Understanding erosion and deposition by debris flows

Field measurements from the Illgraben, Switzerland

Illgraben, Switzerland - study site

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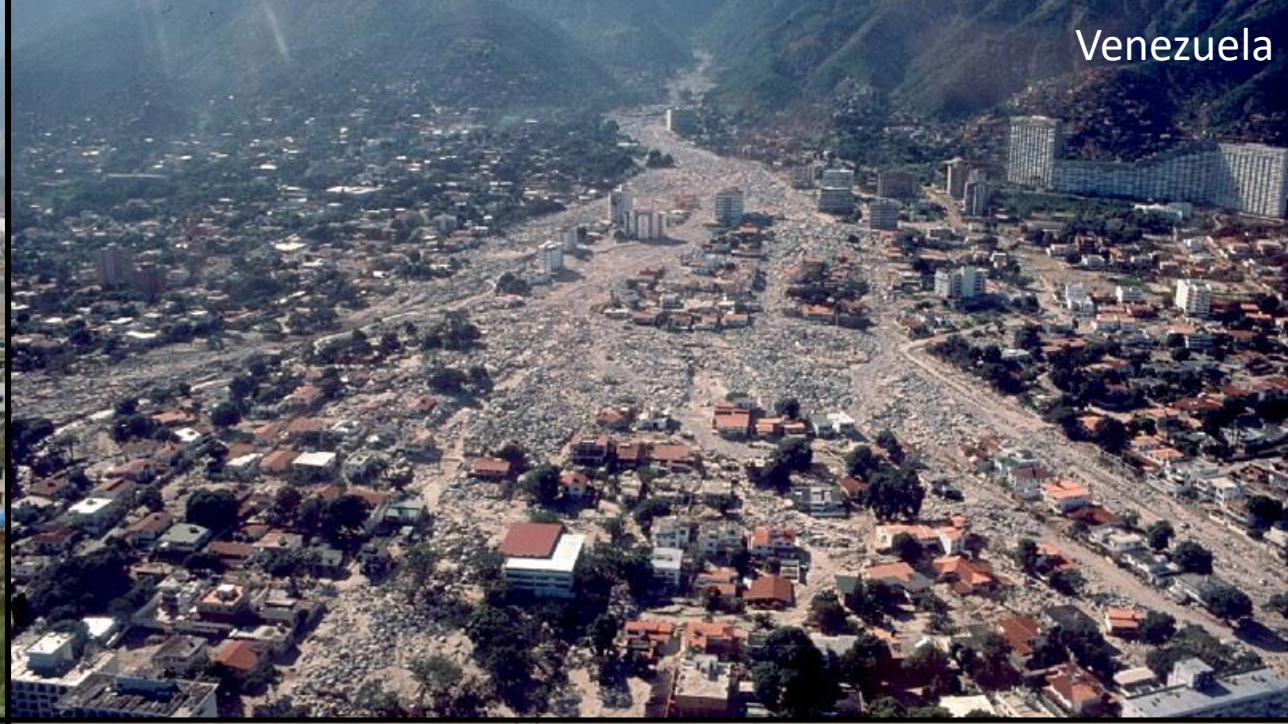
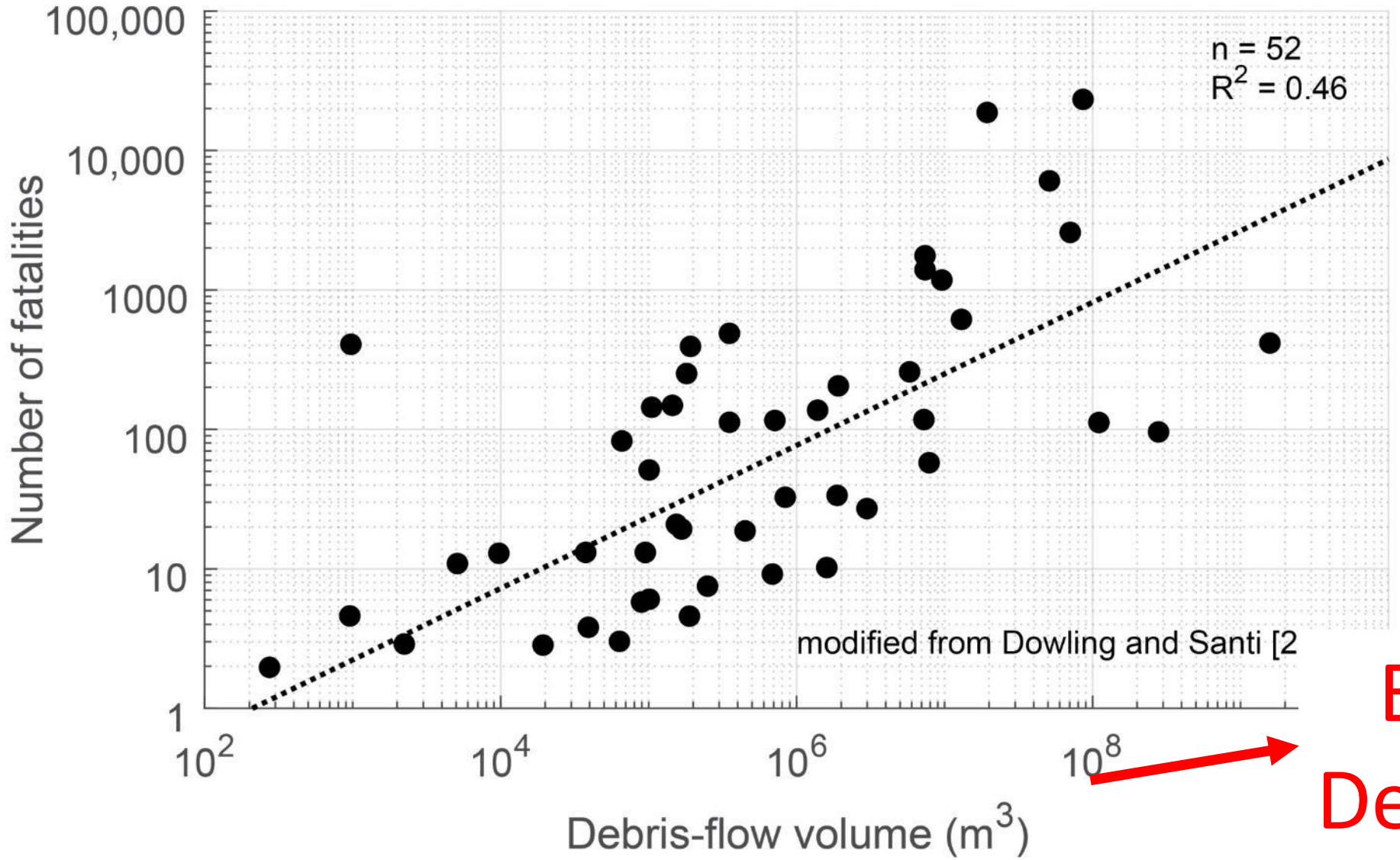
China


