Study on the Koshibu Dam sediment bypass tunnel operation based on sediment transport monitoring in upstream reaches

Étude sur l'exploitation de la galerie de dérivation des sédiments du barrage de Koshibu, basée sur la surveillance du charriage en amont

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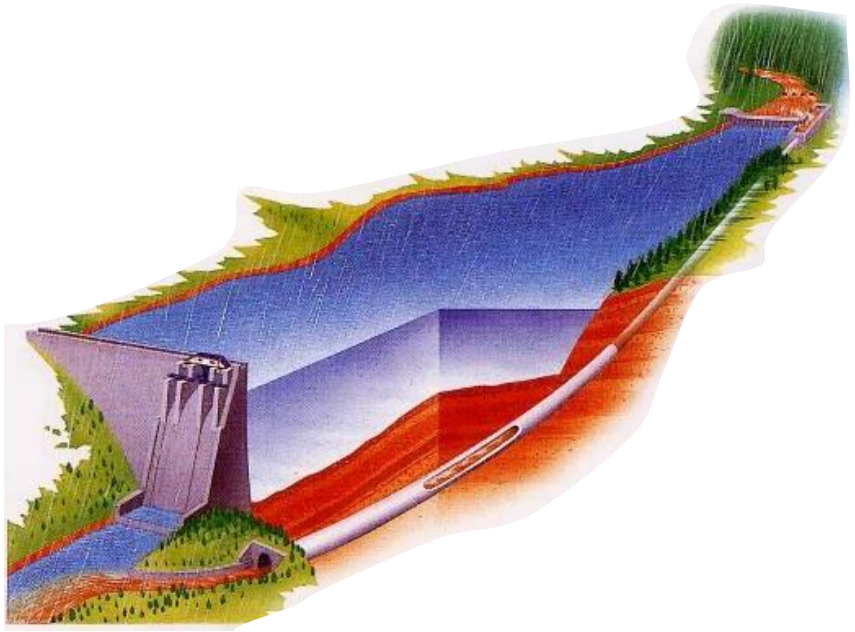
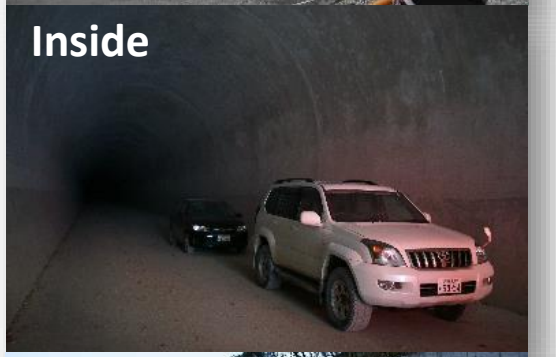
Sedimentation Bypass Tunnels (SBTs)

- SBTs are used to mitigate sedimentation in reservoirs
- SBTs effectively prevent sedimentation
- SBTs are still scarce worldwide (about 30)
  with Switzerland, Japan and Taiwan having the most



