Clinic 1.2 - ANUGA

2017 CSDMS Annual Meeting

May 23, 2017

SEEC N128, 1:30 PM

ANUGA Outline

- **Introduce** ANUGA
- Show some **use cases**
- Run **examples**
- **Experiment**

ANUGA

Australian **N**ational **U**niversity

Geosciences **A**ustralia

- **Hydrodynamic** inundation modelling tool
- Discretized on **irregular mesh of triangular cells**
- Solves **2D Shallow Water Wave** equations
  - Tracks **depth** and **horizontal momentum** over time
- **Finite-volume** method
  - Can simulate **hydraulic jumps** & transitions from **sub- to super critical flow**
  - OK with **discontinuities** in the bed and water surface
- Robust **wetting/drying** capability
  - **Water edge** is not an explicit boundary condition
  - Good for **overland flow** and **flow around structures**
- **Python, C** for computationally intensive parts
- **Open Source** since December 2006

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ANUGA Limitations

- Discretized on **irregular mesh of triangular cells**
  - Coordinates assumed to be **UTM**
    - **Can't have domain larger than 6 degrees** without distortion

- Solves **2D Shallow Water Wave** equations
  - **Depth averaged** flow
  - **No vertical convection**
    - No breaking waves
    - No 3D turbulence (vorticity)

- **Finite-volume** method
  - **Not as fast** as finite-difference method
  - Better for complex geometries and wetting/drying

- **Inviscid fluid** (no kinematic viscosity)

- Frictional resistance is **Manning's formula**

ANUGA

- Free and **Open Source**
  - https://github.com/GeoscienceAustralia/anuga_core
- Powerful
- Easy to use
- Benchmarked
- **Parallel**
- Modular and **flexible**

2004 Indian Ocean tsunami

impact on Patong Beach

isprs International Journal of Geo-Information

MDPI

Article

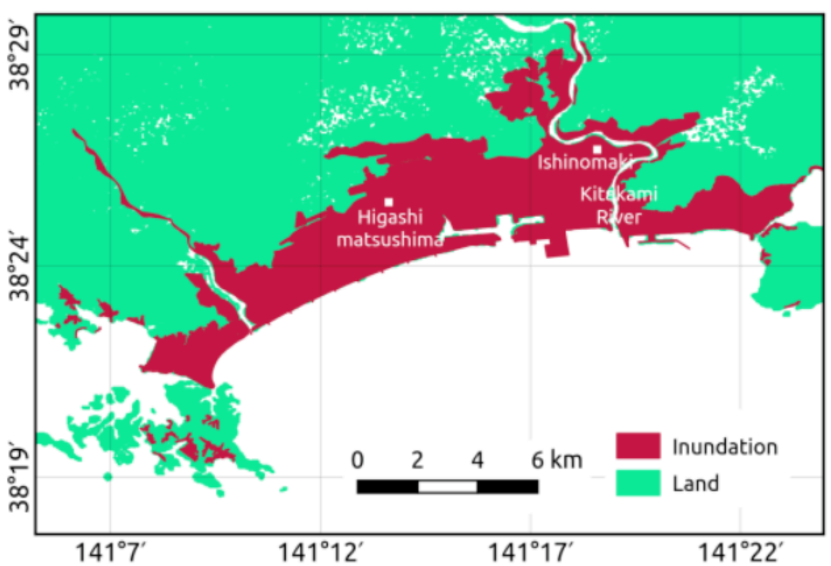
Implementation of Algorithm for Satellite-Derived Bathymetry Using Open Source GIS and Evaluation for Tsunami Simulation

Vinayaraj Poliyapram [1,*], Venkatesh Raghavan [1], Markus Metz [2], Luca Delucchi [2] and Shinji Masumoto [3]

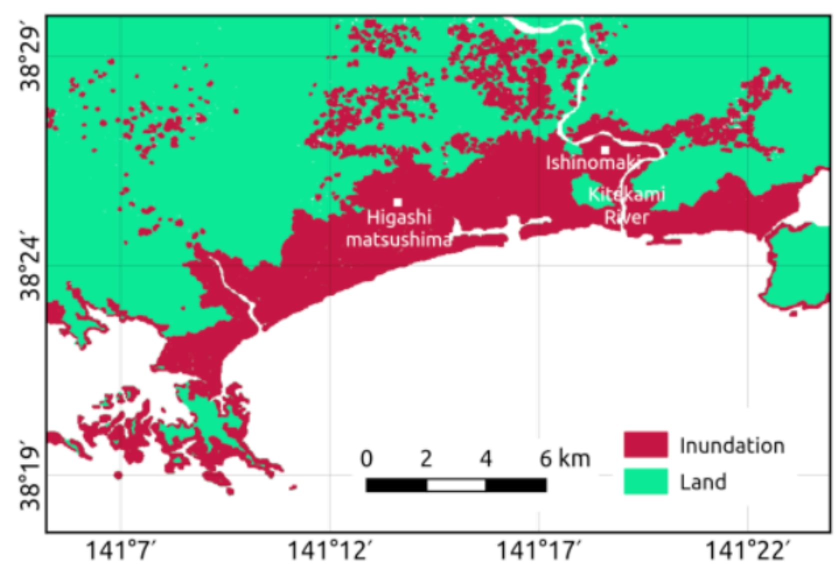
ISPRS Int. J. Geo-Inf. **2017**, 6, 89; doi:10.3390/ijgi6030089

Evaluation of **Tohoku tsunami (Japan, 2011)** simulation results with post survey data

