Some methodological issues in the reconstruction of flood histories from sedimentary records

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CHRONOLOGY OF FLOOD DEPOSITS

Accurate and precise chronologies of flood deposits are needed to:

- Determine the frequency of floods of different magnitudes.
- Identify deviations from stationarity of flood series.
- Identify trends, clusters and/or gaps in flood series.
- Relate variations in flood frequency and magnitude to changes in average climate and climate forcings.
- Determine if flooding is increasing as a result of anthropogenic climate change.

TECHNIQUES

RADIOCARBON

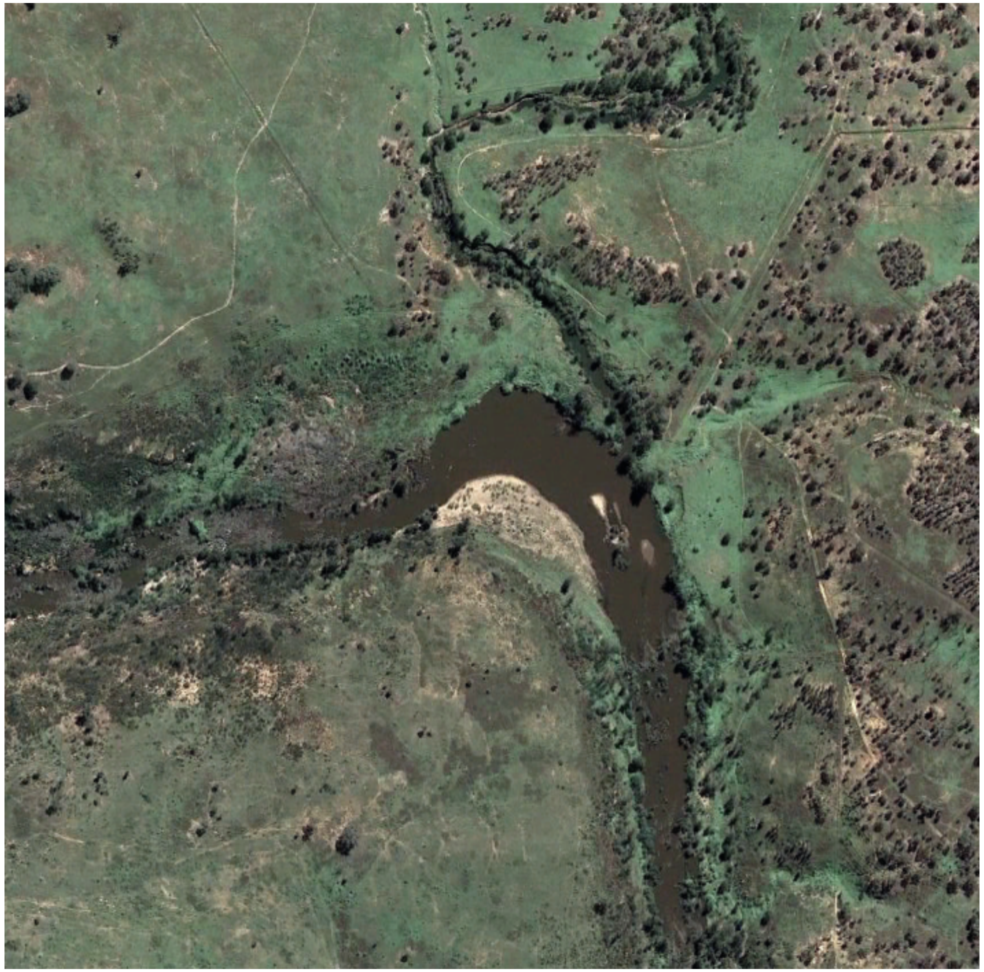
- The most commonly used technique.
- Ideally applied to leafs and twigs to reduce the difference between the time of deposition of the organic fragments and mineral sediment.
- The residence time of charcoal in a catchment can be centuries. This is a serious problem.

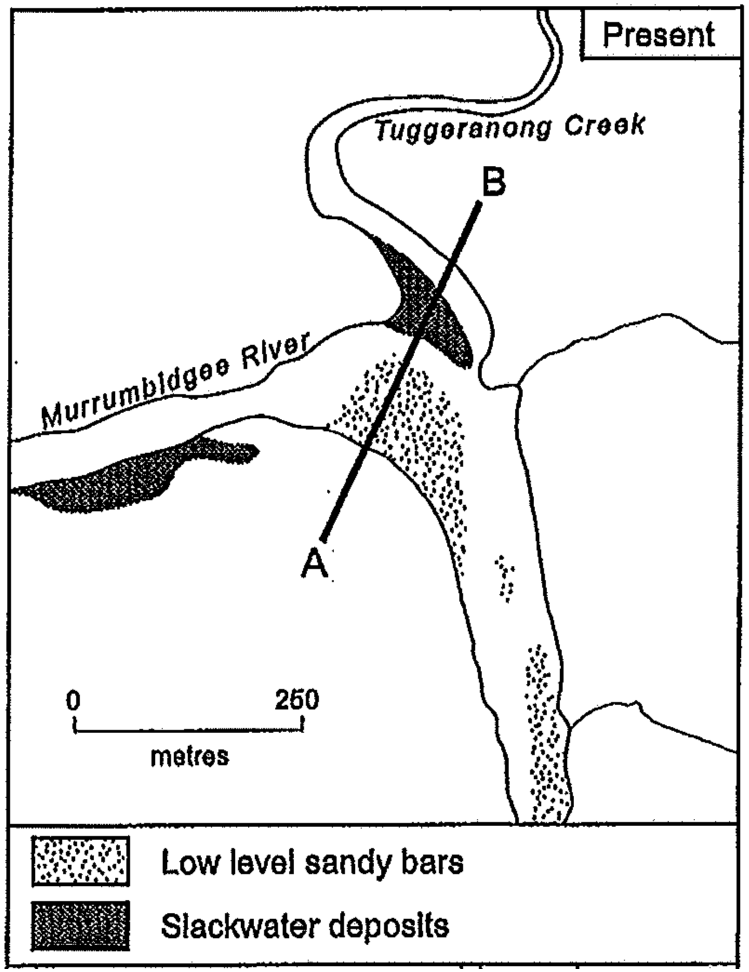
TECHNIQUES (Continued)