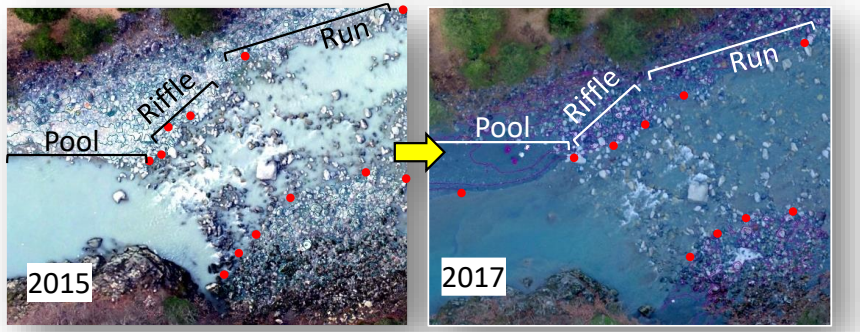


Research topics on SBT

- Evaluation of bypassing efficiency

- Abrasion control

- Environmental impact

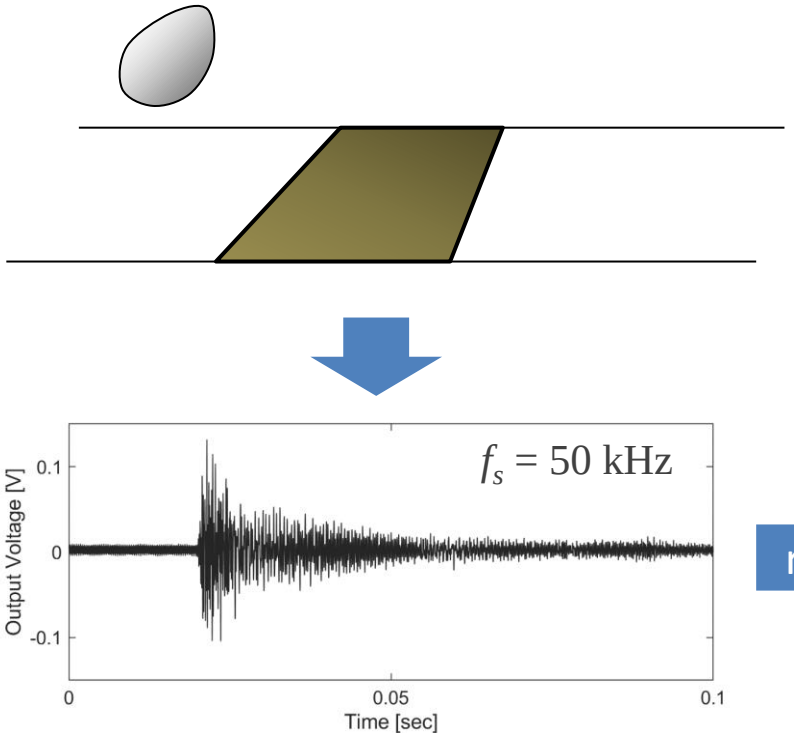


Before SBT After SBT

- Analyzing the properties of sediment transportation is needed to address these topics.
- We are developing bedload transport monitoring under high flow velocities.