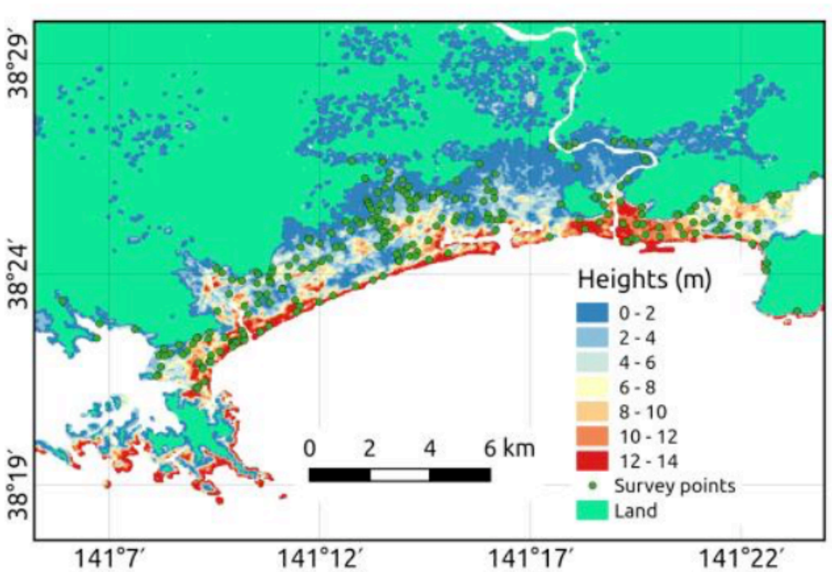
Real inundation extent



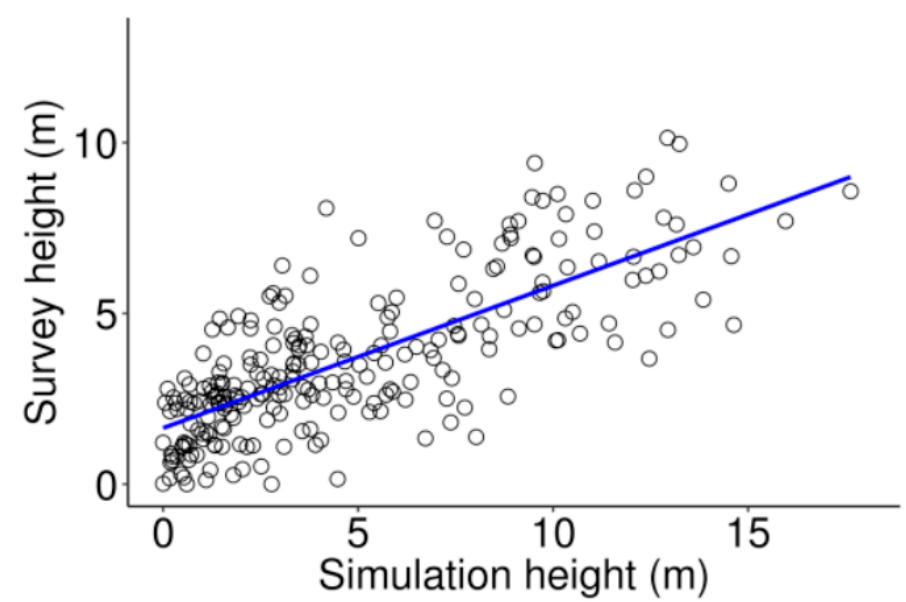
ANUGA inundation extent



ANUGA tsunami height



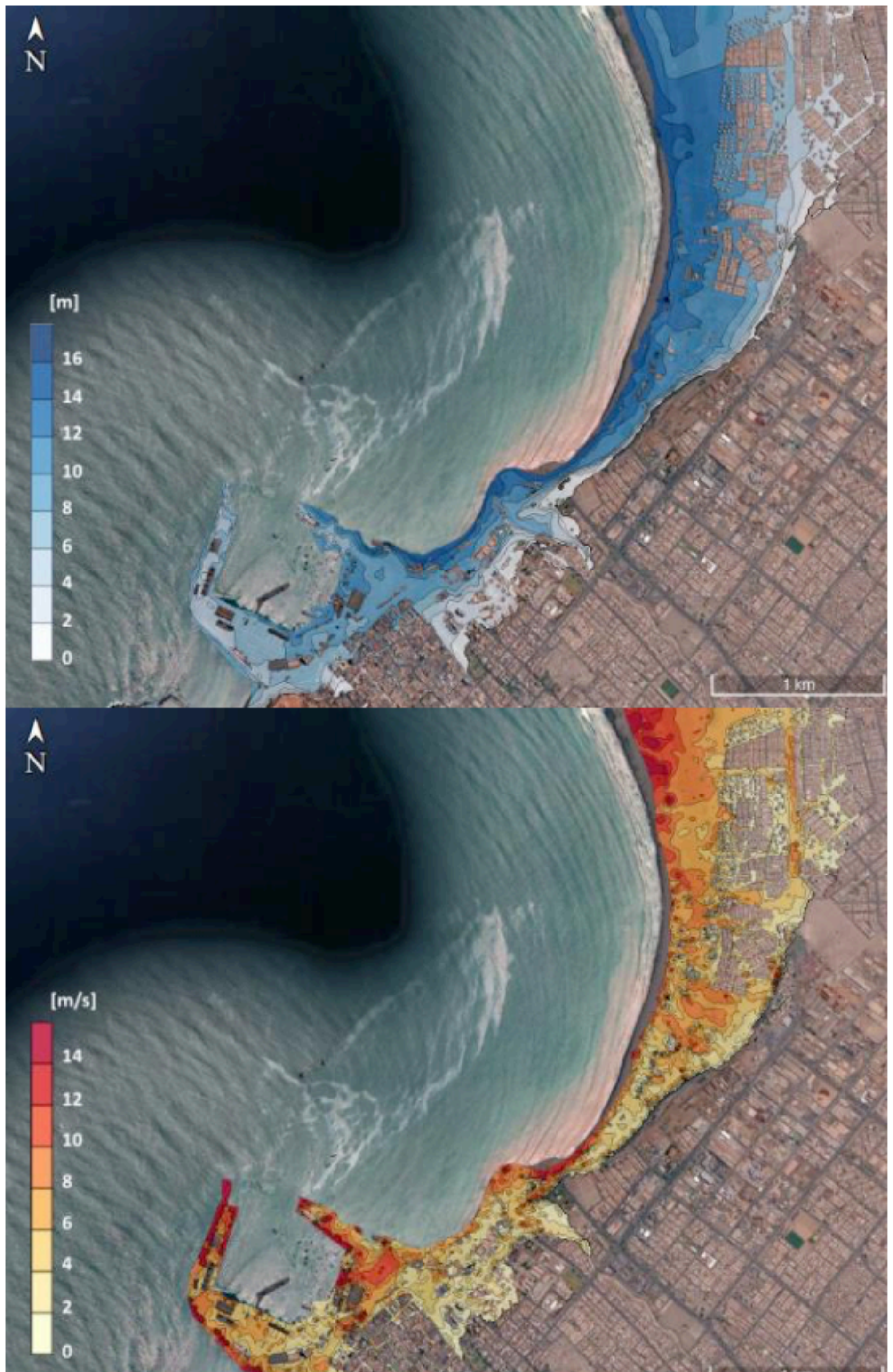
ANUGA vs. survey tsunami height



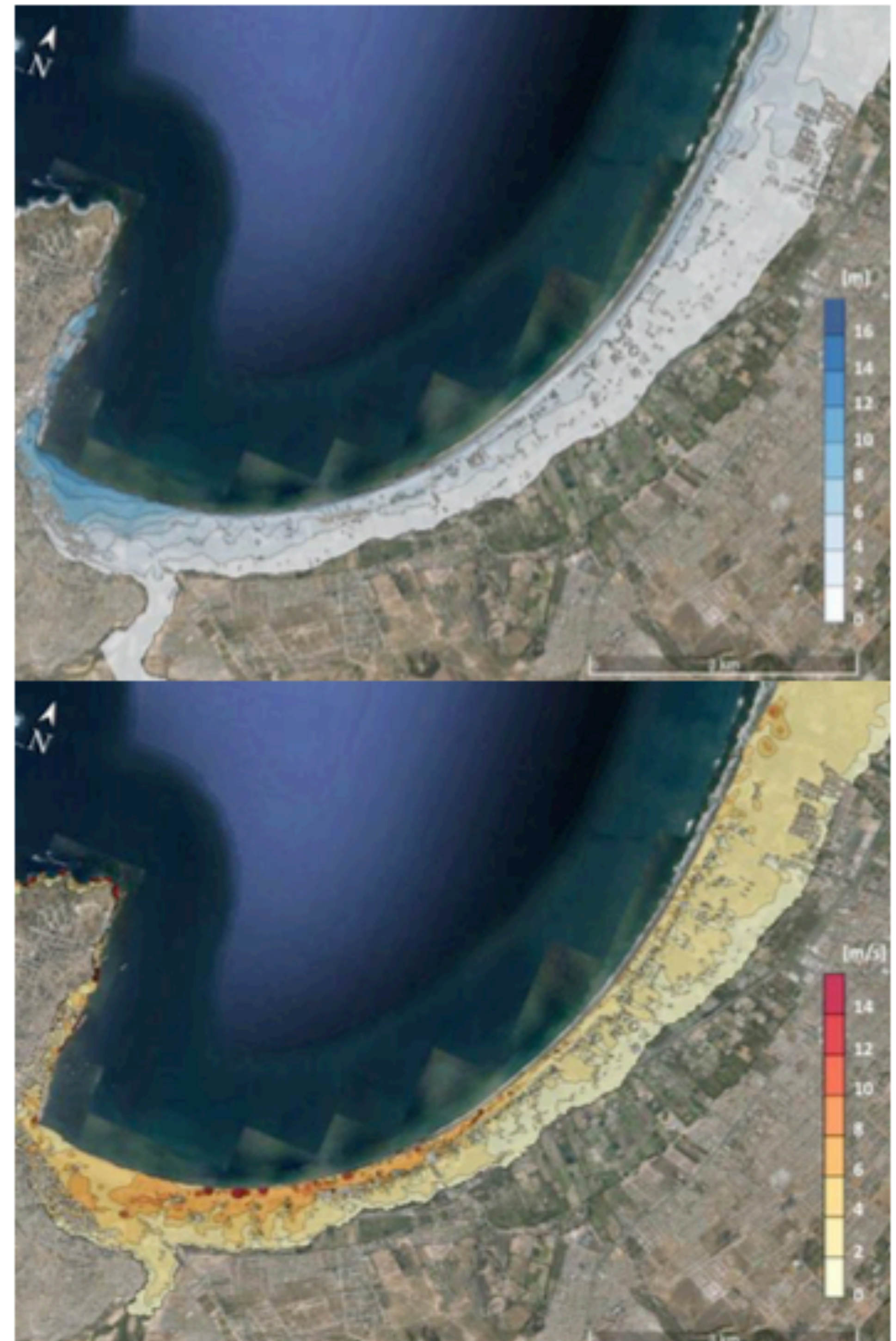
NUMERICAL MODELLING METHODOLOGY FOR TSUNAMI FLOOD RISK ASSESSMENT IN URBAN AREAS

Benjamín Carrión[1], Luis Burgos[2] and Carlos Rozas[3]

COASTAL ENGINEERING 2016



Arica, Chile



La Serena, Chile

doi:10.1038/nature19817

Progressive incision of the Channeled Scablands by outburst floods

13 OCTOBER 2016 | VOL 538 | NATURE | 229

Isaac J. Larsen[1,2] & Michael P. Lamb[2]