LUMINESCENCE

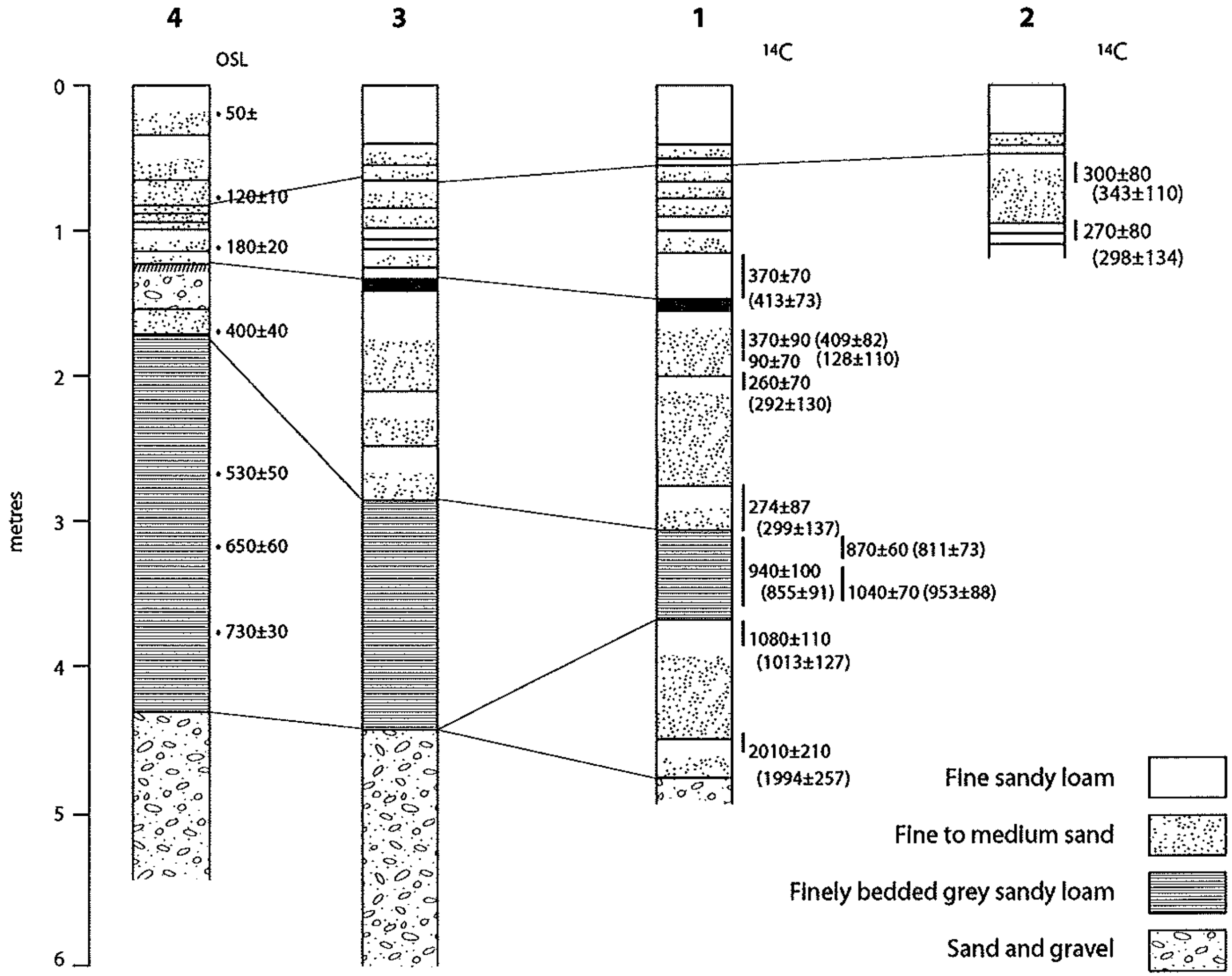
- In principle, optically stimulated luminescence (OSL) dates the time of burial of mineral sediment.
- If sampling is appropriate, OSL dates the time of deposition of a flood layer
- However, incomplete bleaching of mineral grains (usually quartz) will provide an OSL age that is too old.
- Single-grain analyses are preferred, and the use of the lowest 10% ($\pm 1\sigma$) of the equivalent dose is suggested rather than any other protocol.

TUGGERANONG CREEK- MURRUMBIDGEE RIVER JUNCTION, SE AUSTRALIA





Stratigraphic Columns showing ^{14}C and OSL dates.



TUGGERANONG CREEK-MURRUMBIDGEE RIVER (Continued)