Bedload monitoring system under high flow velocities

- The Impact Plate system records acoustic energy caused by gravel impact



regression

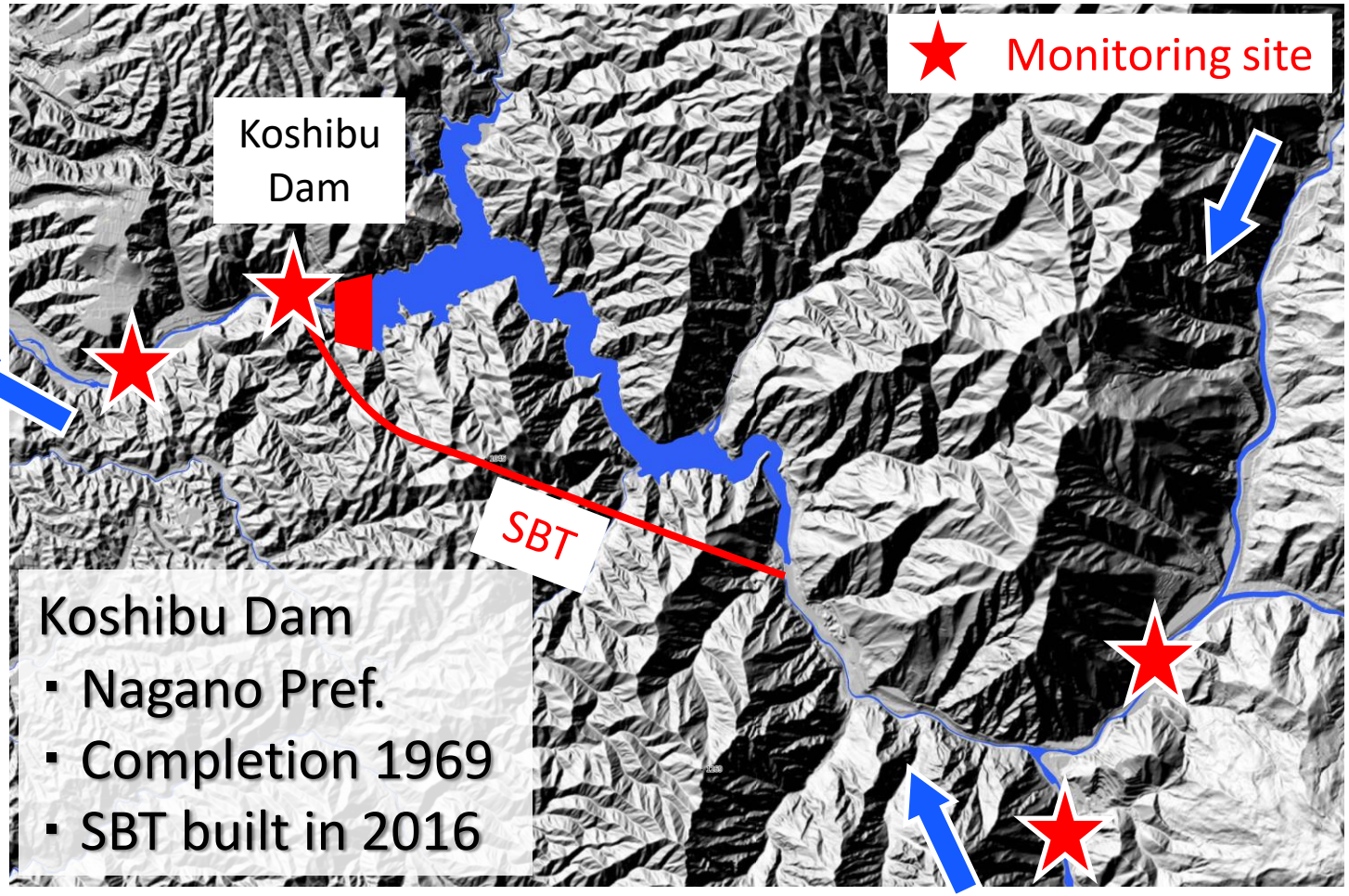
Bedload transport rate (BTR, [m^3/s])