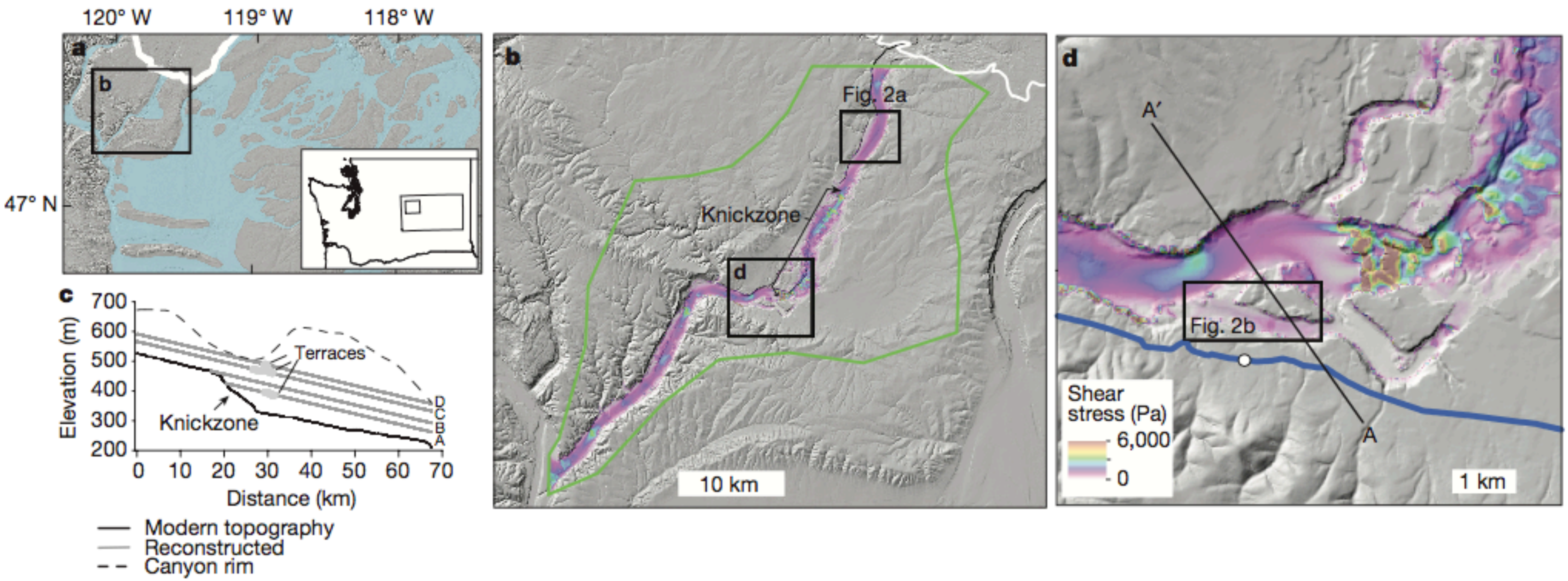
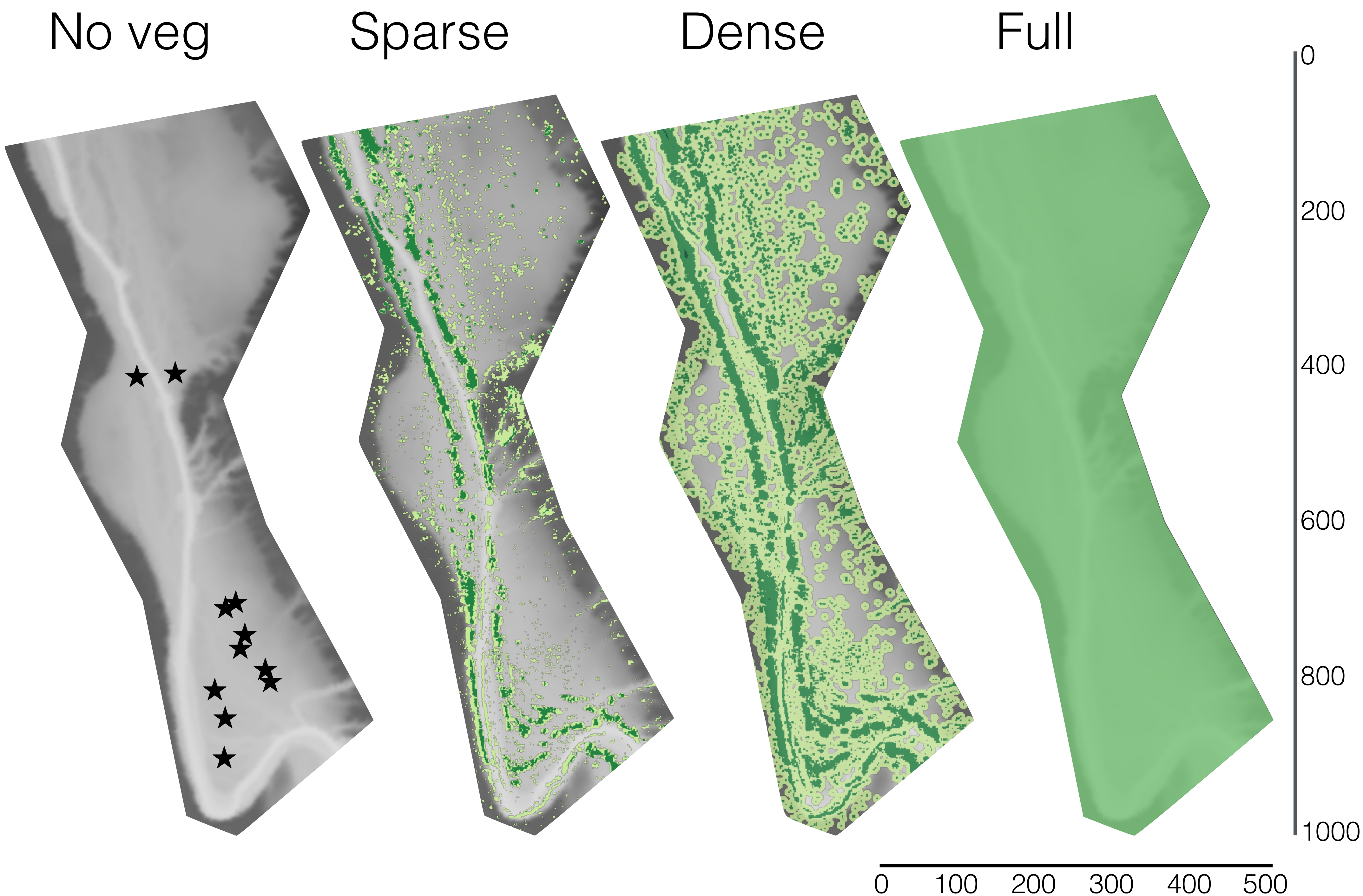
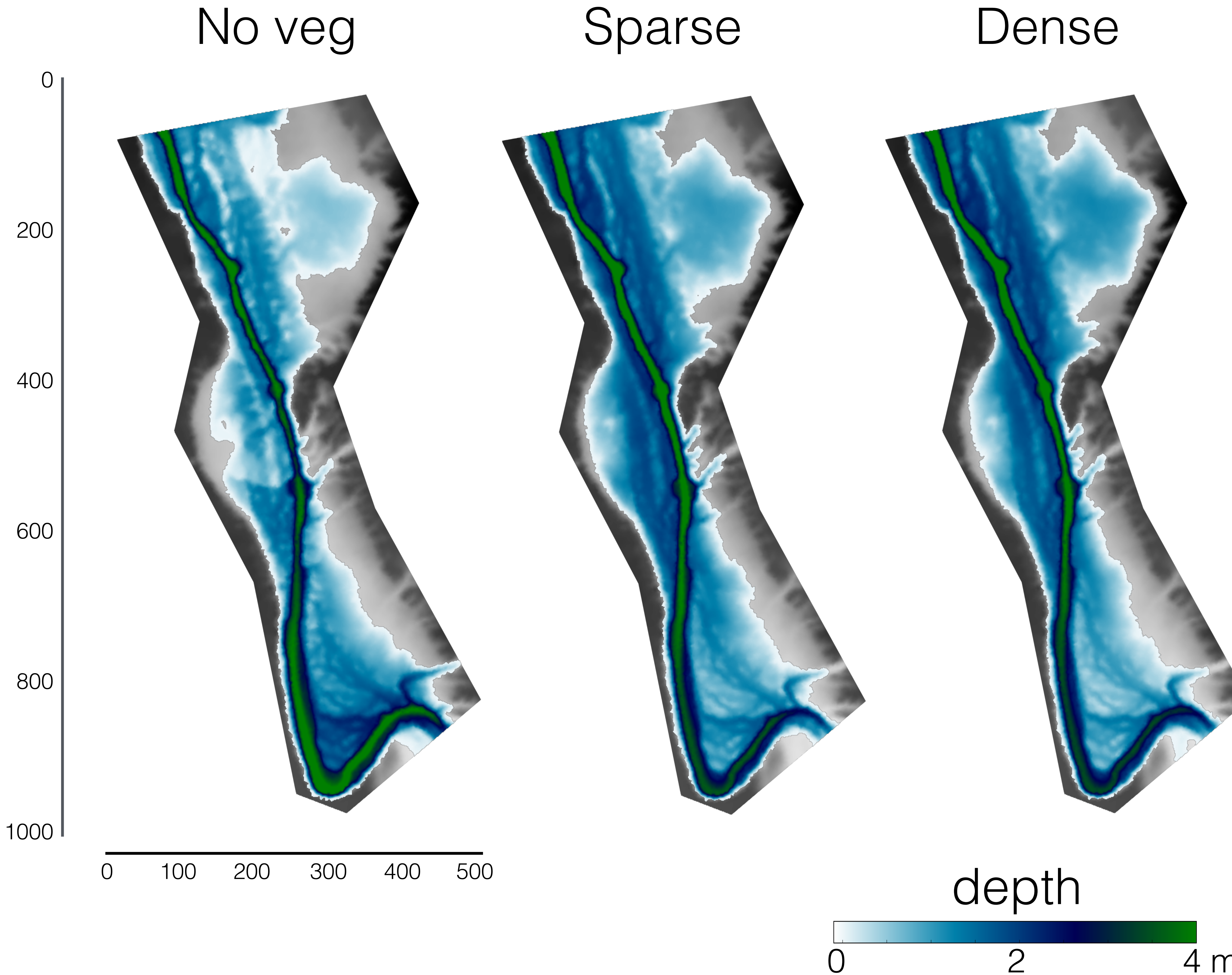