Venezuela

Switzerland

USA

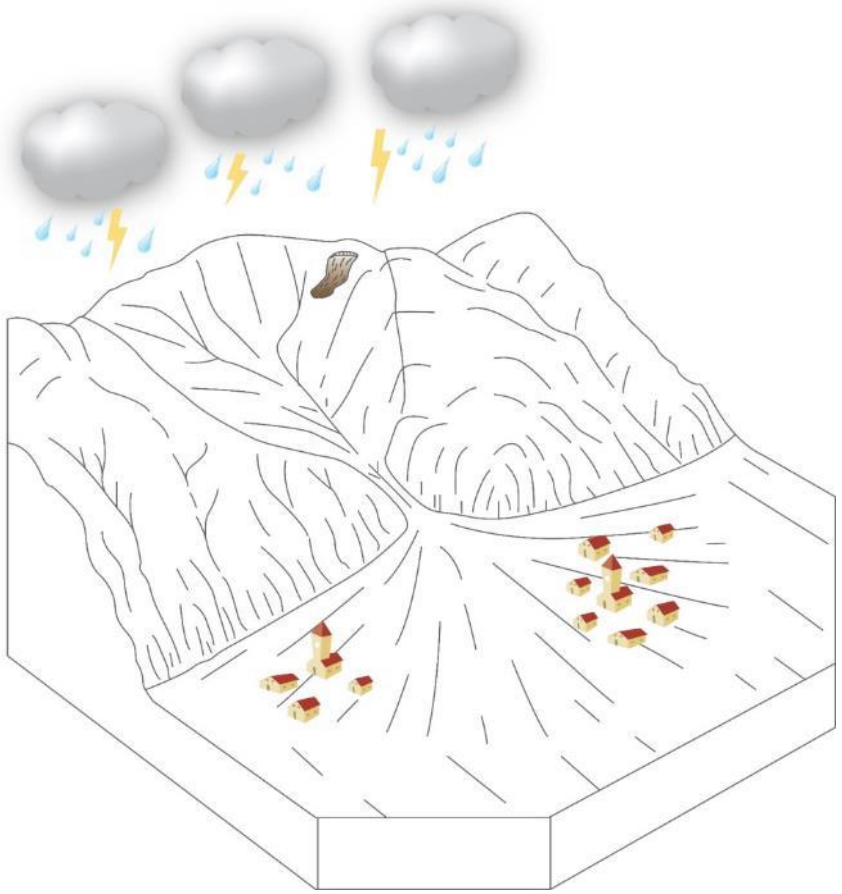
Flow volume versus fatalities



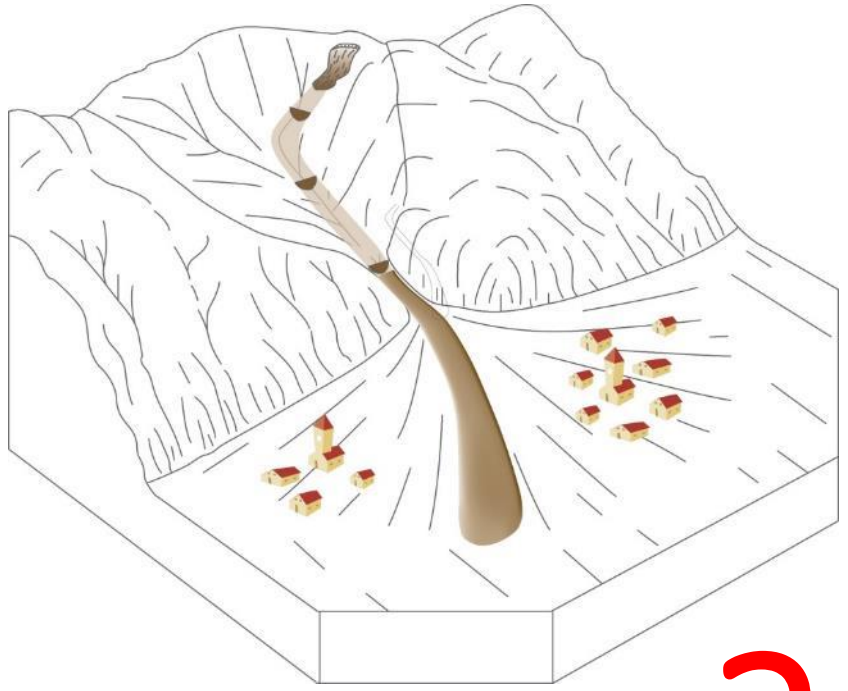
Erosion

Deposition

Erosion, deposition and hazards

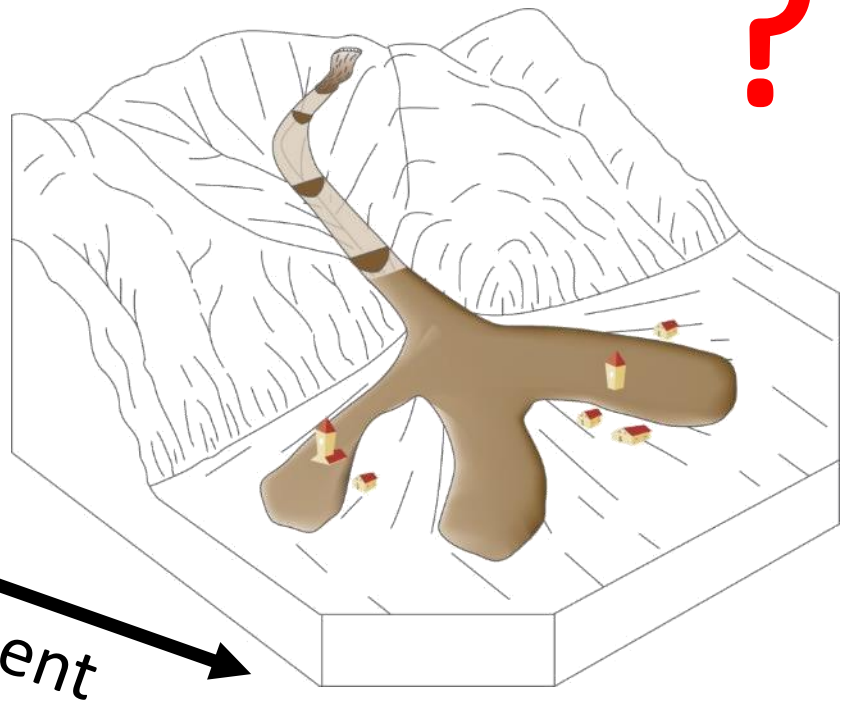


Limited entrainment



?