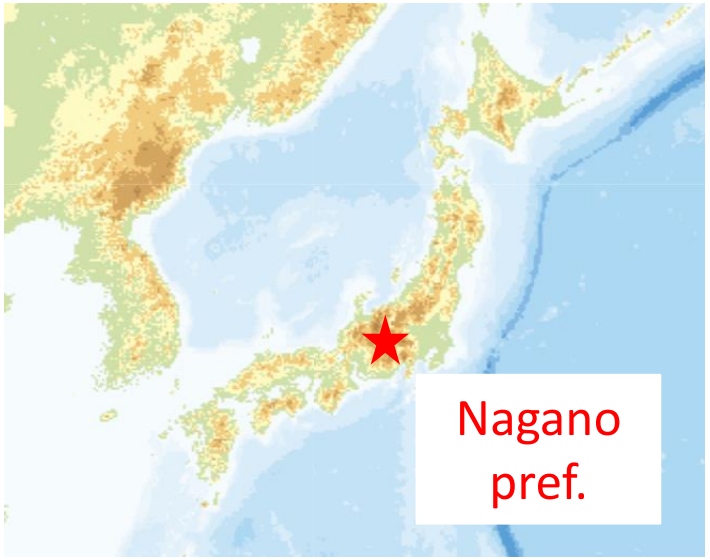
Top

Back side

- Analyze the raw signal to extract the information of sediment transport

Bedload monitoring field: Koshibu SBT





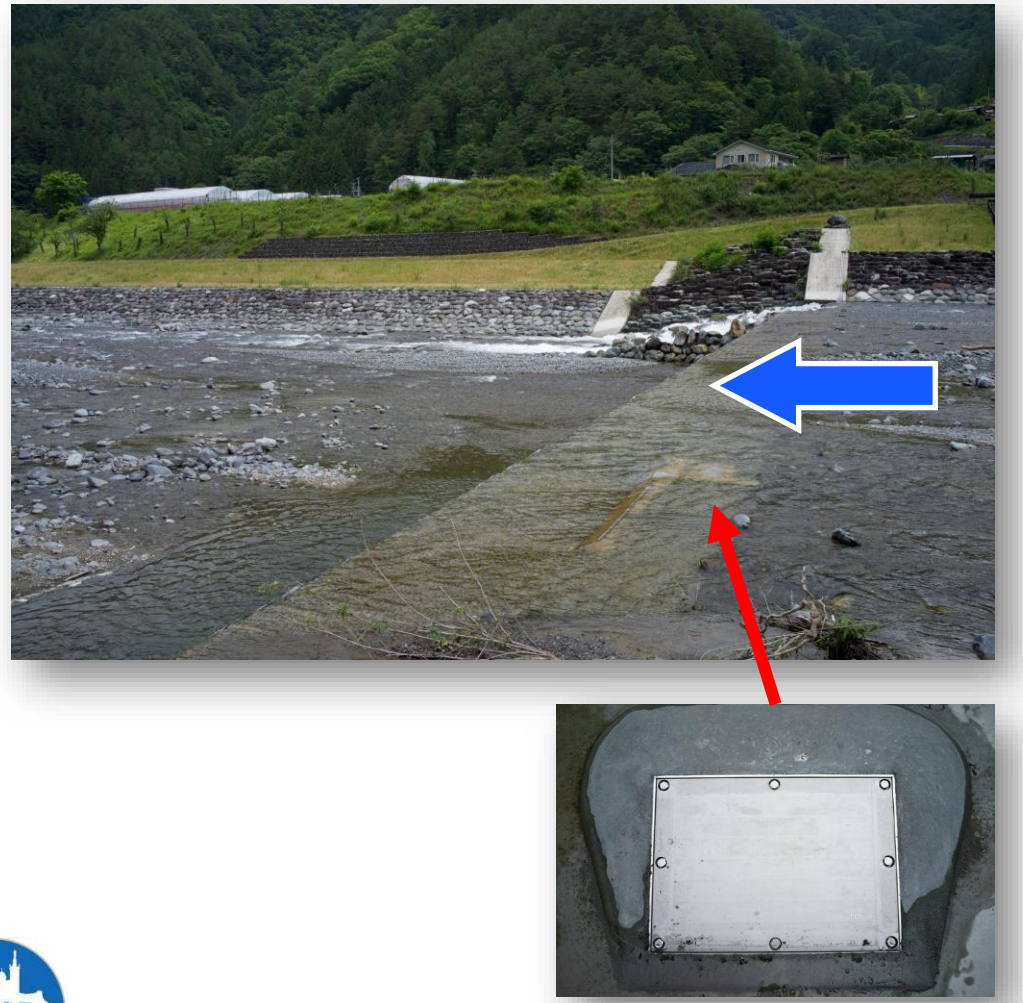
Width: 6.6 m
Length: 4000 m

Inclination: 1/50

Height: 7.5 m