Figure 1 | The Moses Coulee study site. a, Moses Coulee in eastern Washington, USA (location indicated by the smaller boxed region in the inset). Blue areas were inundated by late-Pleistocene floods and the white line delineates the southern extent of the Cordilleran ice sheet. Flood and ice extent are interpreted from version 3.0 of the Washington Department of Natural Resources digital 1:250,000 scale state geological map. **b,** Moses Coulee with modelled bed shear stresses (see colour scale in **d**) during a flood with a discharge of $0.6 \times 10^6\ m^3\ s^{-1}$; the model domain is outlined in green. **c,** Long profile of Moses Coulee showing the modern bed topography (solid black line), mapped bedrock terraces (grey circles) and the bed topography reconstructed from the terrace elevations (grey lines labelled A–D). The rim of the canyon is indicated by the dashed black line. Elevation is with respect to sea level. **d,** The study reach. The white circle shows the location of the field-defined high-water mark; the blue line shows the high-water line interpreted from aerial imagery. The line A–A′ shows the location of the cross-section in Fig. 4.

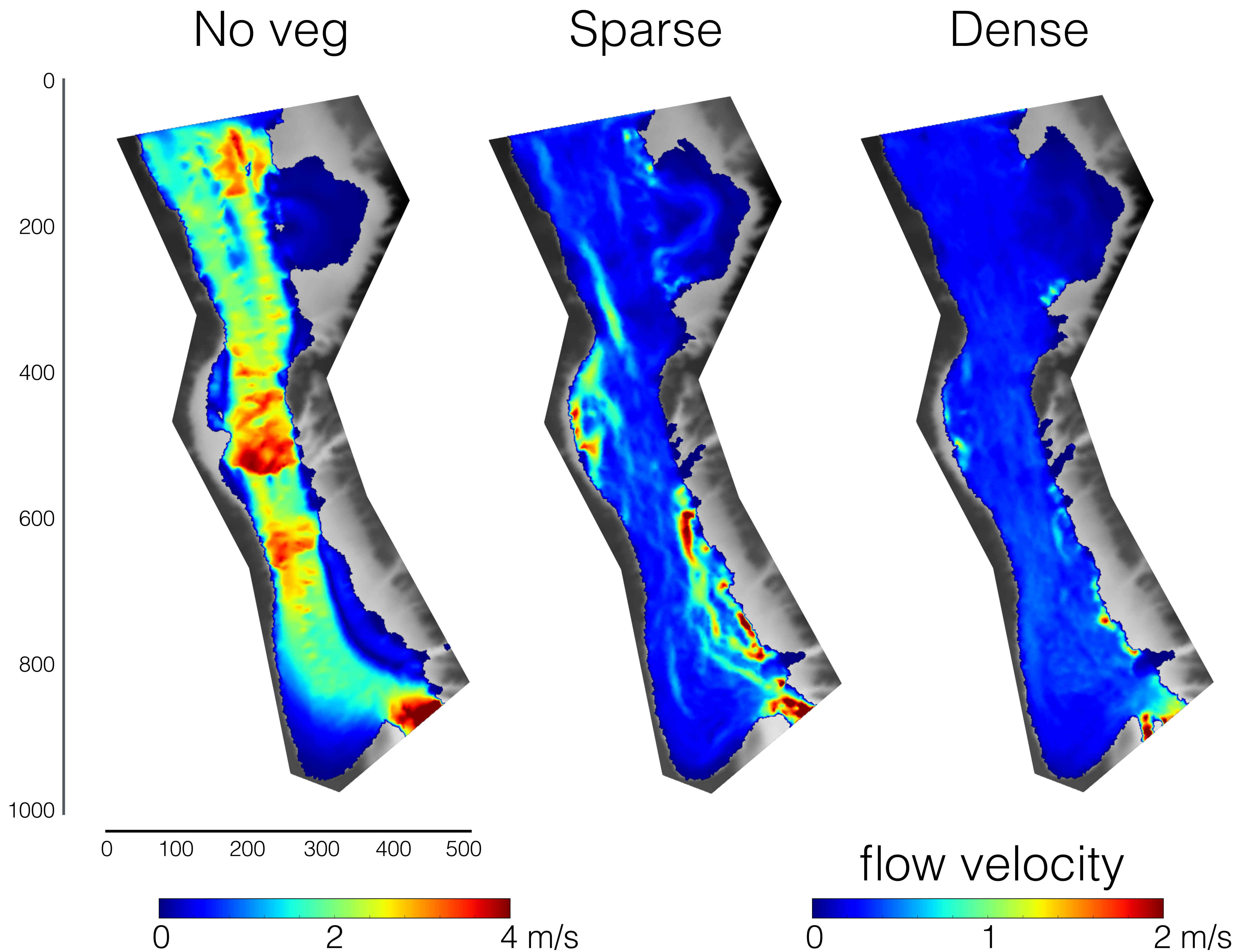
New ANUGA modules:
vegetation drag as arrays of cylinders

Different results than increasing Manning's n!

