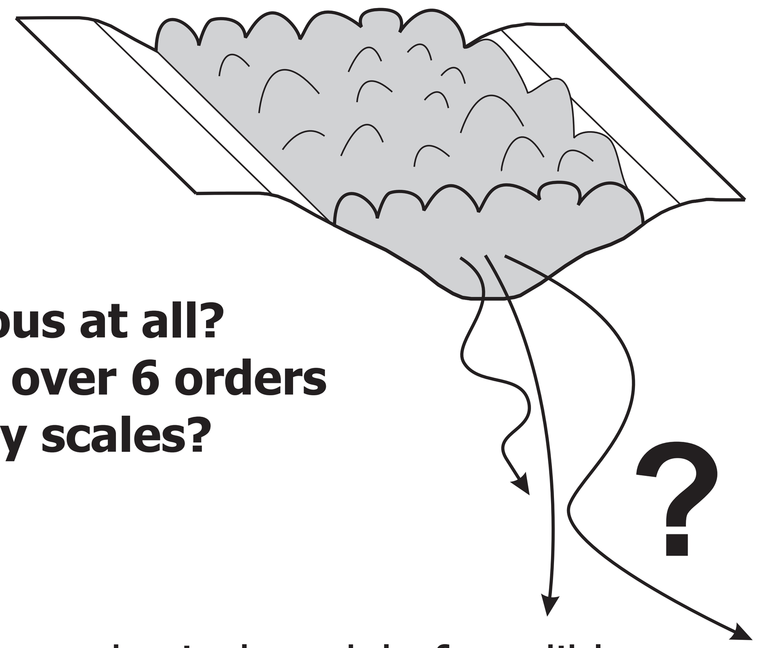
Universiteit Utrecht

Meander-wavelength / Flow width ratios in freely meandering experimental sandy turbidity currents.

Natalie Duncan, Joris Eggenhuisen, Matthieu Cartigny.

Problem:

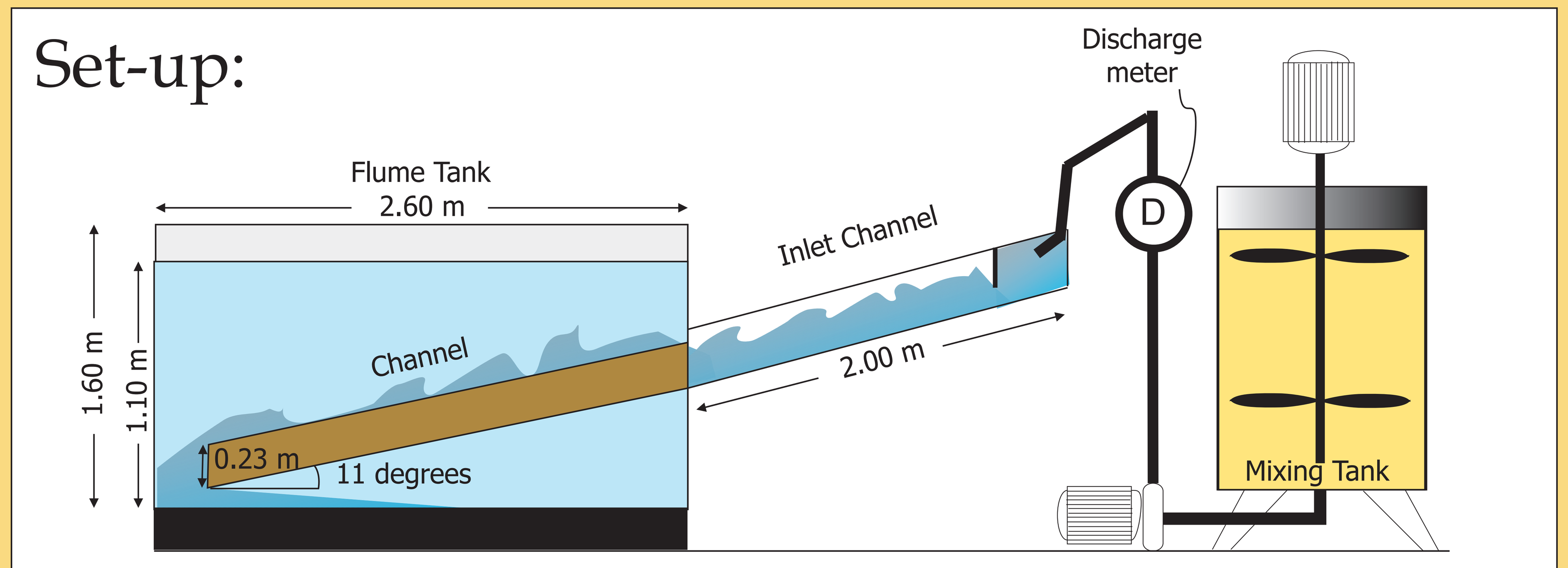
Physical modeling of self-formed sinuous submarine channel initiation and development has proved to be extremely difficult, and a viable approach has been to build pre-formed channel morphologies in non-erodible substrates. Such experiments inadvertently raise questions of scaling relations between channel morphology and experimental flow parameters:



Does the flow "want" to be sinuous at all?
Do meander scaling laws extend over 6 orders of magnitude, down to laboratory scales?

Here we present results obtained from a physical model of erodible channels that have undergone sinuous turbidity currents, and aim to confirm a quantitative relationship between submarine channel dimensions and meander wavelength.

Set-up:



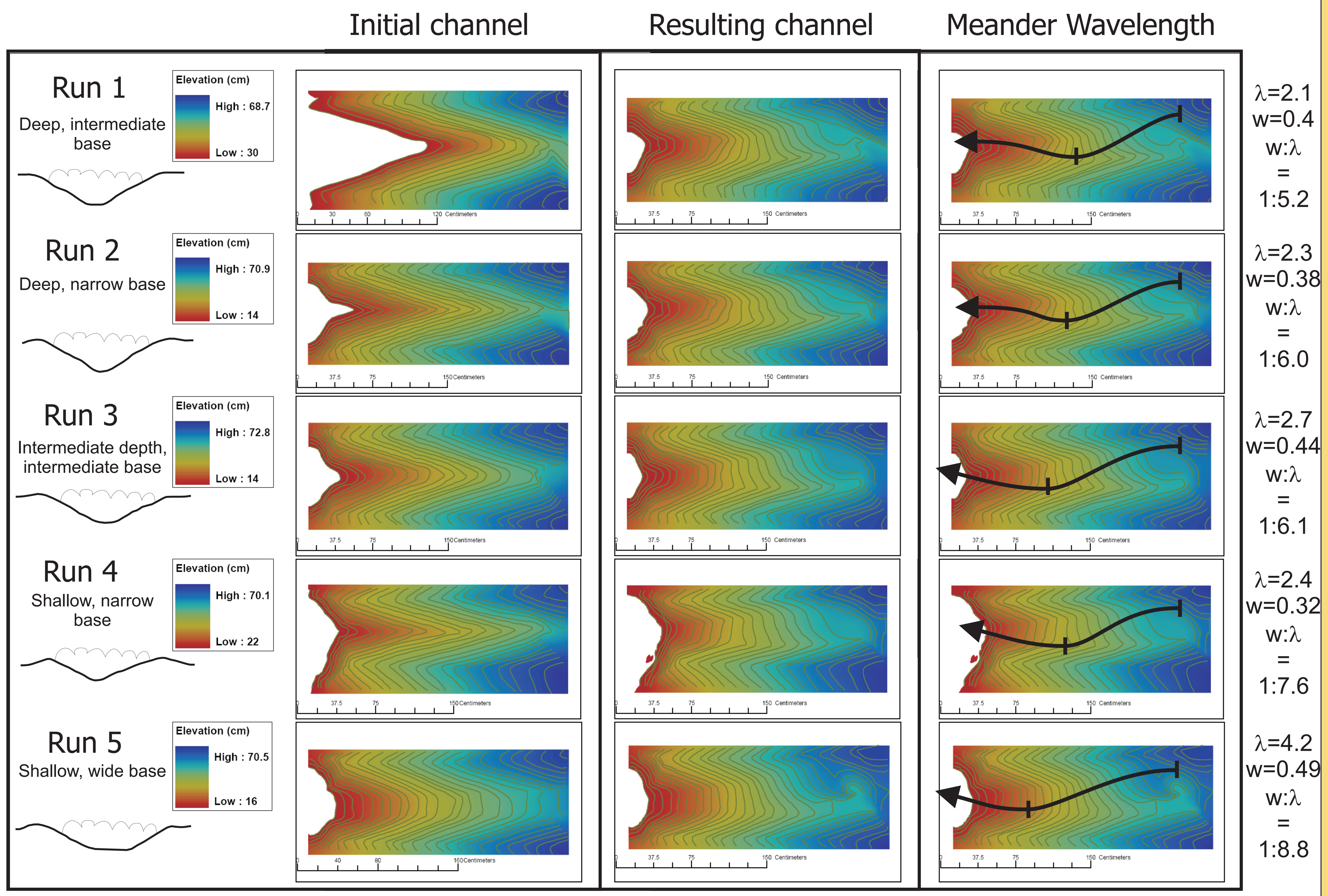
Experiments were performed in a flume tank 2.60m long, 1.50m wide and 1.60m deep. An inlet channel (26cm wide, 2m long, 25cm deep and 9° angle) entered the flume tank on one end. This inlet channel fed into a 2.62m long straight channel constructed in loose 160µm fine sand with a slope angle of 11°.