Max: Discharge 370 m^3/s
Velocity 20 m/s

Ogawara monitoring site: upstream of the SBT

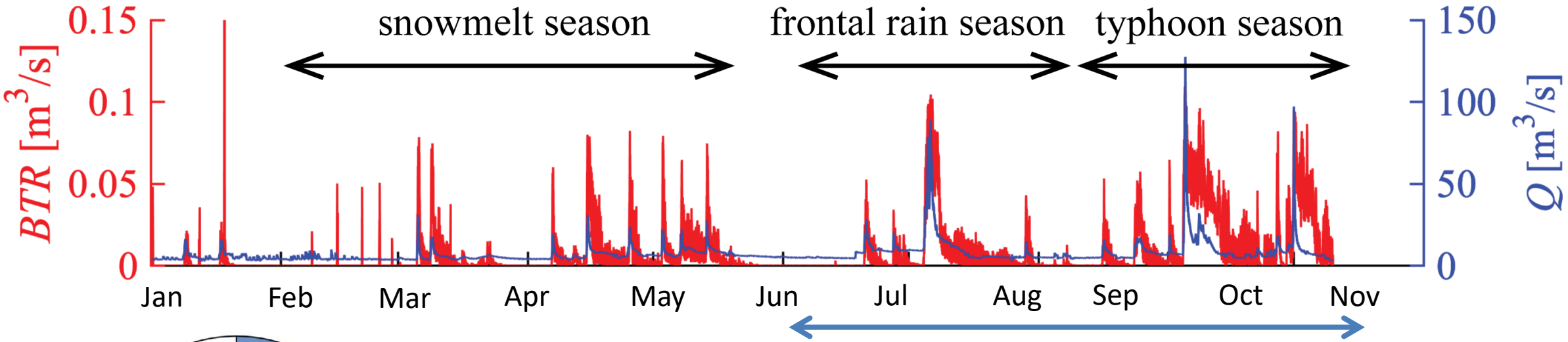


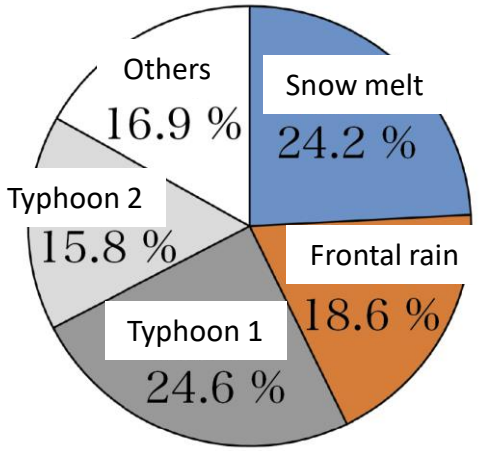
Monitoring contents

- flow depth
- flow velocity
- flow discharge (*Q*)
- bedload transport rate (*BTR*)
- turbidity