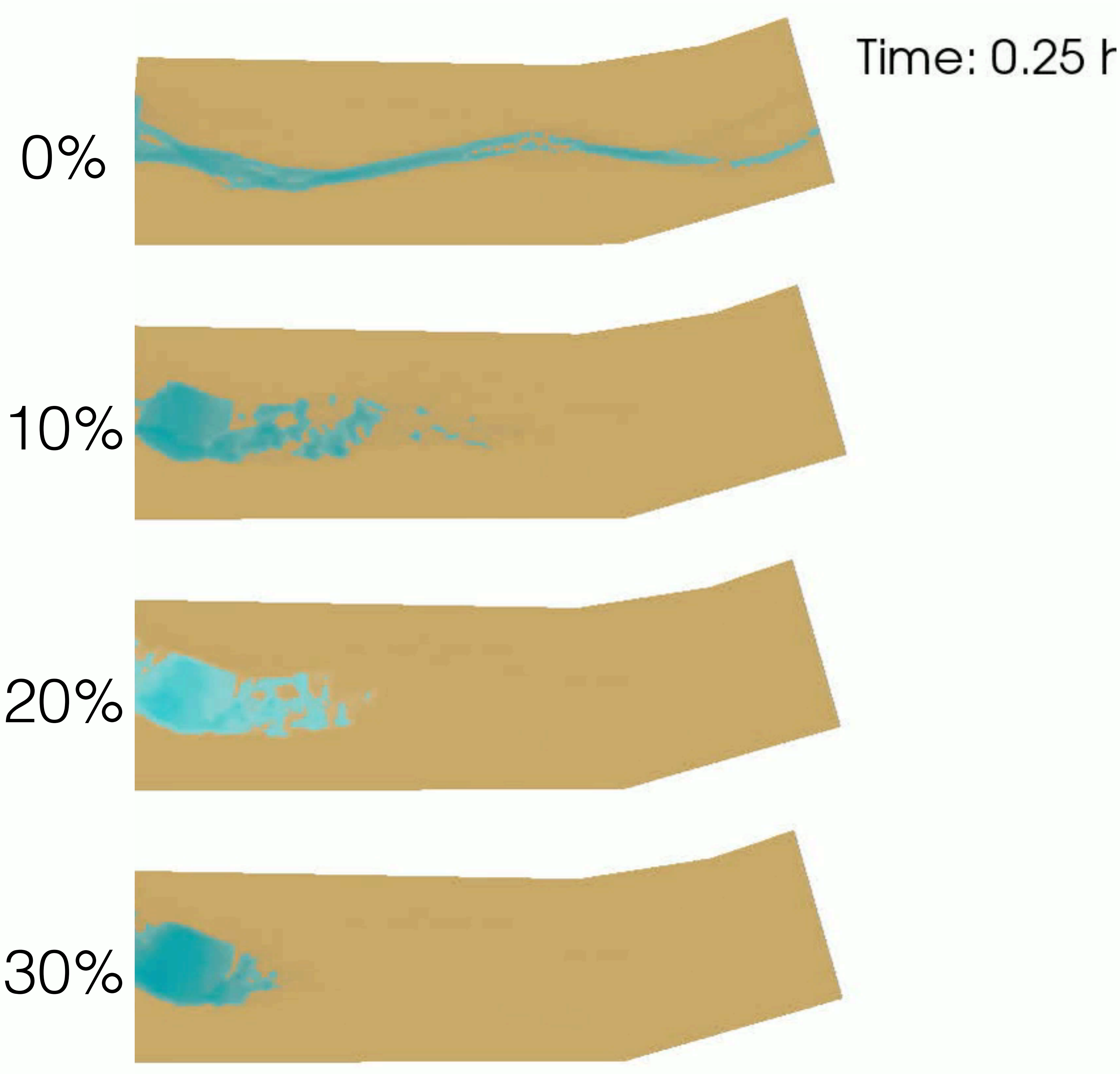




No veg
Sparse
Dense
0
200
400
600
800
1000
0
100
200
300
400
500
depth
0
2
4 m

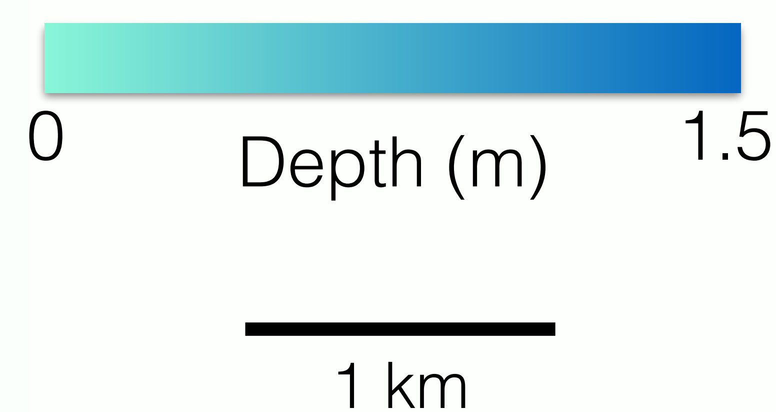

No veg
Sparse
Dense
0
200
400
600
800
1000
0
100
200
300
400
500
0
2
4 m/s
flow velocity
0
1
2 m/s

