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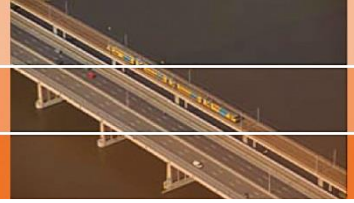
Enabling Delta Life

Reservoir Sedimentation (modelling) Crash course (Delft3D FM)

Sanjay Giri and Amgad Omer

Royal HaskoningDHV

Program



13:00 – 13:30 Welcome and Introduction

13:30 – 15:00 Model setup - simulation

15:00 – 15:30 Model results visualization

15:30 – 16:00 Wrap up and outlook

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GREETINGS
WELCOME
HELLO
HI
HOWDY
GLAD YOU'RE HERE

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Introduction

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Reservoir sedimentation

Reservoir Storage Loss: A Global Concern

- ✓ ~50% Storage Loss by 2050
- ✓ ~100% within 200 to 300 years

(ICOLD, 2009)

- ✓ Water & Energy Demand
- ✓ Flood Management & Risk
- ✓ Safety Concerns

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Reservoir sedimentation

Sediment-induced problems in reservoirs are more than the storage loss only…

Safety issue

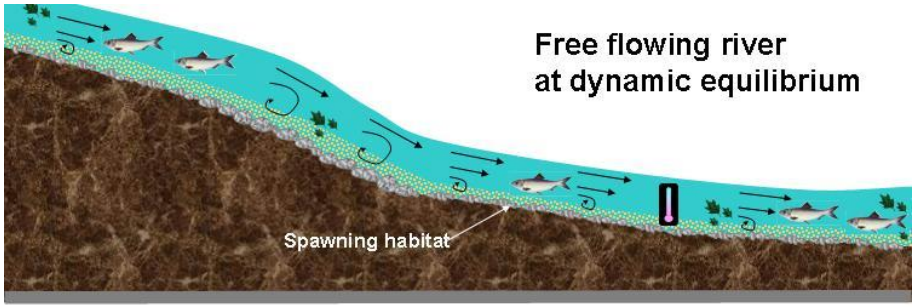
Abrasion and damages of structures and apparatuses

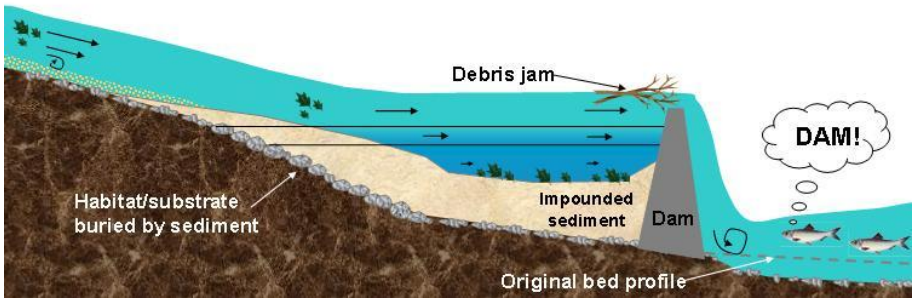
Downstream erosion

Reservoir sedimentation

Sediment-induced problems in reservoirs are more than the storage loss only…

Environmental/ecological





Graphic courtesy of American Rivers

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Guidelines

Assessment

What cannot be measured, cannot be managed!

Management

When you can't solve the problem, manage it!