➢ This presentation reports monitoring results obtained in 2018

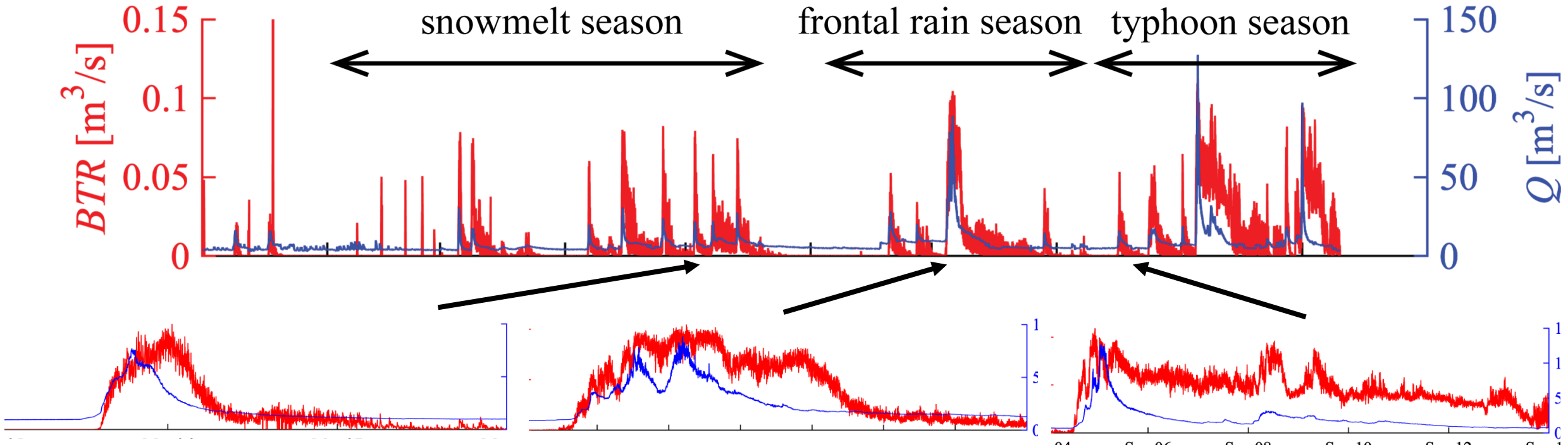
Hydrograph and BTR in 2018





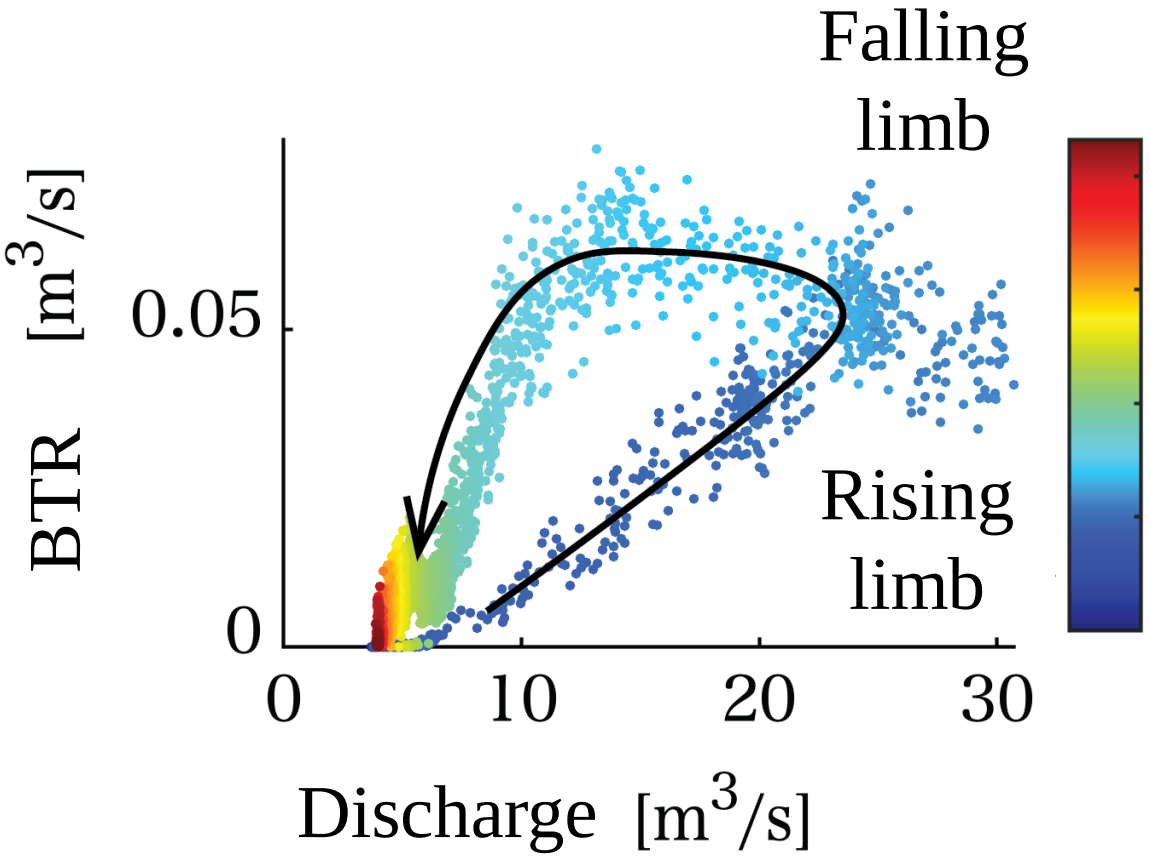
- The SBT is operating only during frontal and typhoon season currently, But sediment inflow during snow melt season should not be ignored.