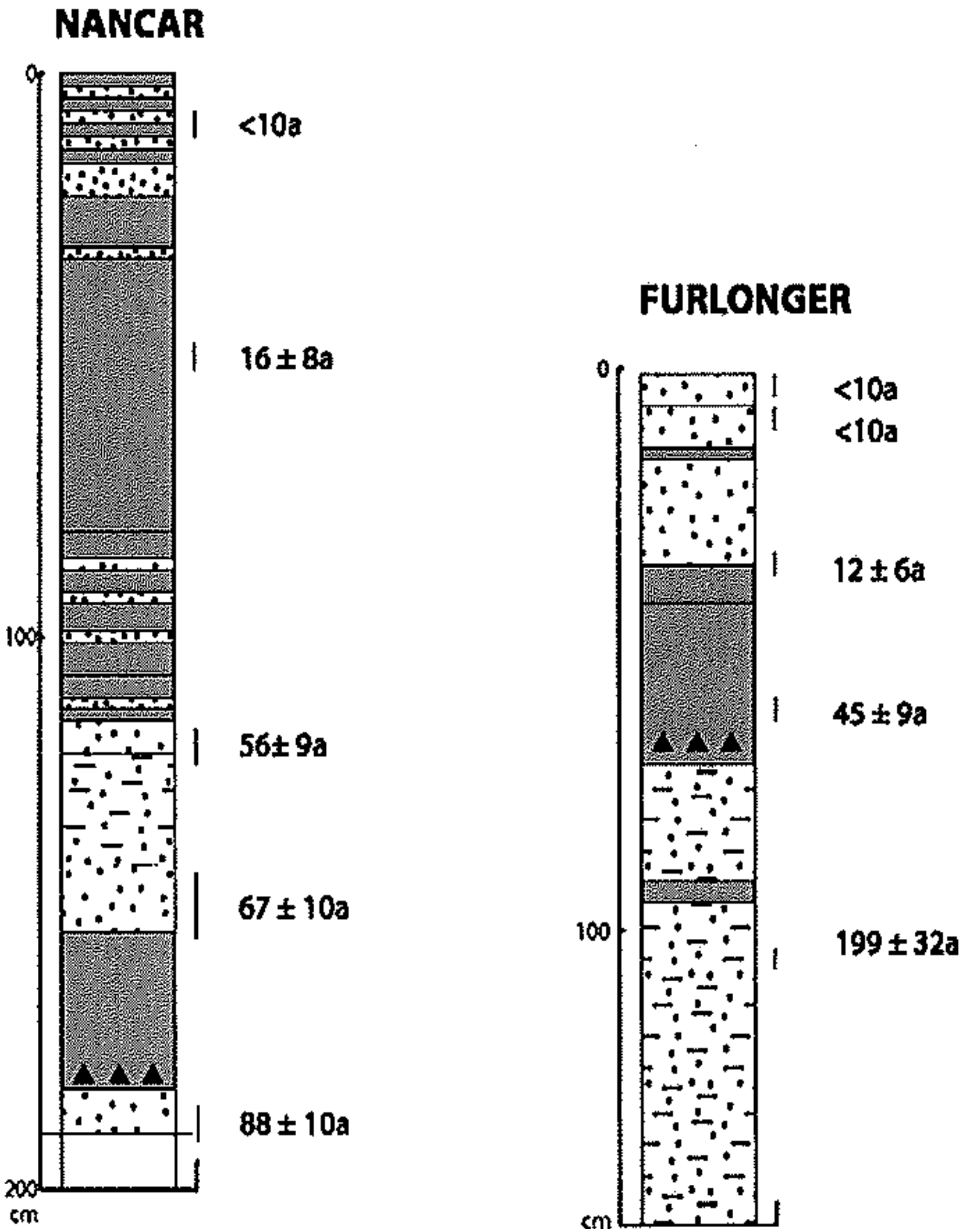
- Above the finely bedded grey sandy loam (a low velocity deposit), the ^{14}C ages show no stratigraphic order.
- They appear to represent a population of charcoal of about the same age; 383±41 cal BP (1567±41 AD).
- This charcoal was probably released gradually from burned areas and deposited in 9 different flood layers.
- Comparison of ^{14}C and OSL ages suggests a maximum of 260 years and a minimum of 160 years; with the weight of evidence favouring 200 years.
- This assumes the OSL ages are accurate!

TESTING OSL RESULTS

DALY RIVER, NORTHERN TERRITORY

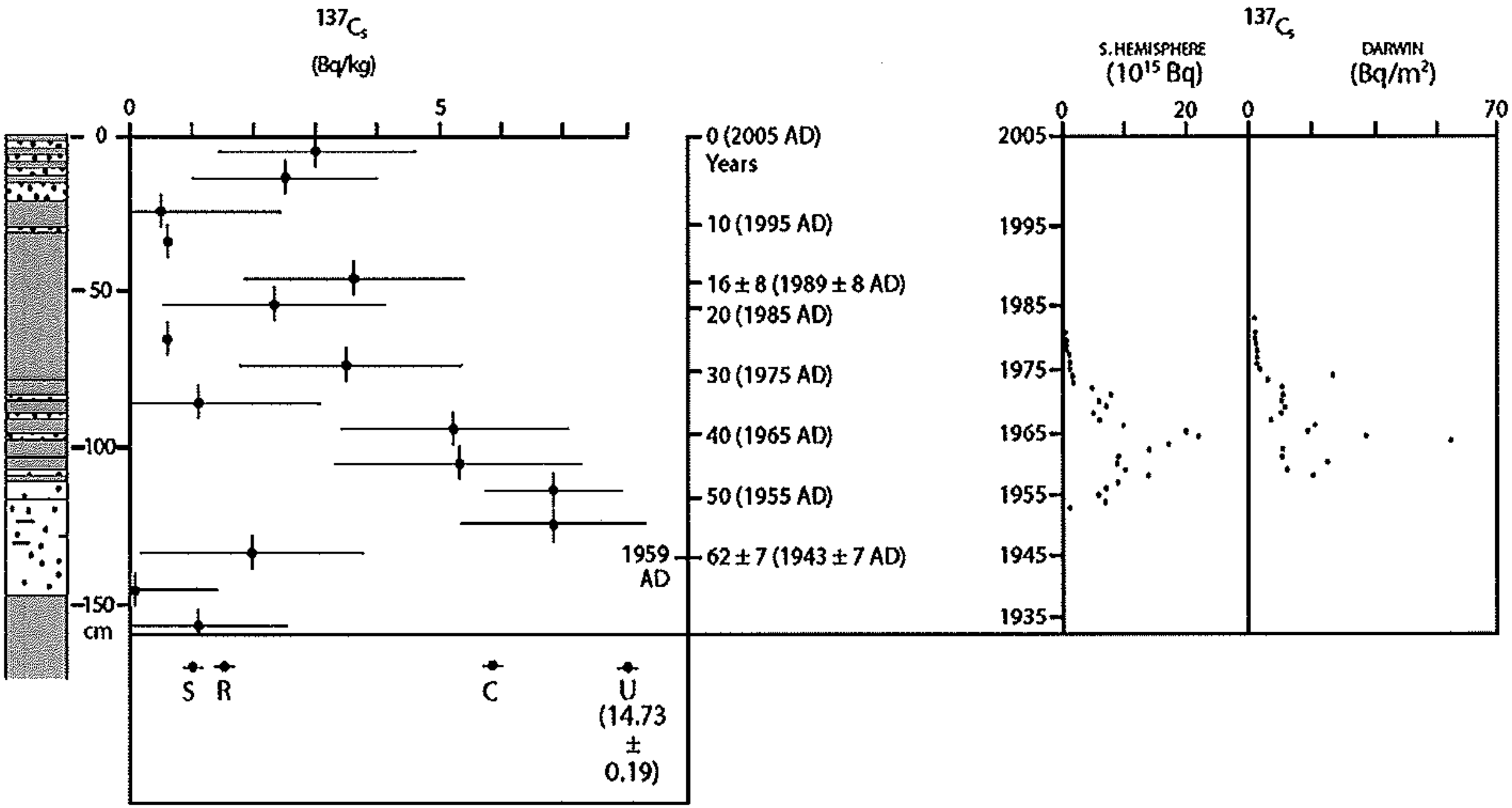
- Floodplain benches are set below high level floodplains.
- The benches are built from laminated flood couplets of sand topped by mud.
- Sand deposits have been dated by OSL.