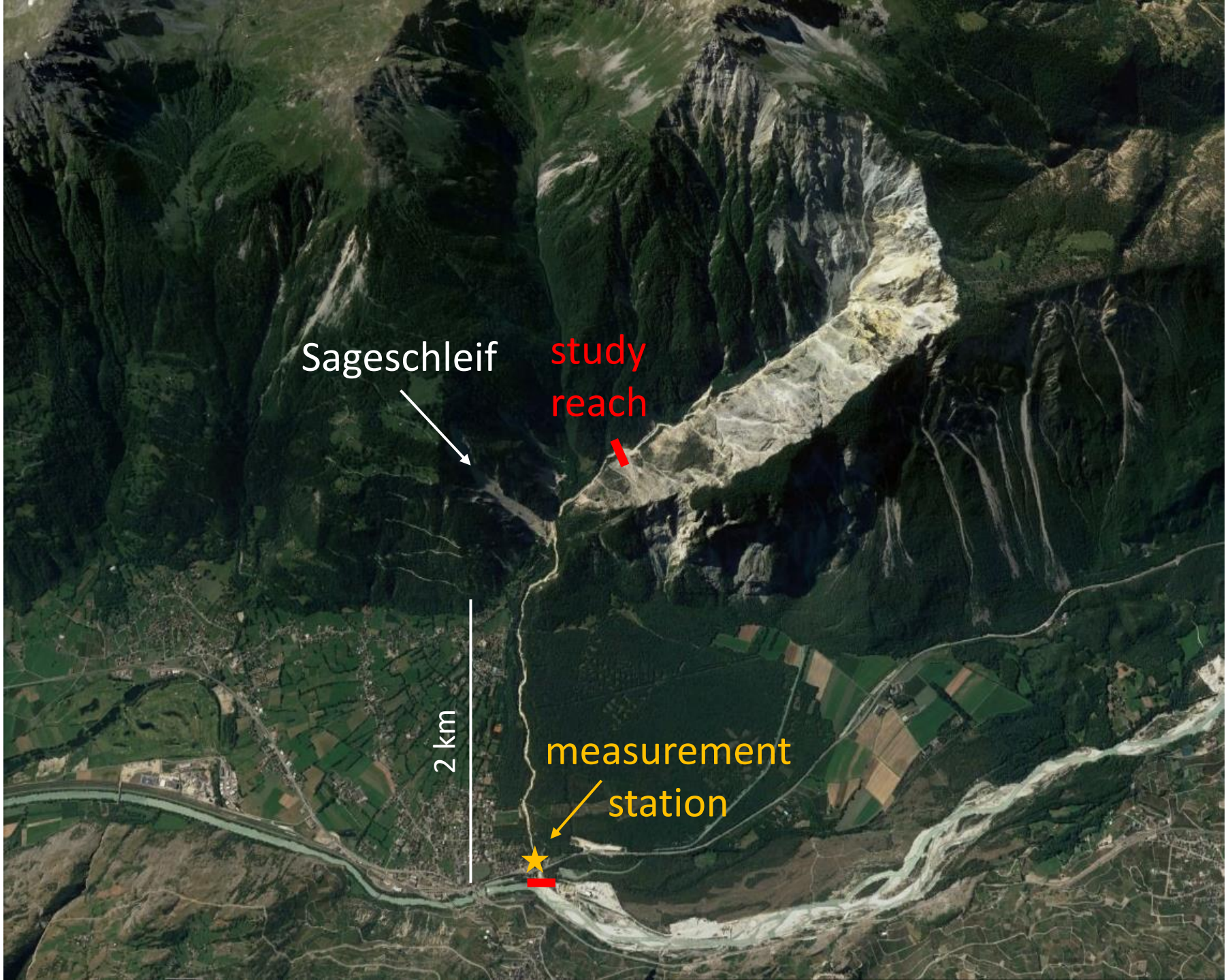
Substantial entrainment



Objectives

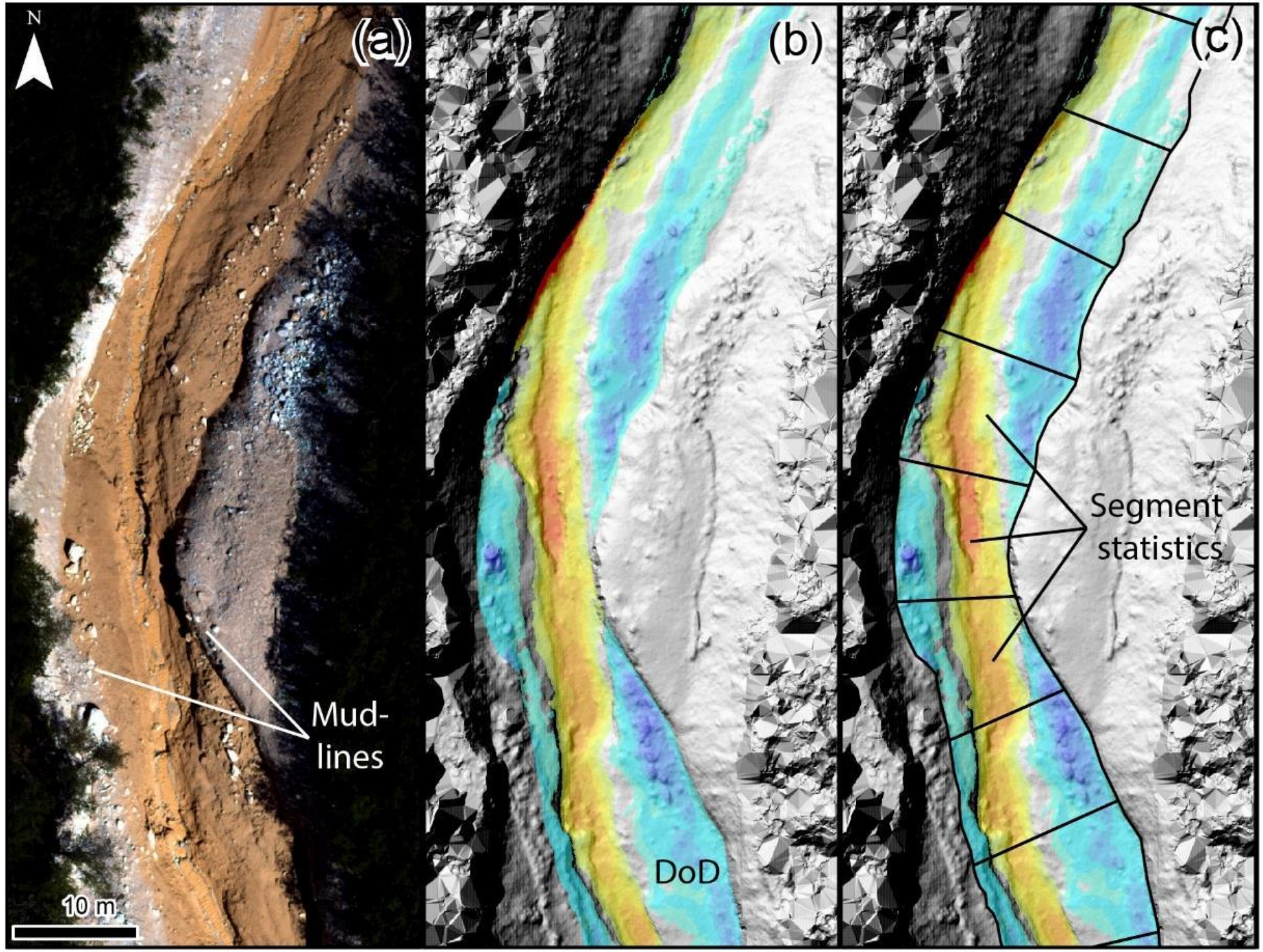
1. Quantify spatio-temporal erosion and deposition patterns in natural debris-flow streams