Monitoring & Adaptation

Sediment assessment

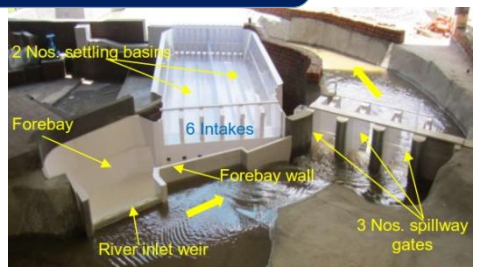
Ground measurements/monitoring

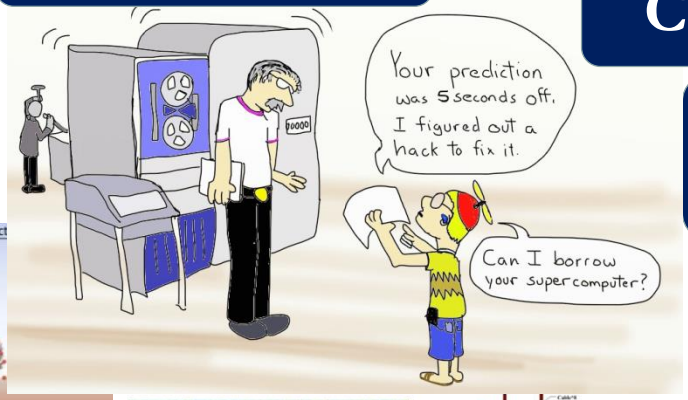
Remote sensing/satellite imagery

Calculations

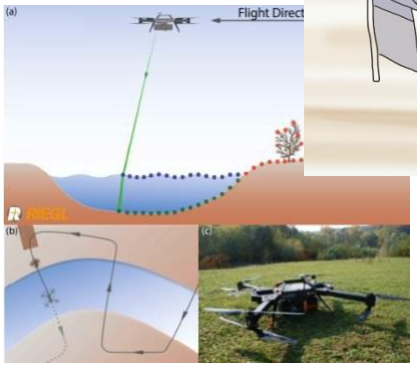
Computational modelling

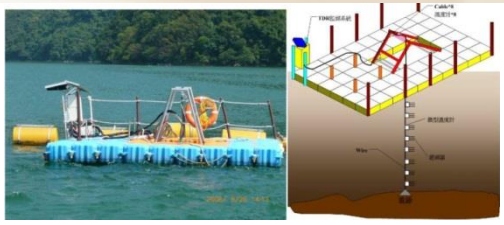
Physical modelling

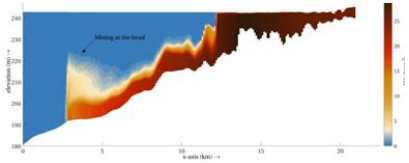


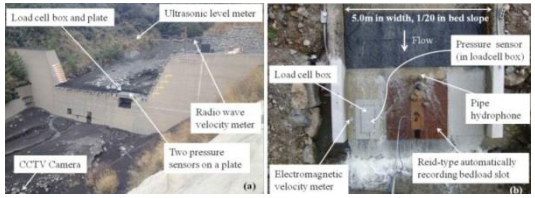