Min grain size = 0.075mm
Max grain size = 2.36mm
Specific gravity of sediment = 2.6
Grain diameter d_{35}=0.6mm, d_{50}=0.75mm, d_{90}=1.15mm
Sediment deposition



Stratigraphic diagram of the bench sediments at the Nancar and Furlonger sites, with OSL dates.
Dots — fine to medium sands. Dots and dashes — muddy sand. Grey — mud. Triangles — charcoal.

OSL ages were tested against ^{137}Cs measurements in the same bench.



RESULTS OF THE COMPARISON AT NANCAR

- Highest values of ^{137}CS centred on 1949 AD (based on OSL), 16years before peak fallout.
- That the peak of ^{137}Cs is the result of direct fallout, and not the result of input of topsoil (which has high concentrations of both ^{137}Cs and $^{210}Pb(ex)$), was tested by measuring $^{210}Pb(ex)$ which has no fallout peak. The ^{137}Cs peak is the result of fallout.
- The different chronologies are therefore the result of episodic deposition.
- A sedimentation rate of 2.8±0.3cm/yr since the first detectable ^{137}Cs in the bench (1959±3 AD) compared with 3.0±1.5cm/yr based on OSL.

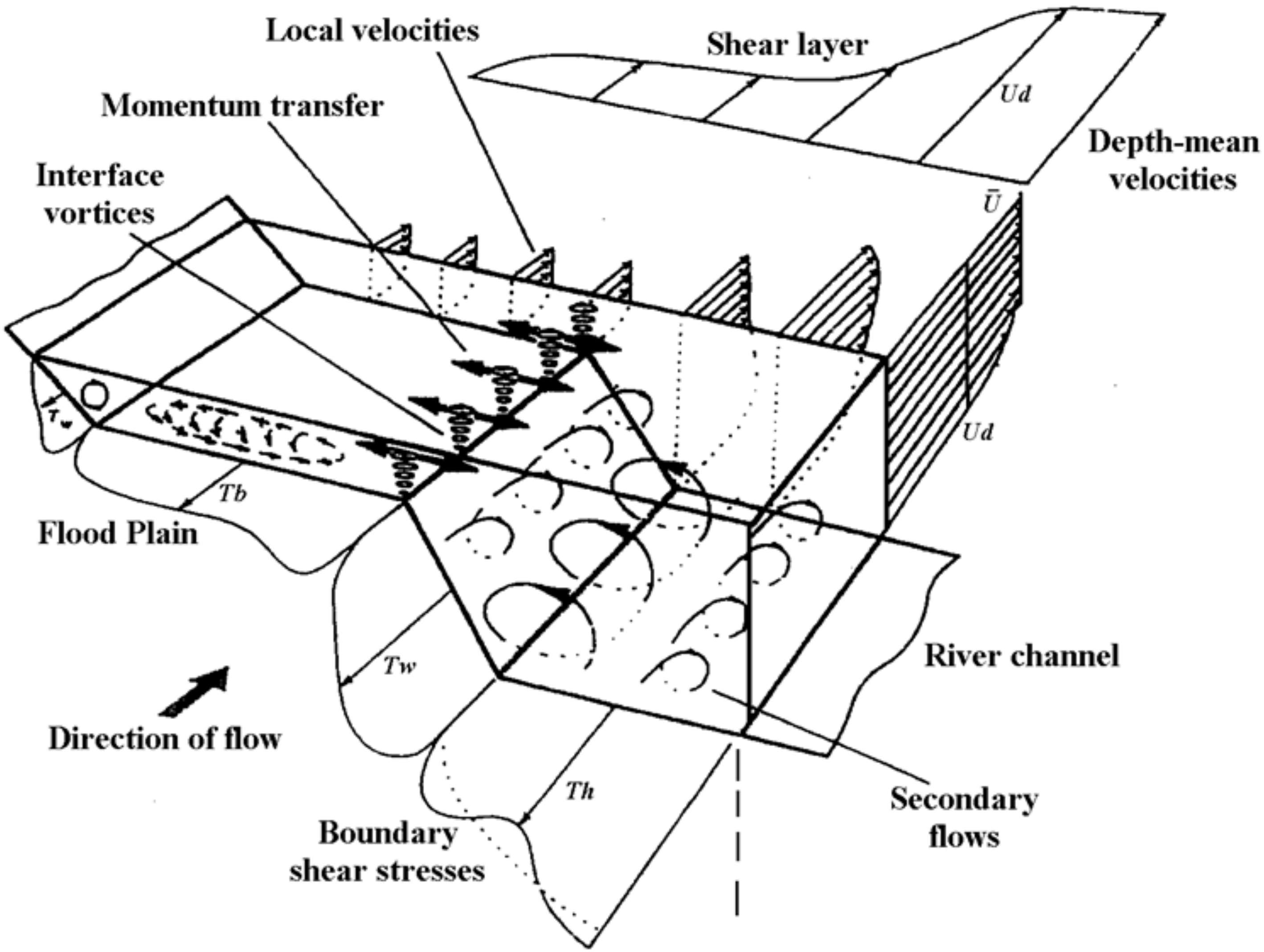
DATING CONCLUSIONS

1. Radiocarbon ages of charcoal can overestimate the age of flood deposits by centuries.
2. OSL ages are in principle more accurate, but incomplete bleaching can produce ages that are too old.
3. The best approach is to use multiple dating techniques. OSL can be checked by ^{137}Cs and $^{210}Pb(ex)$, and Pu isotopes, for very young deposits.
4. In rare circumstances $^{226}Ra(ex)$ and ^{32}Si can be used to test OSL.
5. Also, deposits of known age (from observations by local people) can be dated to test different methods.