2. Unravel controls on erosion and deposition
   - Flow properties?
   - Bed properties?
   - Sub-catchment inputs?
   - Check dams?
   - Memory effects?

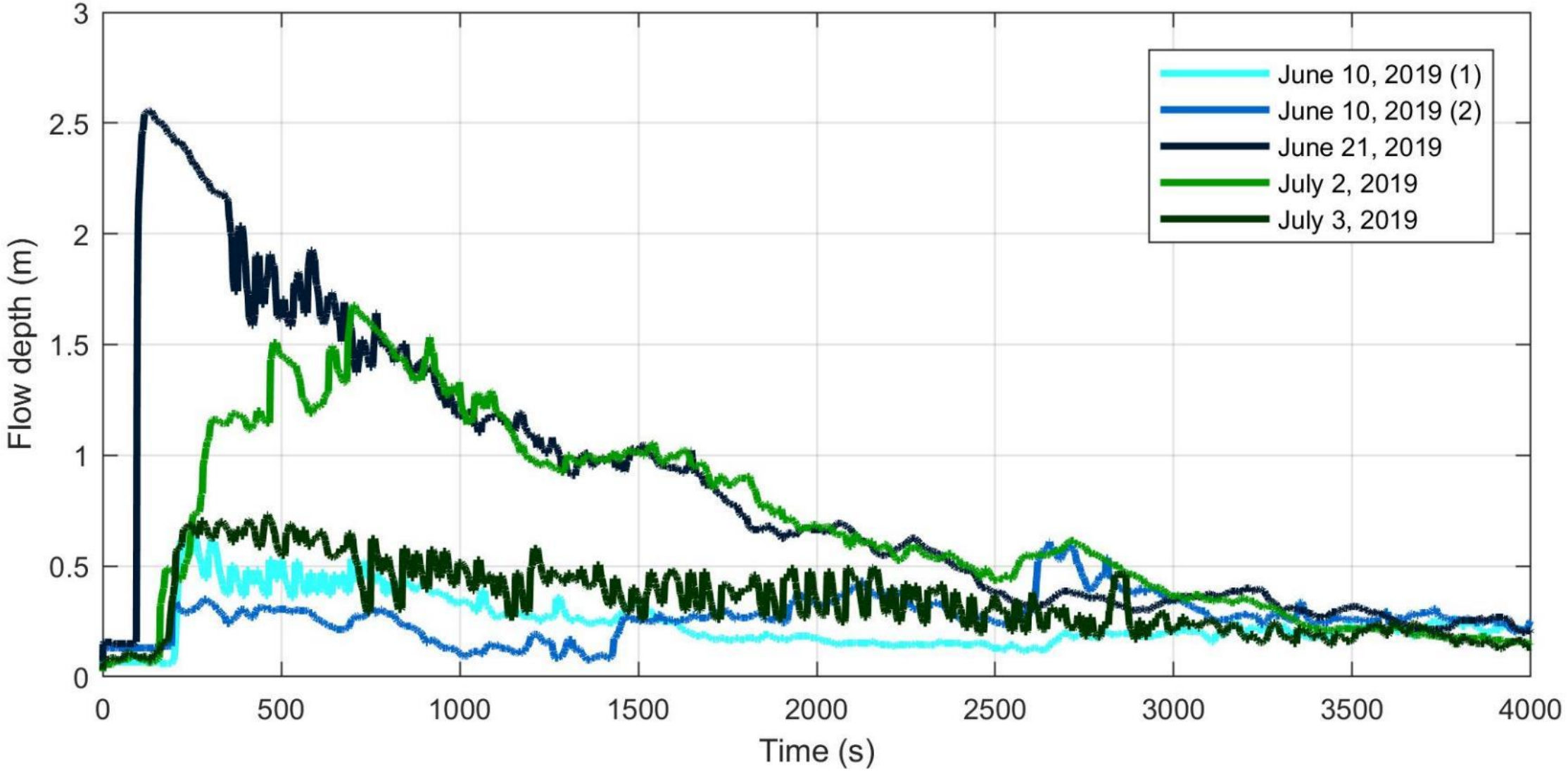

Sageschleif
study
reach
2 km
measurement
station

Methods

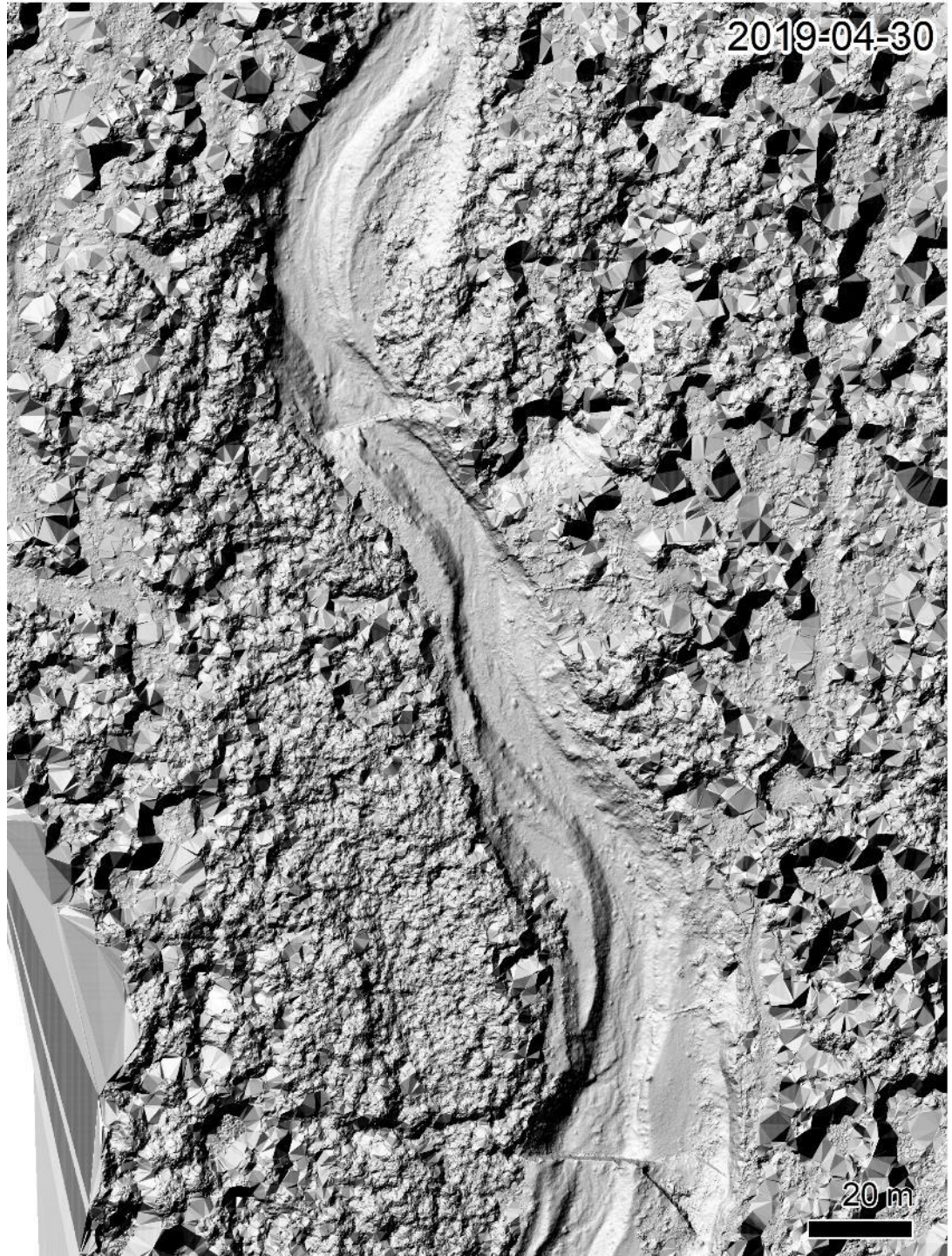
- UAV images after each debris flow (Mavic 2 Pro)
- Structure-from-motion for point cloud generation (Agisoft Metashape)
  - ~60 GCPs
- LasTools for point cloud filtering
  - Removal of overhanging vegetation
- DEMs of difference for identification of erosion and deposition
  - Mudlines indicate flow extent
  - Erosion and deposition statistics in 10 m reaches