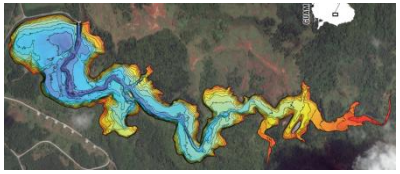
Professional judgement

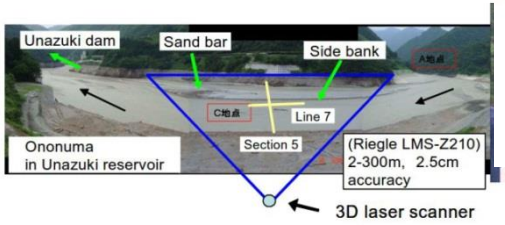












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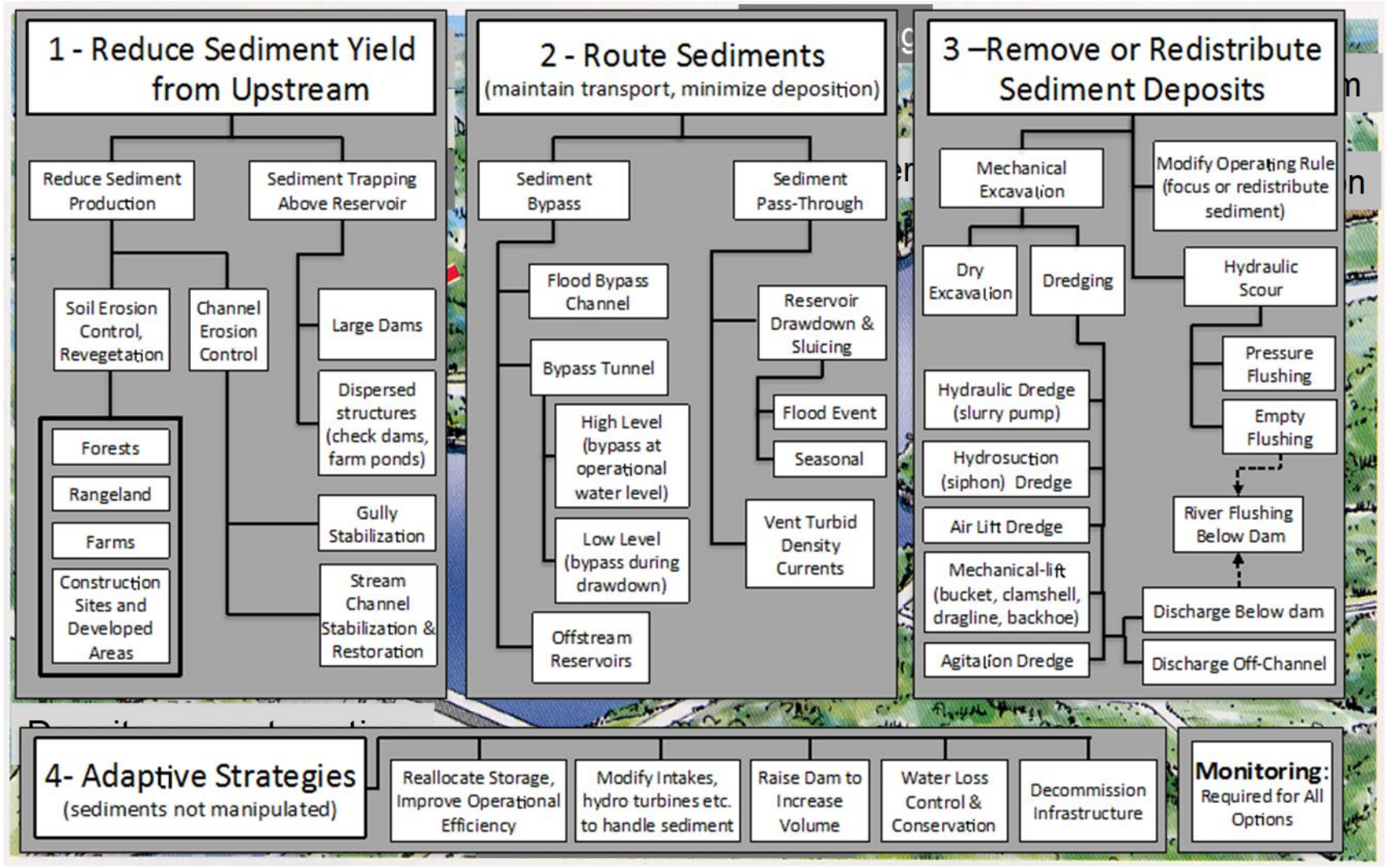
Sediment management practices



Morris (2015)

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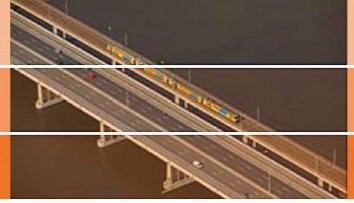
A word on Trap Efficiency