The channel exit was elevated above the flume floor, creating a sump into which any reflected turbidity current could flow.

The flume tank was filled up to 1.1m with tap water (40cm above the highest point of the channel).

The sediment mixture was prepared in a mixing tank to 10% v/v. While still mixing, the mix was pumped at 15 ± 3 m3/hr for ca. 2 minutes into the inlet channel. As the turbidity current entered the flume tank, it was deflected (at a 40° angle) towards the right bank of the channel, for the purpose of making a sinuous current.

Results: Deposit meandering indicates sinuous flow.

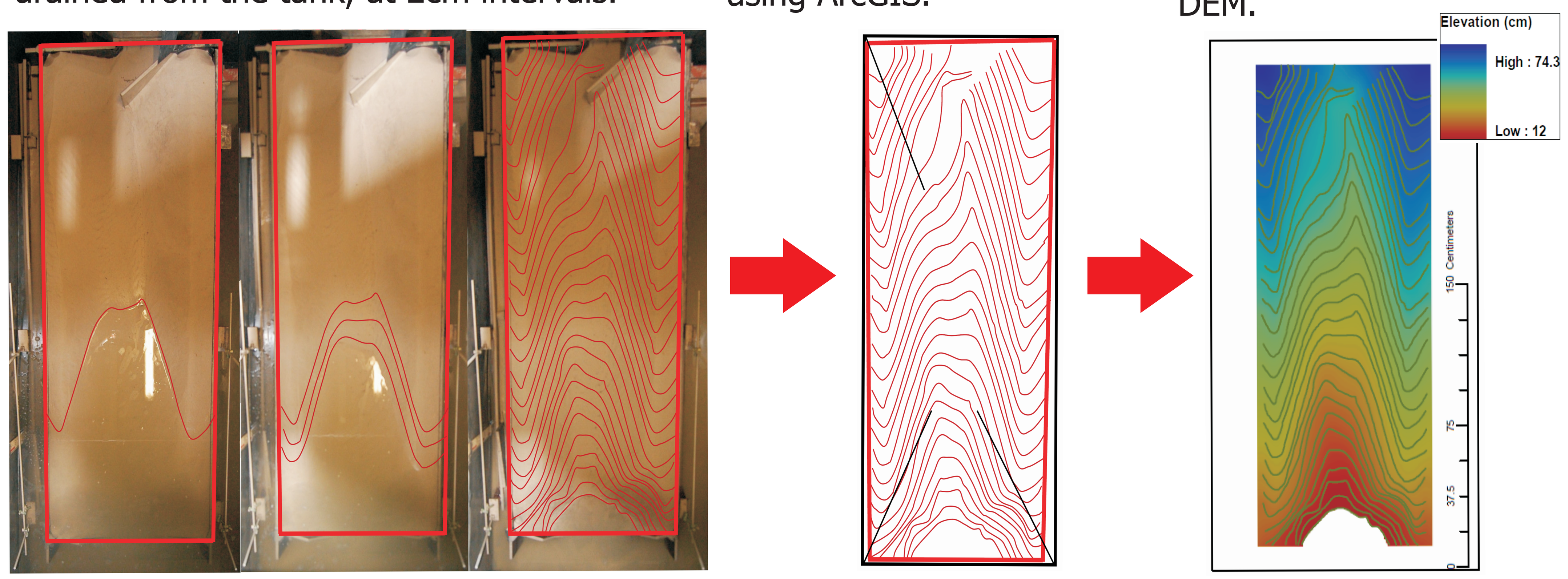


DEM methodology: DEMs were generated from contour plots.

Contours were produced by taking photographs of the channel as the water drained from the tank, at 2cm intervals.

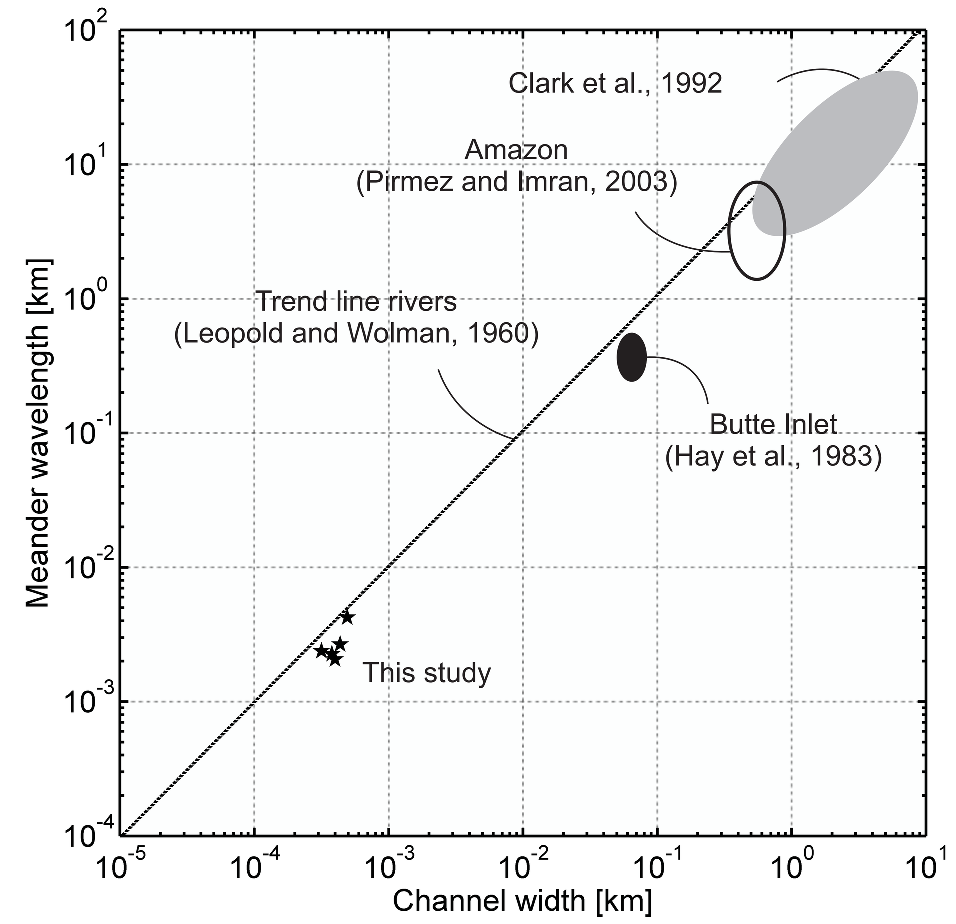
The contours were digitized, registered and rectified using ArcGIS.

Inverse Distance Weighted interpolation was used to produce the DEM.