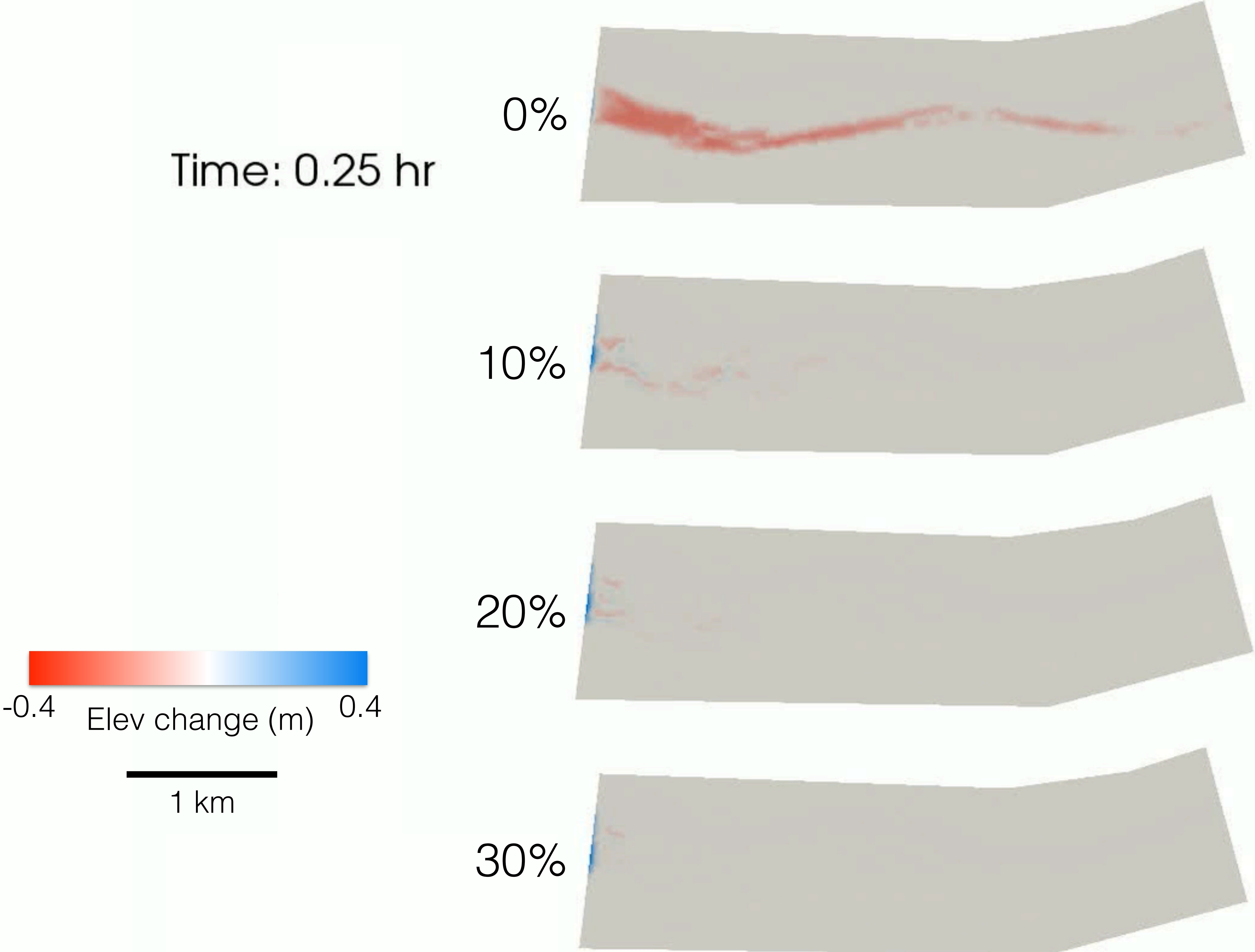
New ANUGA modules:
sediment transport



Arroyo evolution in the **1850s:**
Fully aggraded

High discharge
5% sed concentration
random vegetation

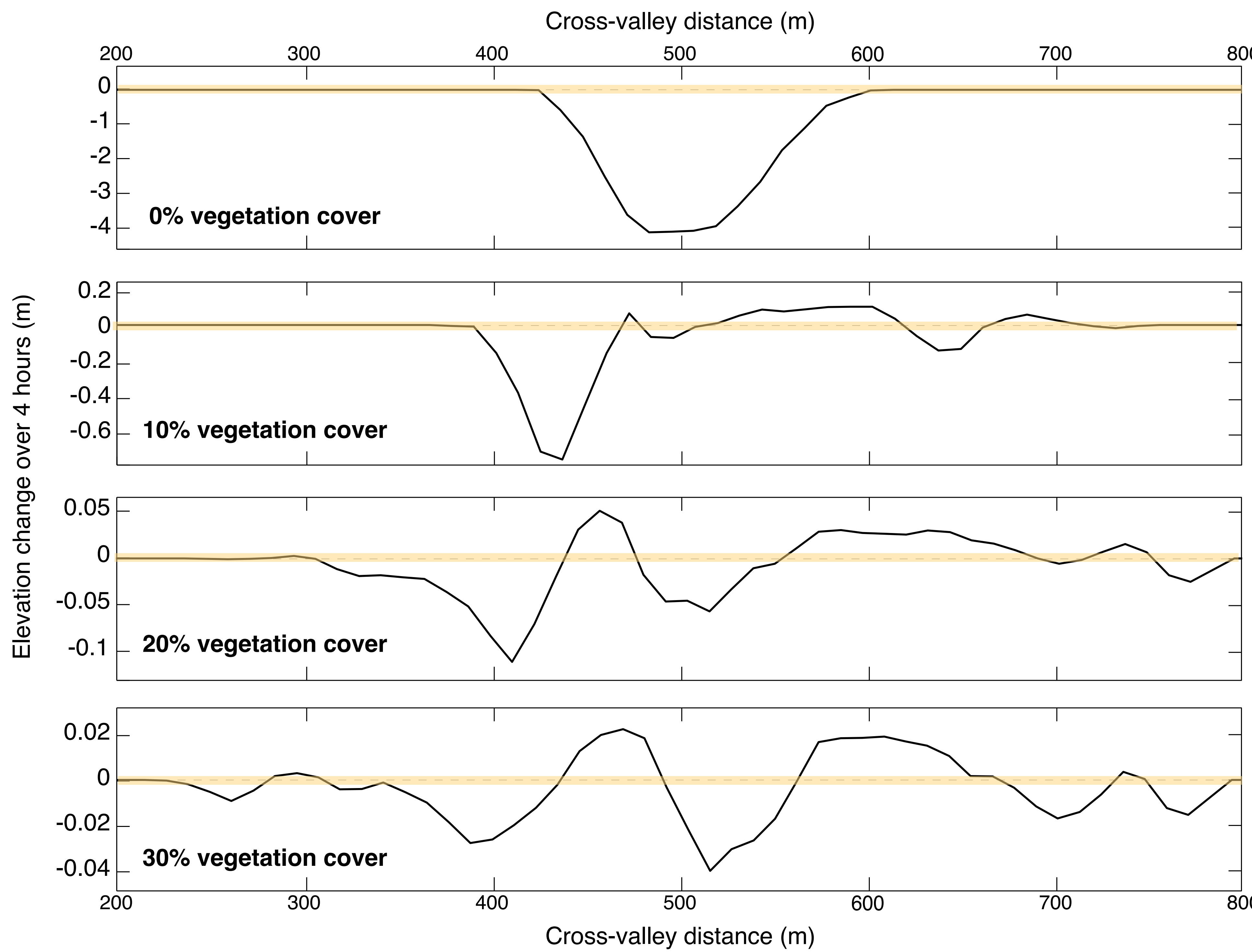



Time: 0.25 hr
0%
10%
20%
30%
-0.4
Elev change (m)
0.4
1 km

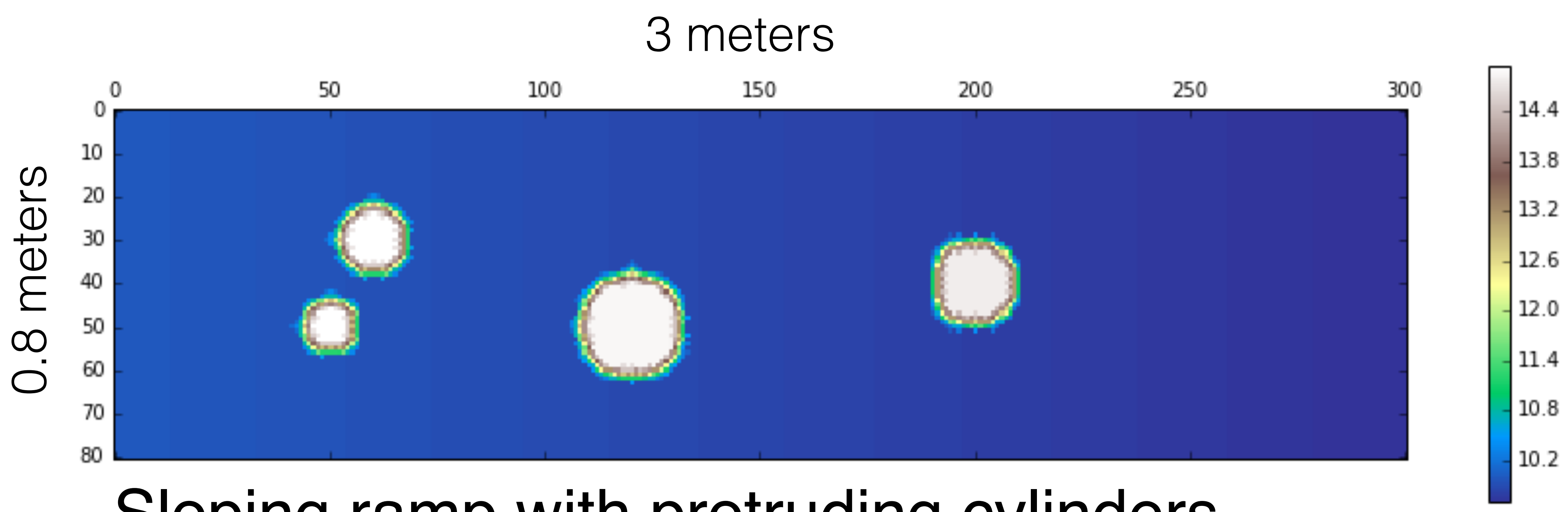
Vegetation leads to **narrow channels,** creates **floodplains**

~10% vegetation cover produces connecting threads

Too little vegetation -> one deep channel
Too much vegetation -> no dominant paths
Just right -> builds floodplains



Sediment transport **around structures**



Sloping ramp with protruding cylinders

run examples

http://bit.ly/2re5dKS