BTR behavioural characteristics: time series



- Minor lag between hydrograph and BTR,
  most probably because the catchment is close to the source of sediment production

BTR behavioural characteristics: Hysteresis



- Anti- clockwise hysteresis
- Currently the

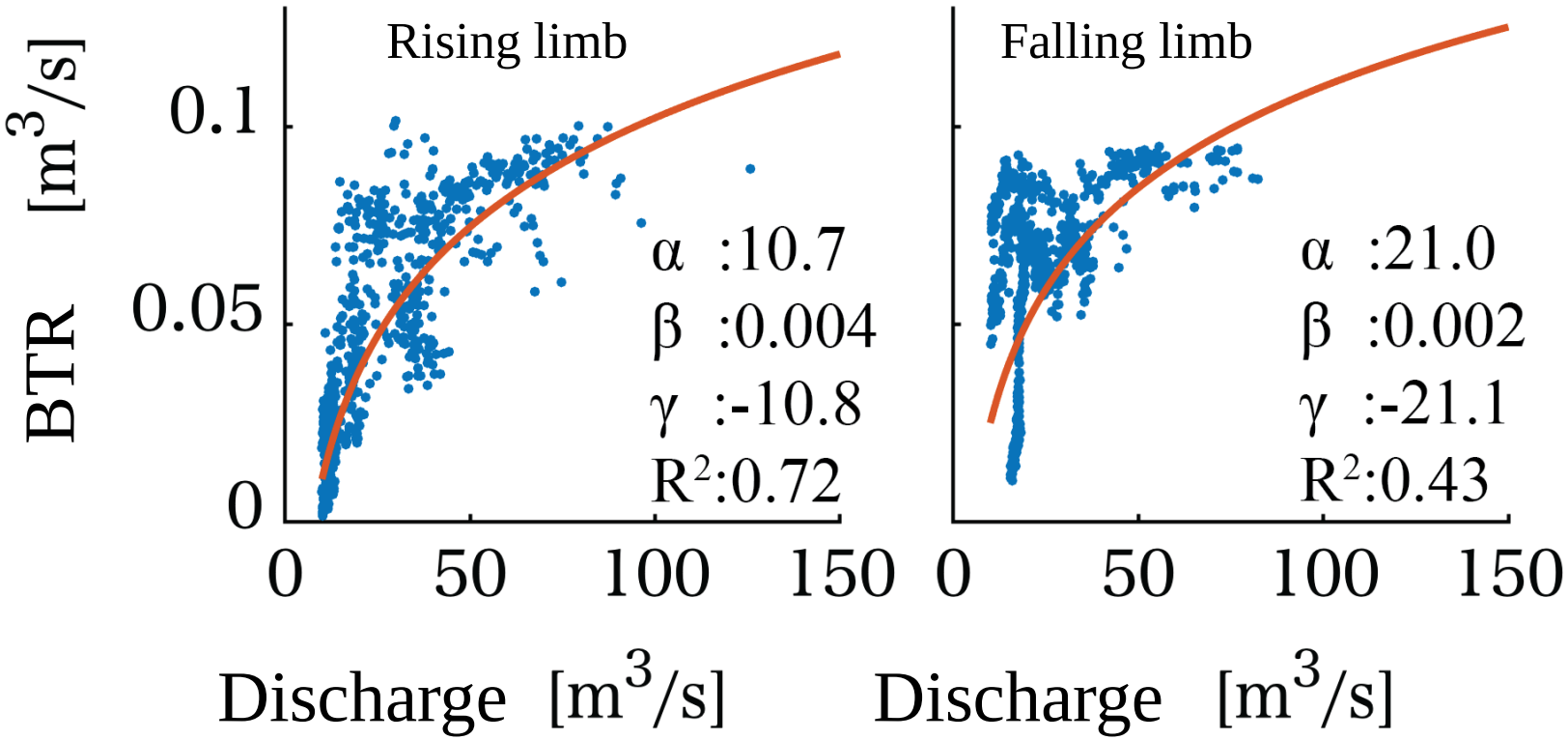
$$BTR = \alpha Q^{\beta}$$

form of BTR estimation formula is used in this river.