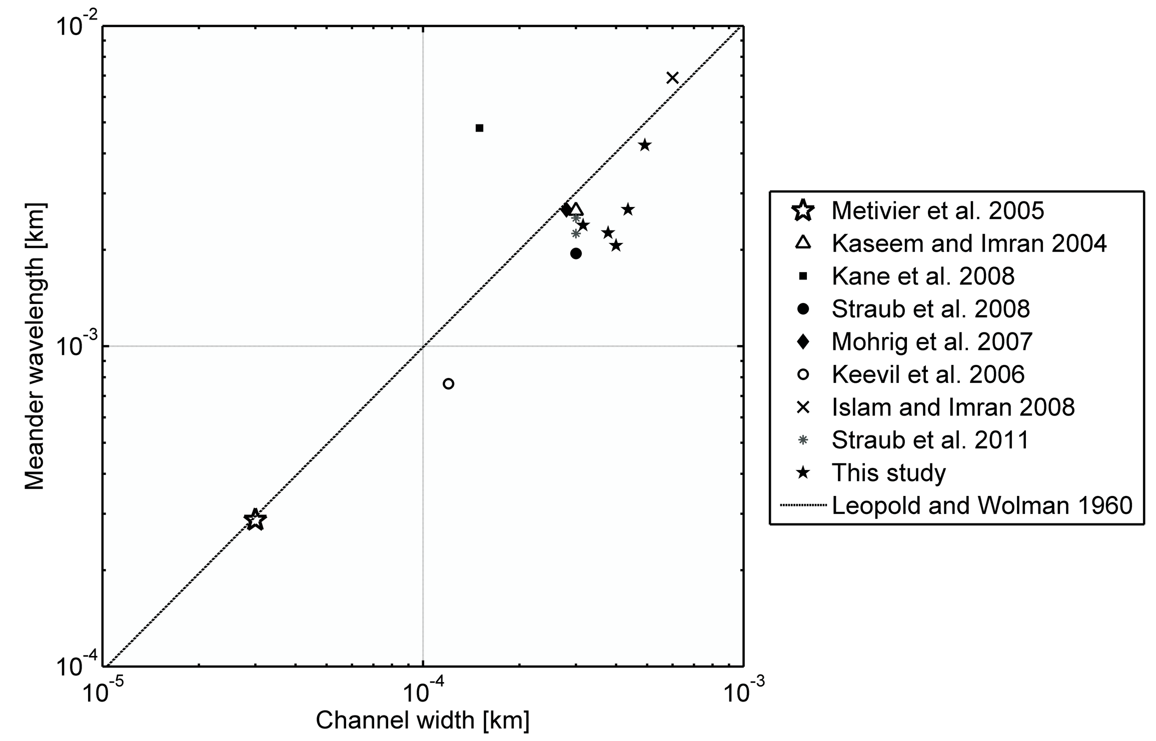


Conclusion:

The meander wavelengths of our freely meandering experimental turbidity currents fall just below the natural trend for river meanders. The deviation from the fluvial trend is similar to that in natural turbidity current data collated in previous studies.



Our data falls amongst the data cloud of previous fixed-channel experiments, and forms a justification of the fixed channel approach: characteristic meandering is present at laboratory scales 6 orders of magnitudes smaller than some real world systems.



Funding: N. Duncan has been funded through a research assistantship of the Royal Dutch Academy of Sciences (KNAW).

References: Clark et al., 1992, Geology, 20, 633-636; Hay et al., 1983, Sedimentary Geology, 36, 289-315; Islam and Imran, 2008, Journal of Geophysical Research, 113, C07041; Kane et al., 2008, Geology, 36, 287-290; Keevil et al., 2006, Marine Geology, 229, 241-257; Leopold and Wolman, 1960, GSA Bulletin, 71, 769-794; Metivier et al., 2005, Journal of Sedimentary Research, 75, 6-11; Mohrig and Buttles, 2007, Geology, 35, 155-158; Pirmez and Imran, 2003, Marine and Petroleum geology, 20, 823-849; Straub et al., 2008, GSA Bulletin, 120, 368-385; Straub et al., 2011, Marine and Petroleum Geology, 28, 744-760.