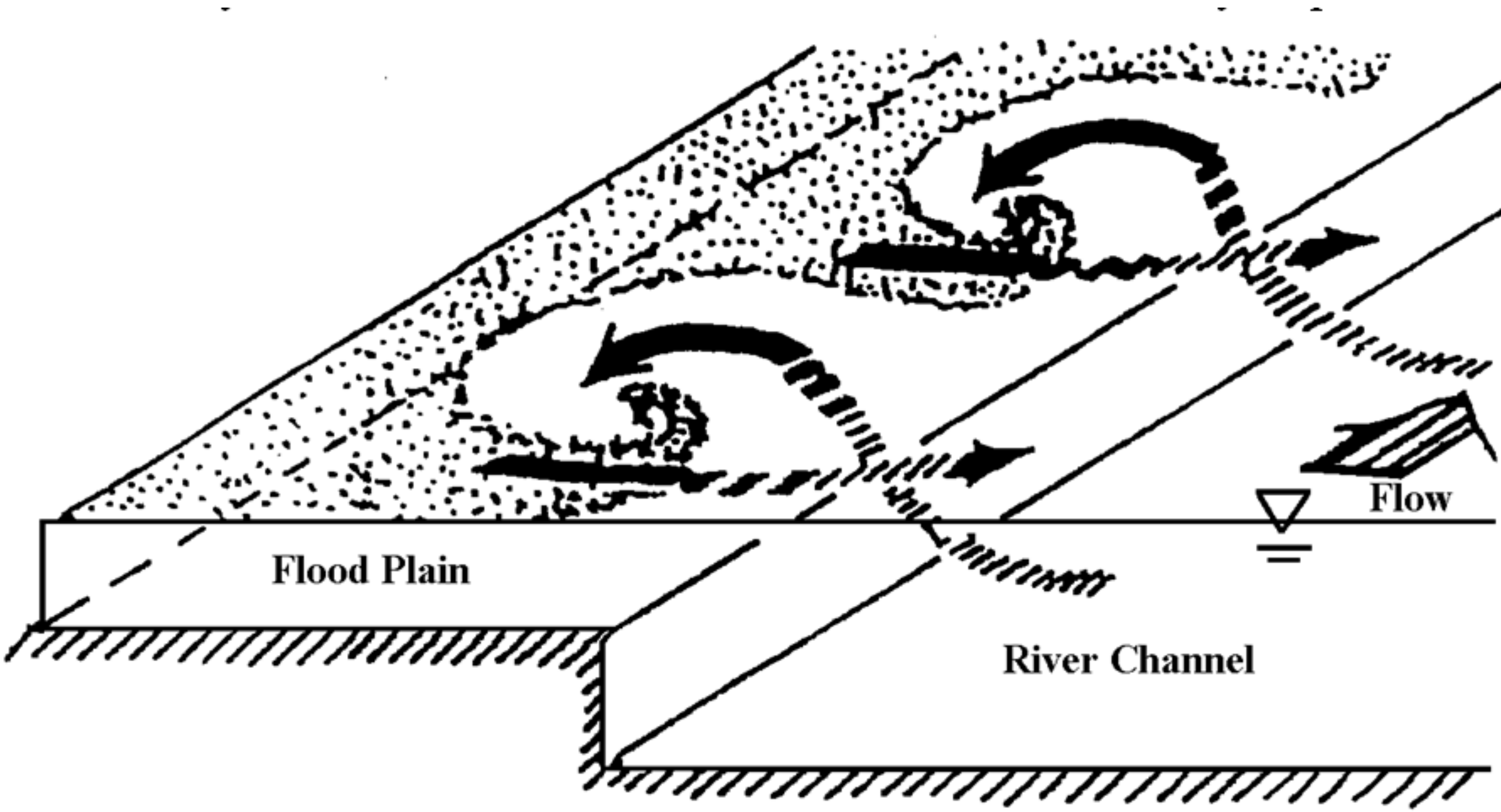
HYDRODYNAMIC AND MORPHOLOGICAL MODELS

- Resource Management Associates Suite RMA10 and 10S
- 2 and 3-D finite element
- Solves the Reynolds Stress form of Navier Stokes
- Applies sediment transport and morphological models

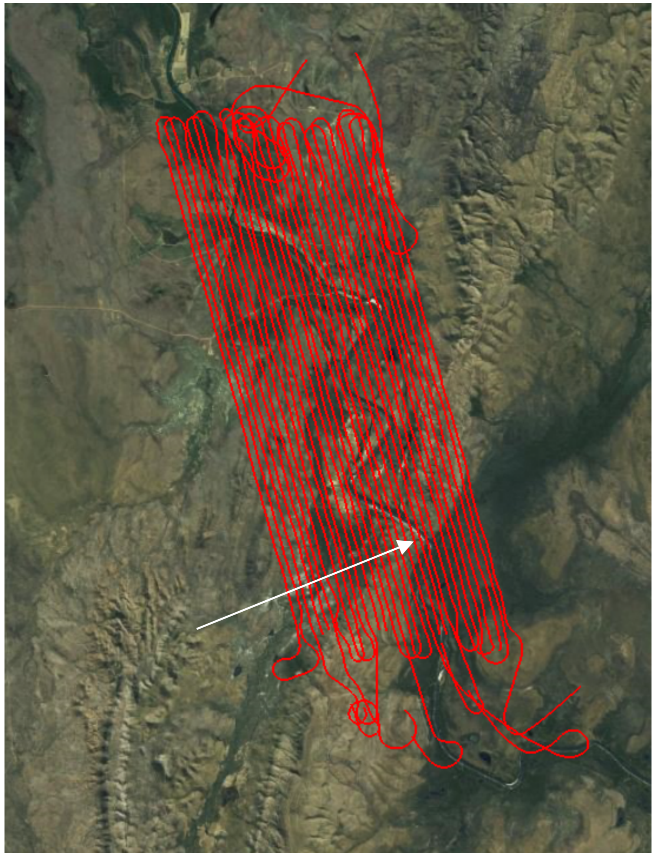
Hydraulic parameters associated with overbank flow (after Knight & Shiono, 1996)