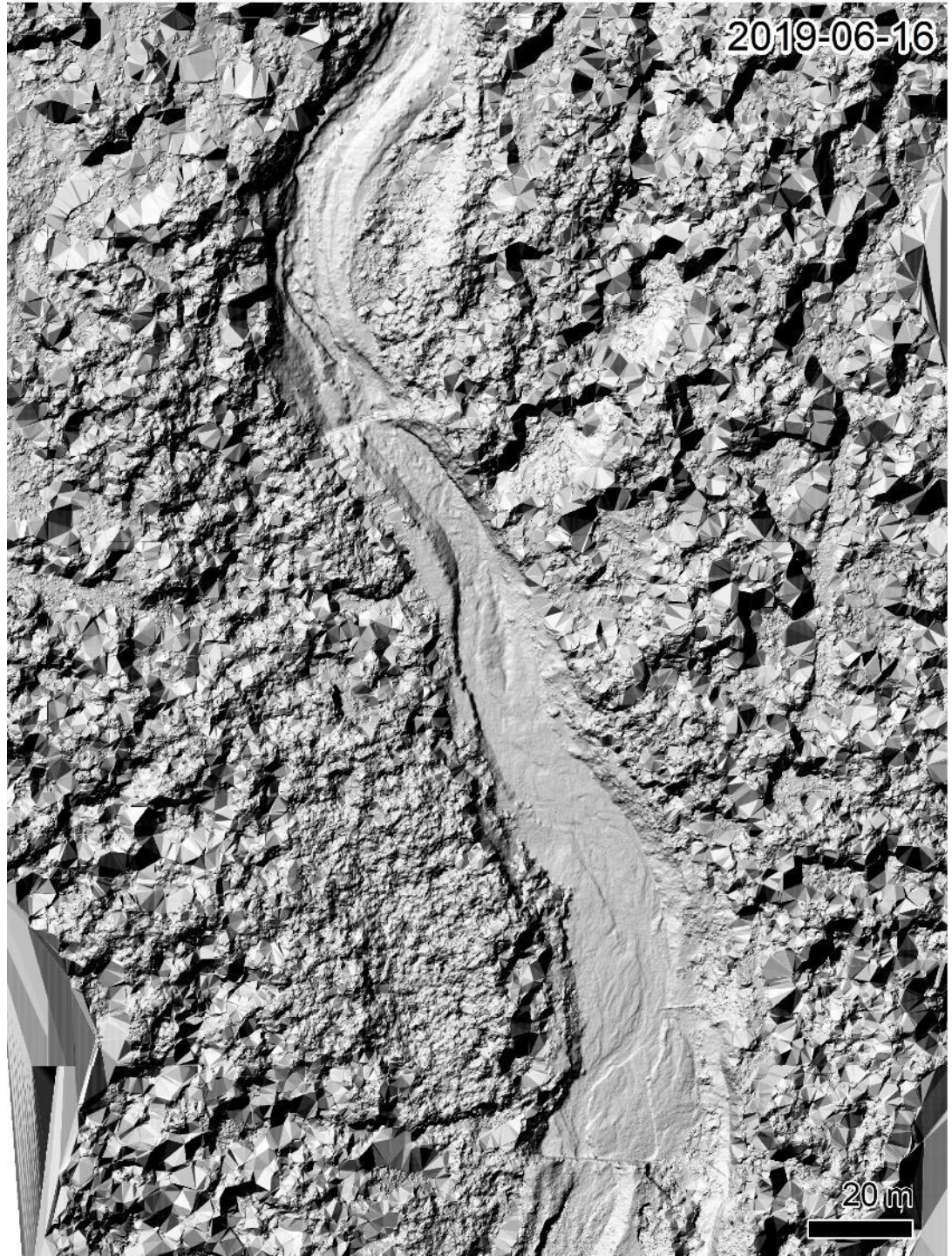

N
(a)
(b)
(c)
Mud-
lines
10 m
DoD
Segment
statistics

Flow hydrographs



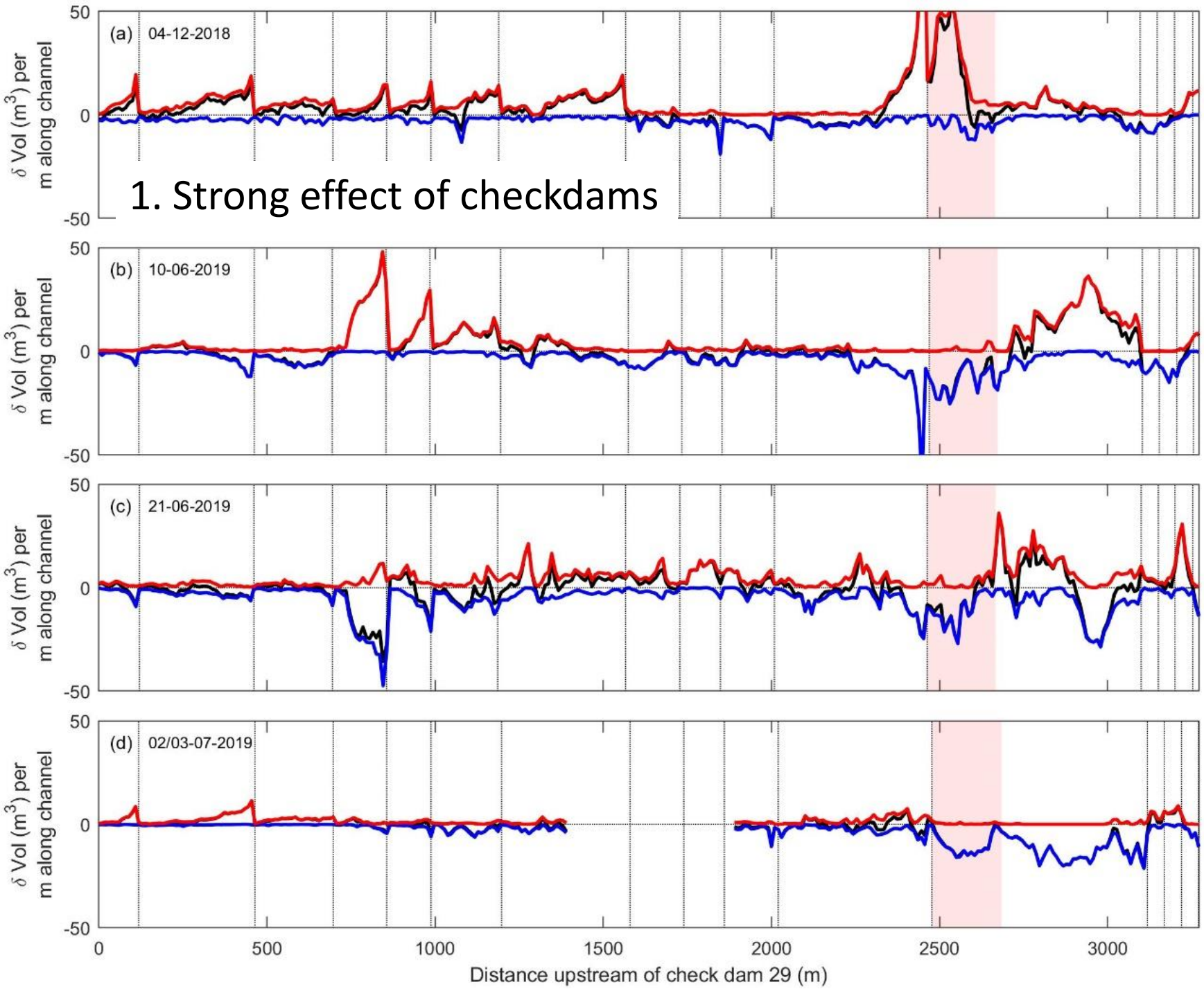
