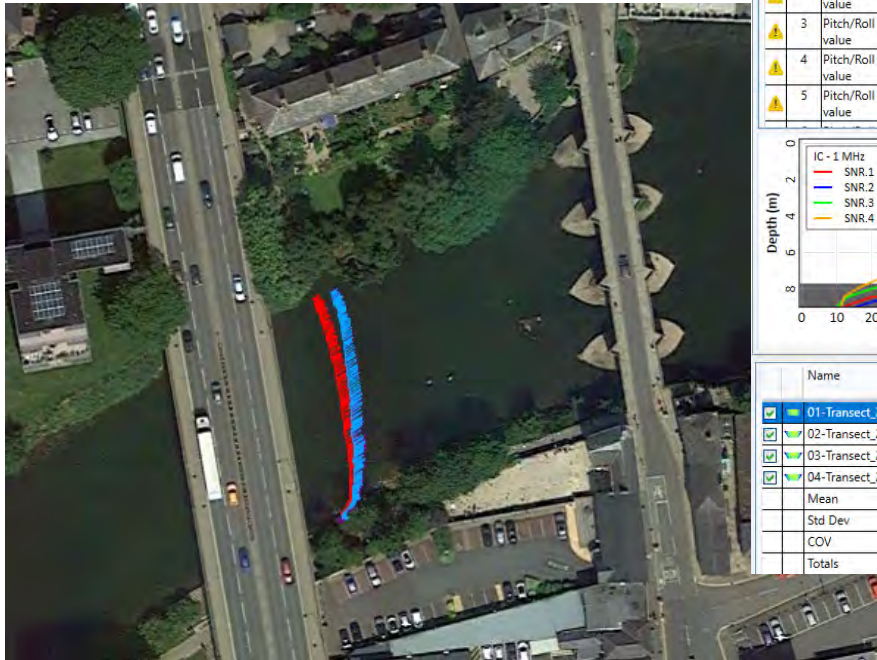
Measuring in Flood Conditions: River Severn: Belmont

(Data courtesy of Rob Davies)



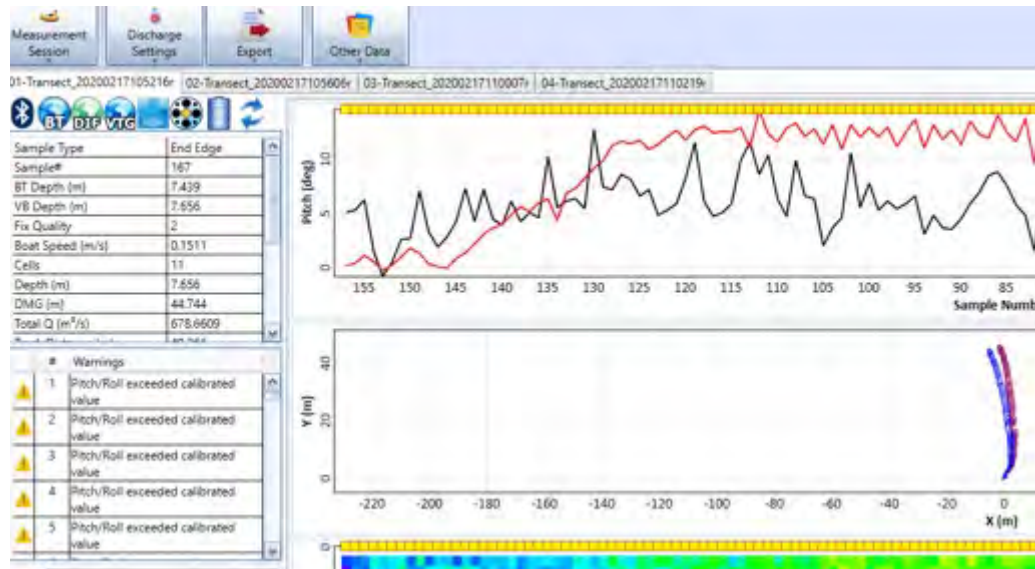
Measuring in Flood Conditions: River Severn

Measured Q = 692.5 cms
Max speeds ~ 3.5 m/s



Field Tip: combatting excessive pitch and roll

- Try to calibrate the compass to match the pitch/roll expected in the field (we correct velocities for pitch/roll!)
- Various techniques with weights to bring down the tip of the float



Featured instruments



RiverSurveyor RS5

It is the smallest and lightest complete ADCP solution for moving boat discharge measurement available.



SonTek RTK **New!**

Fully integrated one-piece receiver/antennas/batteries for use with the RS5 for centimeter accuracy. Includes network RTK integration.



RiverSurveyor M9

Multi-frequency ADCP that measures from shallow to deep. Automatically adjusts the frequency and pulse type using SmartPulseHD®.



FlowTracker2

The SonTek FlowTracker 2 (FT2) handheld Acoustic Doppler Velocimeter (ADV®) is a wading discharge measurement instrument that is handheld, portable and precise.

Acknowledgements

Jeff Budnick – West Consultants

Rob Davies – UK

Pete Wigzell - Monitoring & Control Laboratories Pty Ltd

South Africa Department of Water Affairs

Lee Pimble – Xylem

Daniel Wagenaar - Xylem

Josh Soutar - Xylem

Field tip – Best flood gauging safety advice!

“If you feel the bridge start to move, drop the ADCP rope and run.”

Steve Gustafson
WEST Consultants
(former USGS)



Questions?