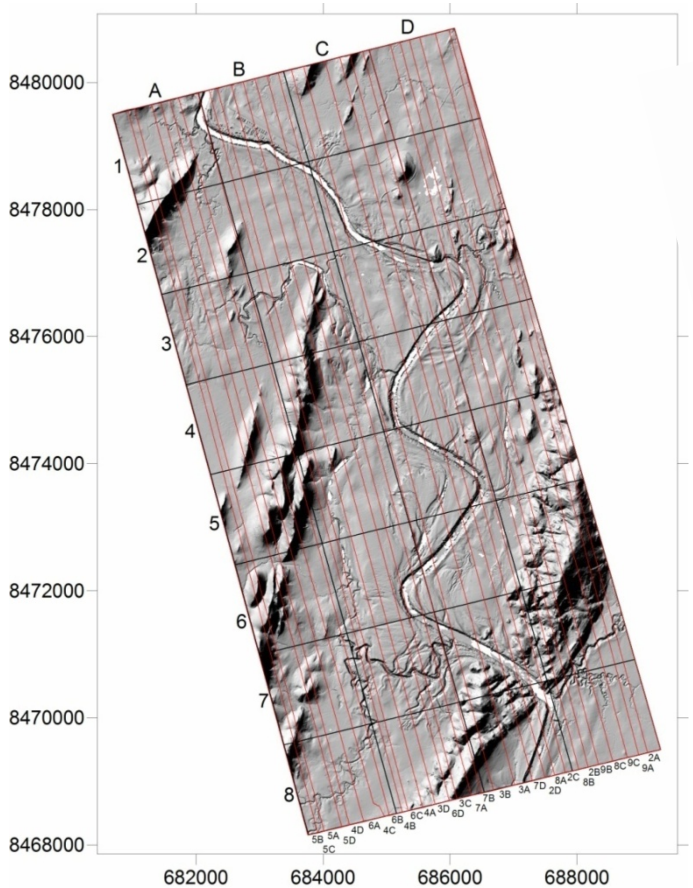


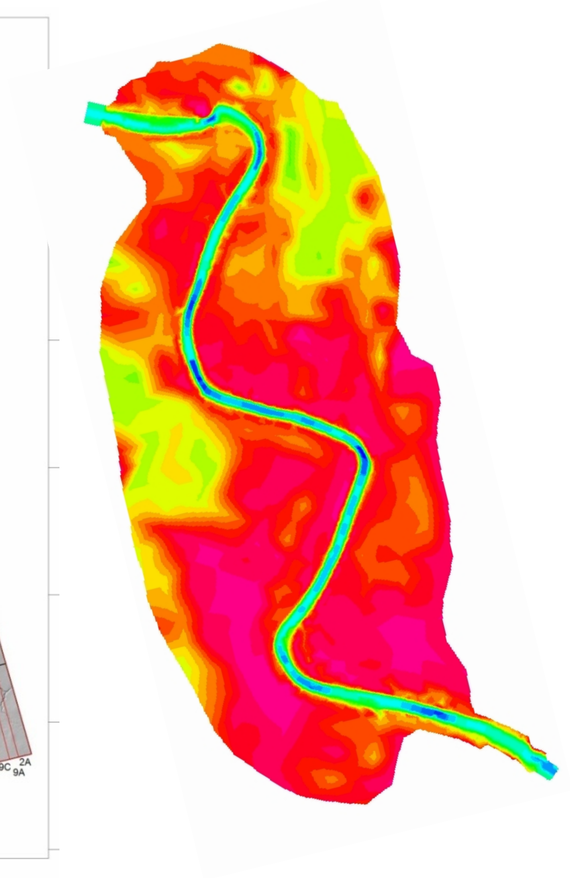
Large-scale vortex structures associated with overbank flow