2018-11-08
20 m


2019-04-30
20 m

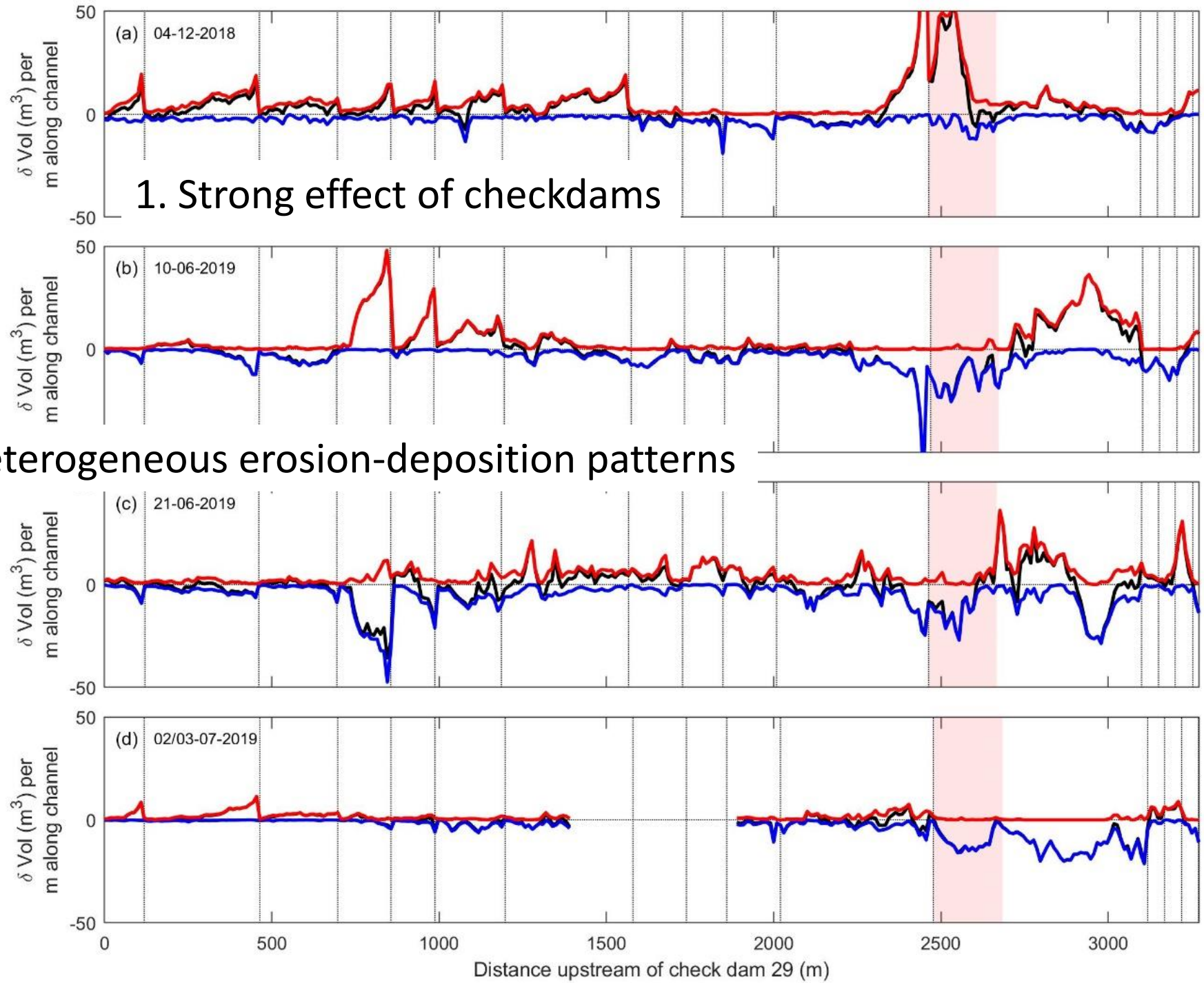

2019-06-16
20 m

2019-06-22
20 m

2019-07-04
20 m

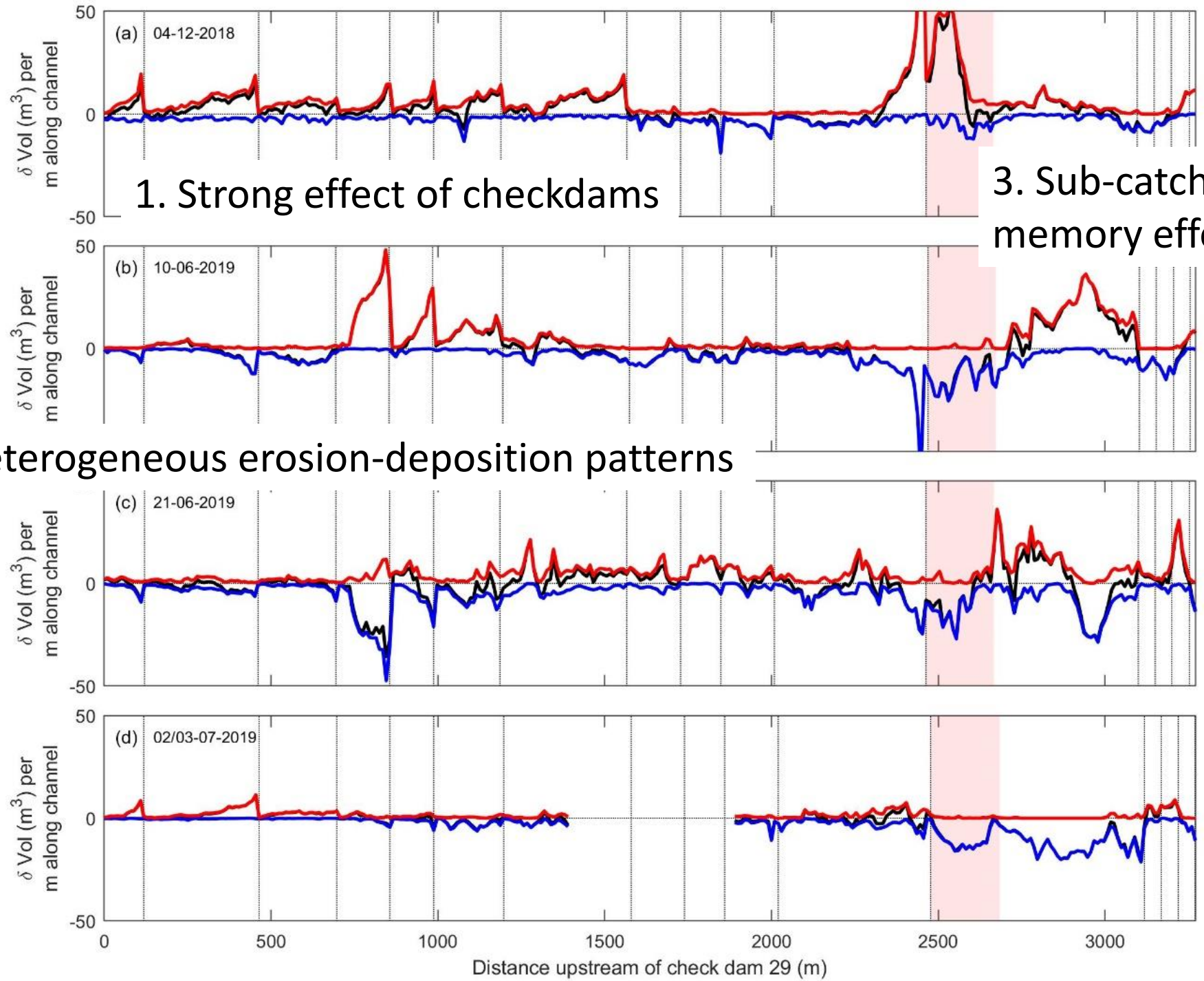