But the results imply more complicated behavior in the relationship between Q and BTR that the formula is unable to express.

BTR regime characteristics: BTR prediction

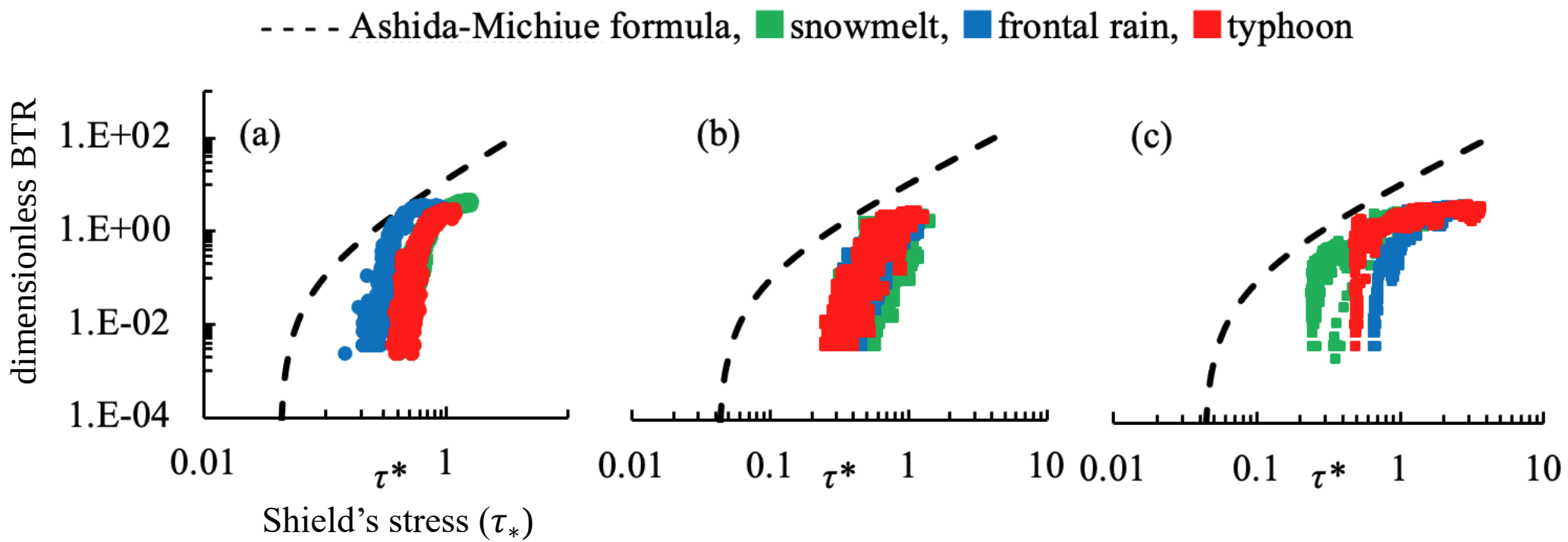
- We recommend separating the falling and rising limbs alternatively increase the higher numbers of parameters.



For example,

$$BTR = \alpha Q^{\beta} + \gamma$$

Comparison of observed and equilibrium BTR



- BTR is quite high which reaches equilibrium BTR.
- This is attributed by the huge fault located in the Koshibu Rivers, where sediment production is quite active.

Conclusion

- We are monitoring bedload transport around the Koshibu SBT

- Impact Plates are widely applicable for small and mid-scale floods to large-scale floods.

- Upstream Bedload monitoring of the SBT provided hints for SBT management;

  ✓ The SBT is located close to the source of sediment production and the volume of sediment is as high as equilibrium sediment production .

  ✓ Koshibu SBT is not used in winter, but the total volume of sediment yield from snowmelt runoff accounts for 25 % of the annual sediment inflow, so operation during winter worth being considered.

  ✓ The correlation between *Q* and *BTR* presenting hysteresis cannot be regressed by exponential regression.

Thank you

Merci

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