DALY RIVER, NORTHERN TERRITORY

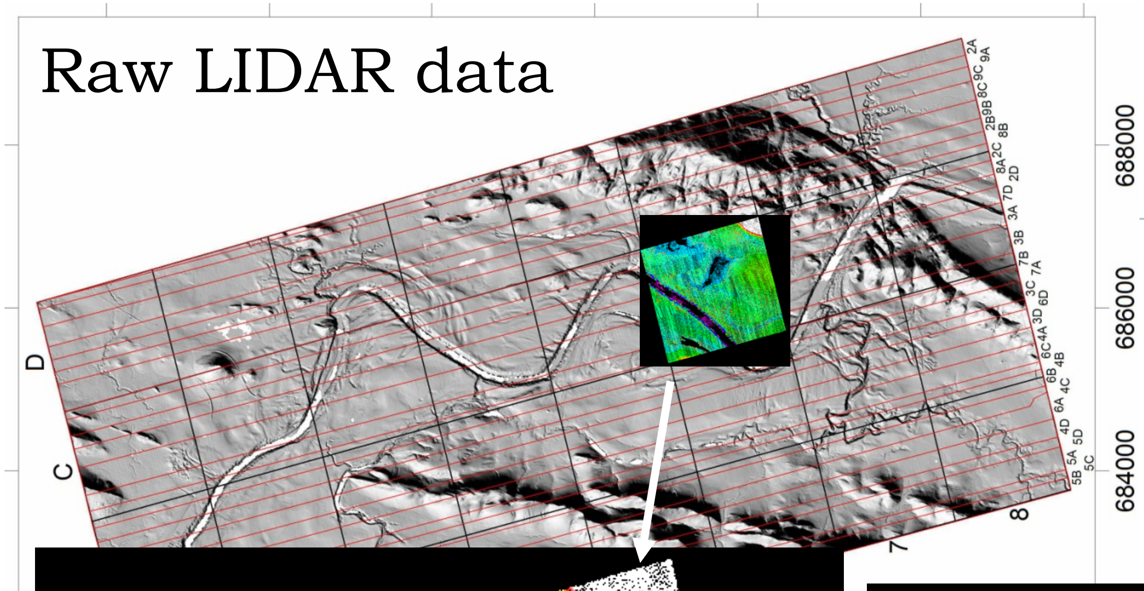


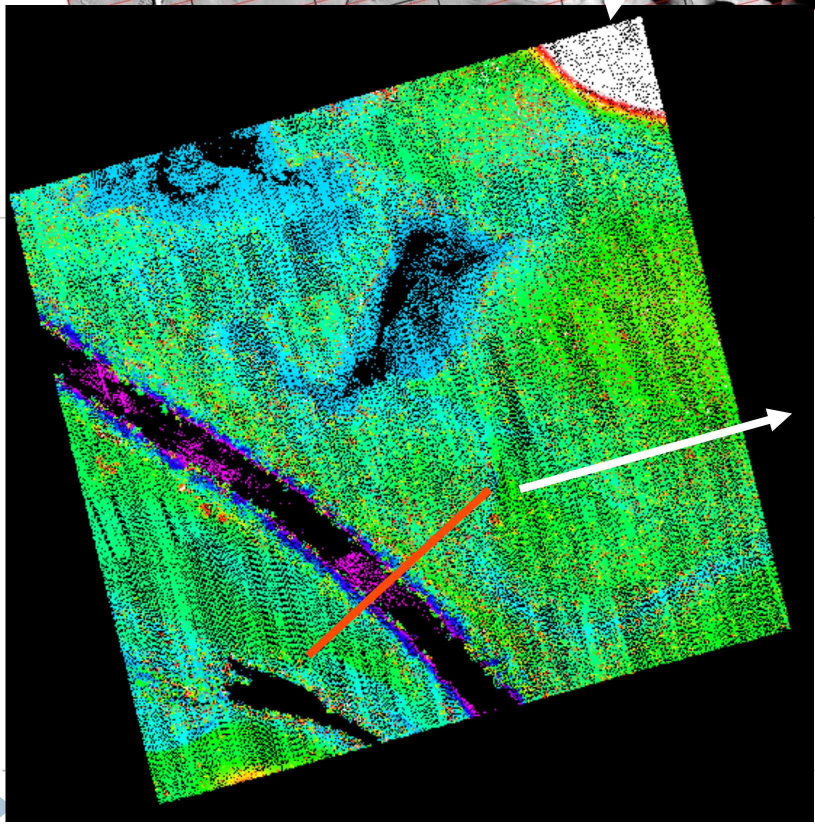


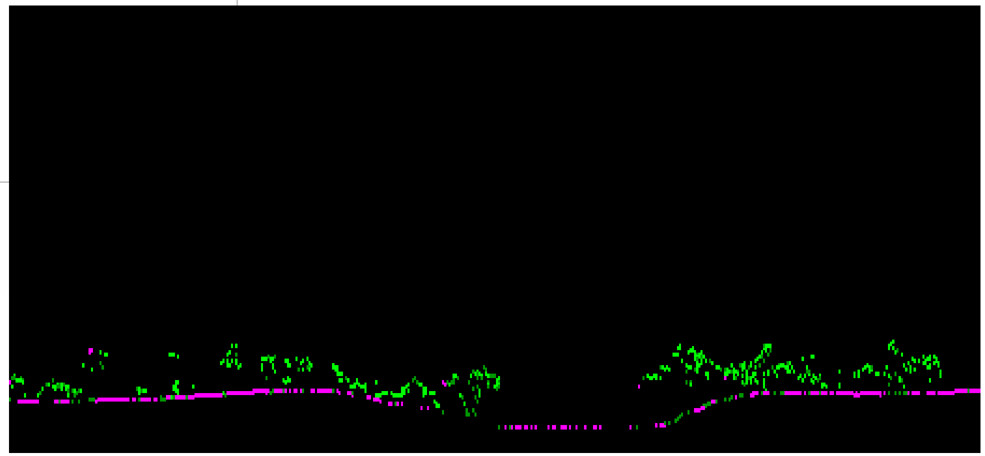


Flight Path for LIDAR
(Light Detection And Ranging)