1. Strong effect of checkdams



1. Strong effect of checkdams

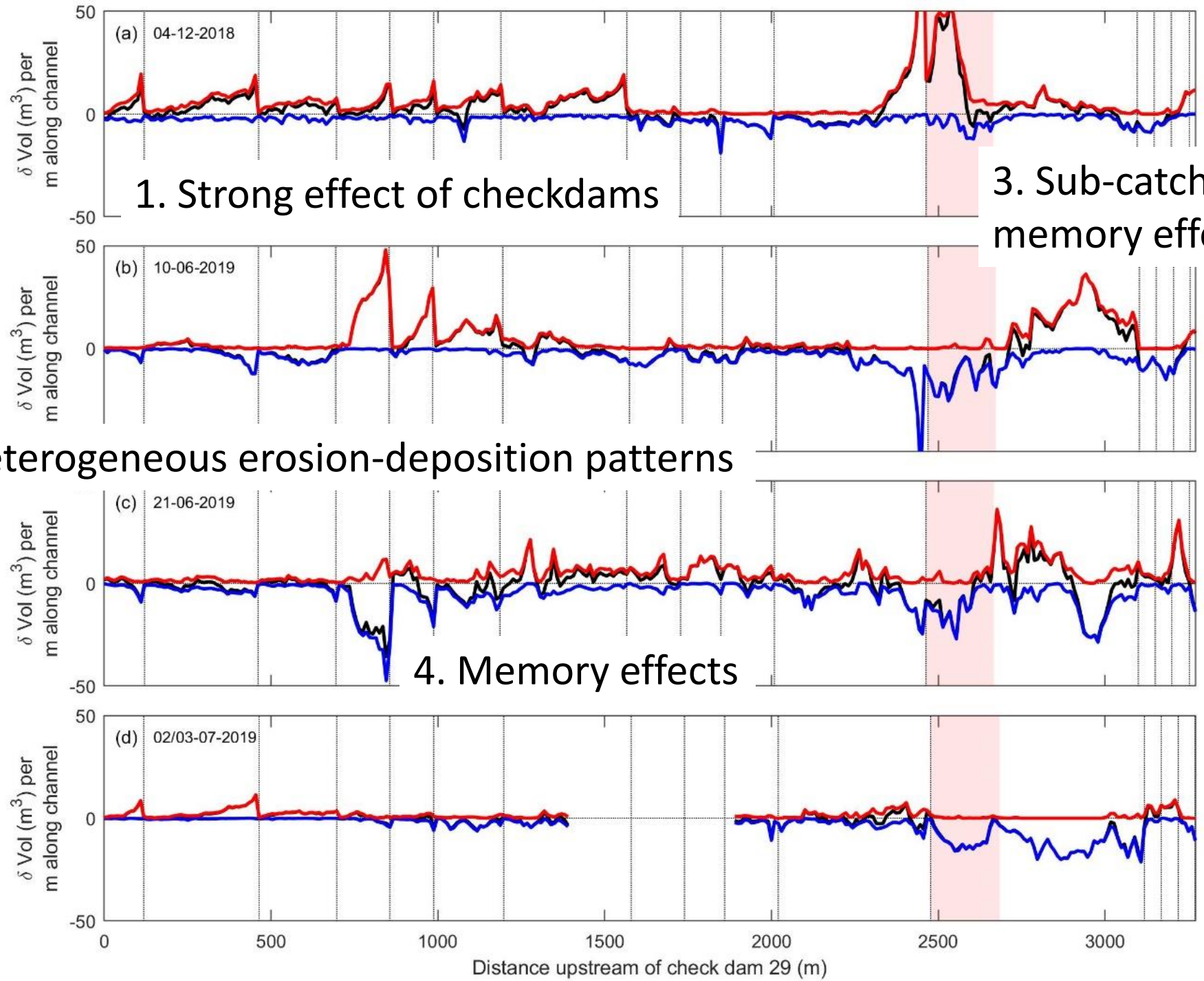
2. Heterogeneous erosion-deposition patterns