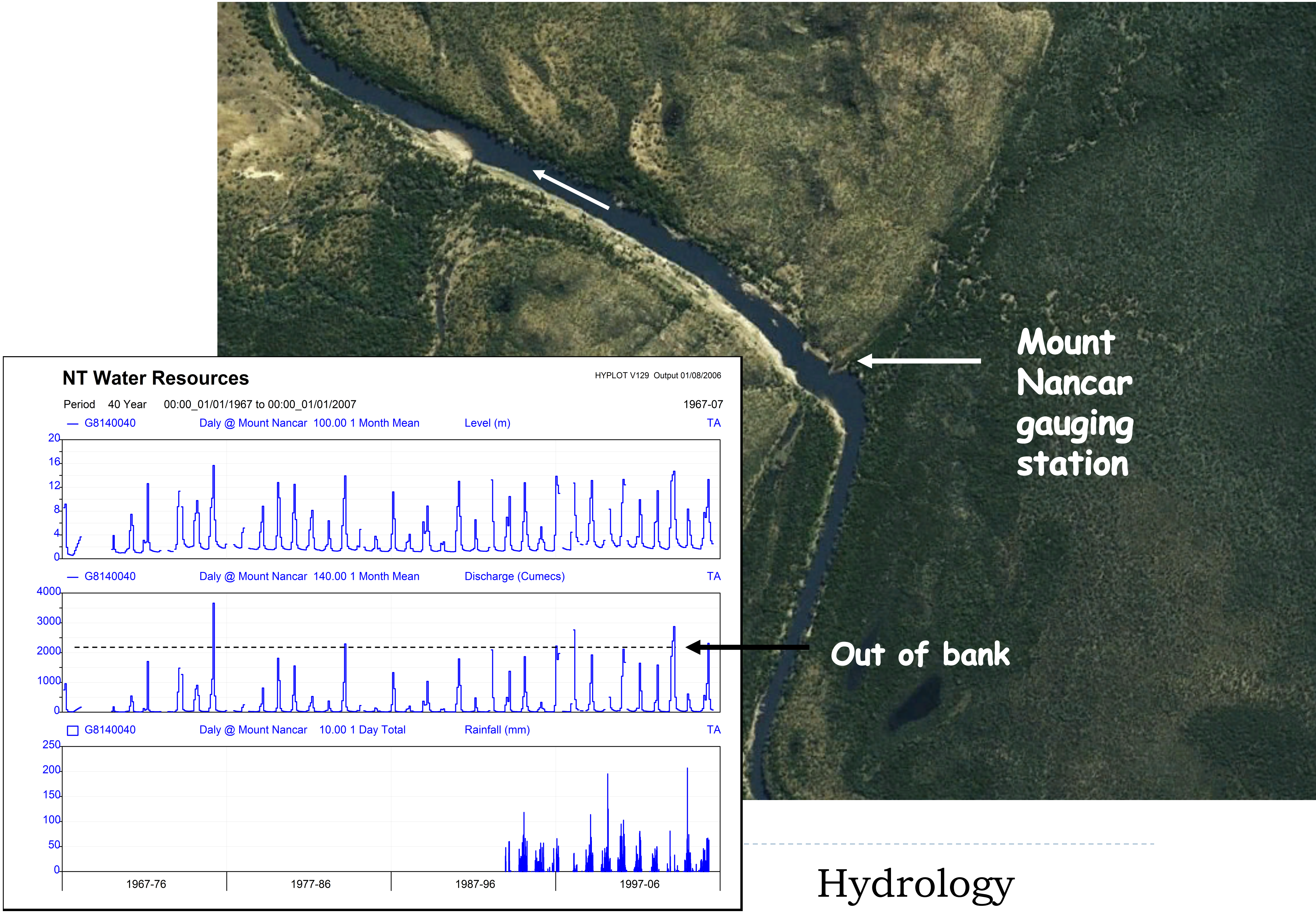
Digital Elevation Model





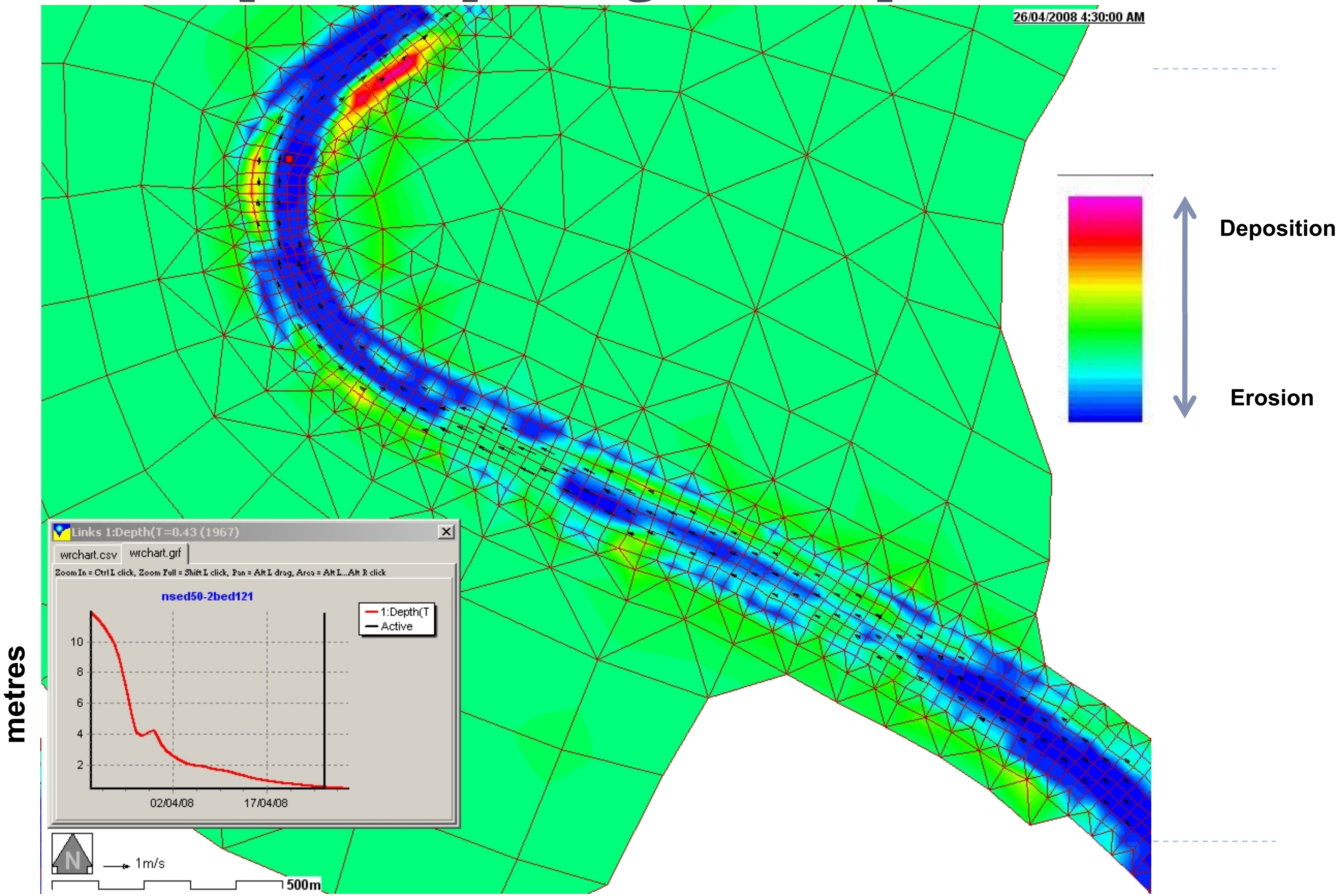


Typical Cross-section to characterise roughness


Mount Nancar gauging station
Out of bank
NT Water Resources
HYPLOT V129 Output 01/08/2006
Period 40 Year 00:00_01/01/1967 to 00:00_01/01/2007
1967-07
G8140040 Daly @ Mount Nancar 100.00 1 Month Mean Level (m) TA
20
16
12
8
4
0
G8140040 Daly @ Mount Nancar 140.00 1 Month Mean Discharge (Cumecs) TA
4000
3000
2000
1000
0
G8140040 Daly @ Mount Nancar 10.00 1 Day Total Rainfall (mm) TA
250
200
150
100
50
0
1967-76
1977-86
1987-96
1997-06

Hydrology

Example morphological output



MODELLING CONCLUSIONS

1. Using 2-D and 3-D techniques shows promise
2. Requires calibration based on channel roughness, sediment sizes and sediment supply
3. Remains difficult to verify
4. Short term (decadal) verification may be achieved by model comparison with remote sensing
5. Requires a better understanding of river channel stability and regime criteria
6. The combination of improved dating techniques and more detailed hydrodynamic models is the way forward