1. Strong effect of checkdams

2. Heterogeneous erosion-deposition patterns

3. Sub-catchment input & memory effects



1. Strong effect of checkdams

2. Heterogeneous erosion-deposition patterns

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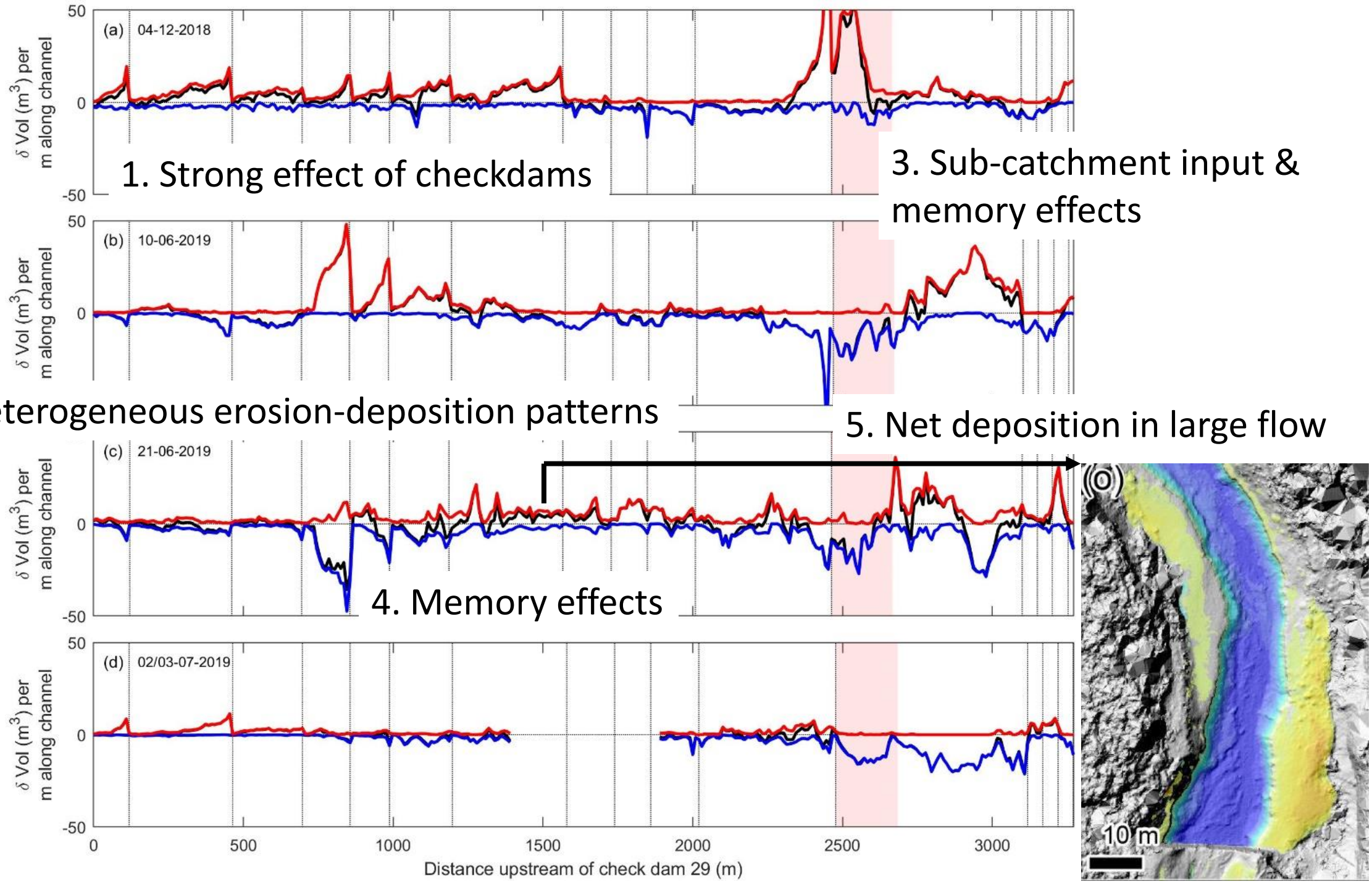
4. Memory effects


(a) 04-12-2018
(b) 10-06-2019
(c) 21-06-2019
(d) 02/03-07-2019
δ Vol (m³) per m along channel
50
0
-50
0
500
1000
1500
2000
2500
3000
Distance upstream of check dam 29 (m)
1. Strong effect of checkdams
2. Heterogeneous erosion-deposition patterns
3. Sub-catchment input & memory effects
4. Memory effects
5. Net deposition in large flow
10 m

Conclusions

- Erosion and deposition patterns can be highly heterogeneous
- Strong control on erosion and deposition of previously overlooked phenomena:
  - Memory effects
  - Sub-catchment inputs
  - Channel geometry
    - Net deposition in large flows
- Numerical models include erosion at best
  - Deposition should also be resolved!

- **Measurements continue! Relate flow properties at station to ero/depo**