- The trap efficiency of a reservoir is the ratio of incoming sediment load that is retained in the reservoir, to the total inflow of river sediments:

$$E = \frac{Y_s(\text{in}) - Y_s(\text{out})}{Y_s(\text{in})}$$

E = trap efficiency (decimal)

Ys = sediment yield in weight units

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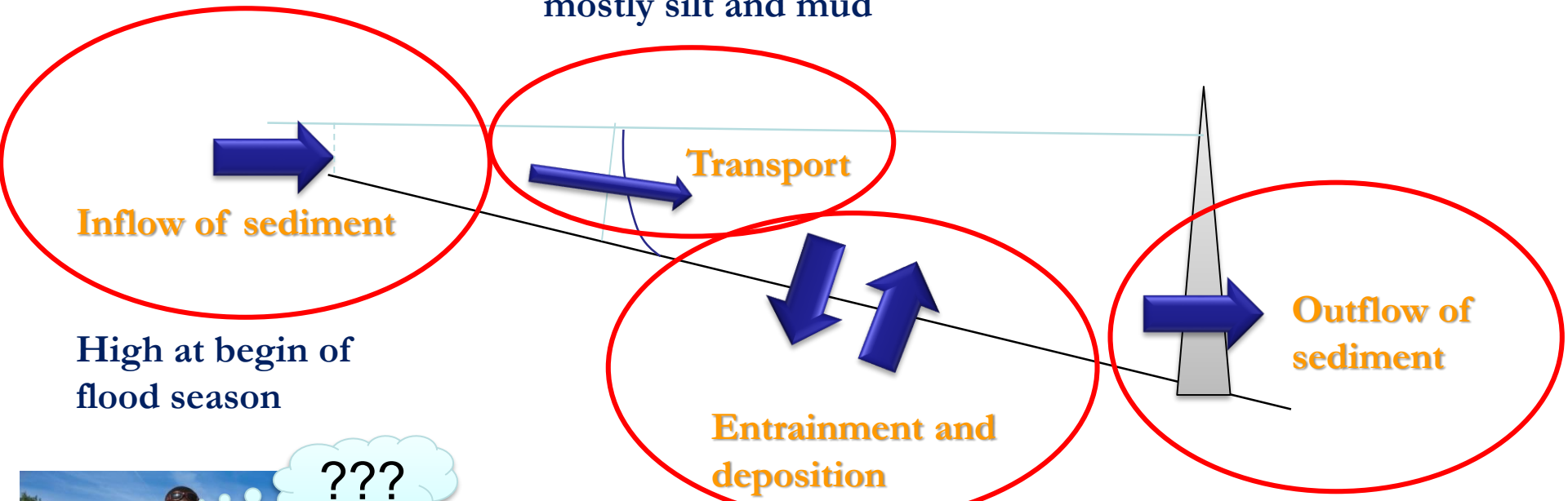
Sediment transport

Basic processes

High velocity and turbulence: much transport mostly silt and mud



High at begin of flood season

Gradual increase of flood levels

High shear stress: net entrainment
Low shear stress: net deposition

Releasing through the main outlets

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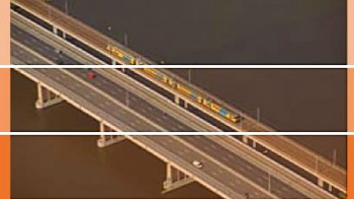
Sediment transport



SUPPLY DRIVEN

Sediment fractions:

- Fine sediments: suspended-sediment modelling using advection-diffusion approach (with *Krone/Partheniades* entrainment and deposition terms)
- Coarse sediments: also include bed-load transport (transport model of *Van Rijn, EH, MPM,…*)

Fractions in Delft3D & FM models:

- silt/clay, fine sand, coarse sand, gravel

Local shear stress

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Exercise :Model setup and Simulation

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1. Study Area: Funagira Dam

- 1977
- 9 Gates
- 3 Turbines
- Last dam in the Tenryuu cascading system

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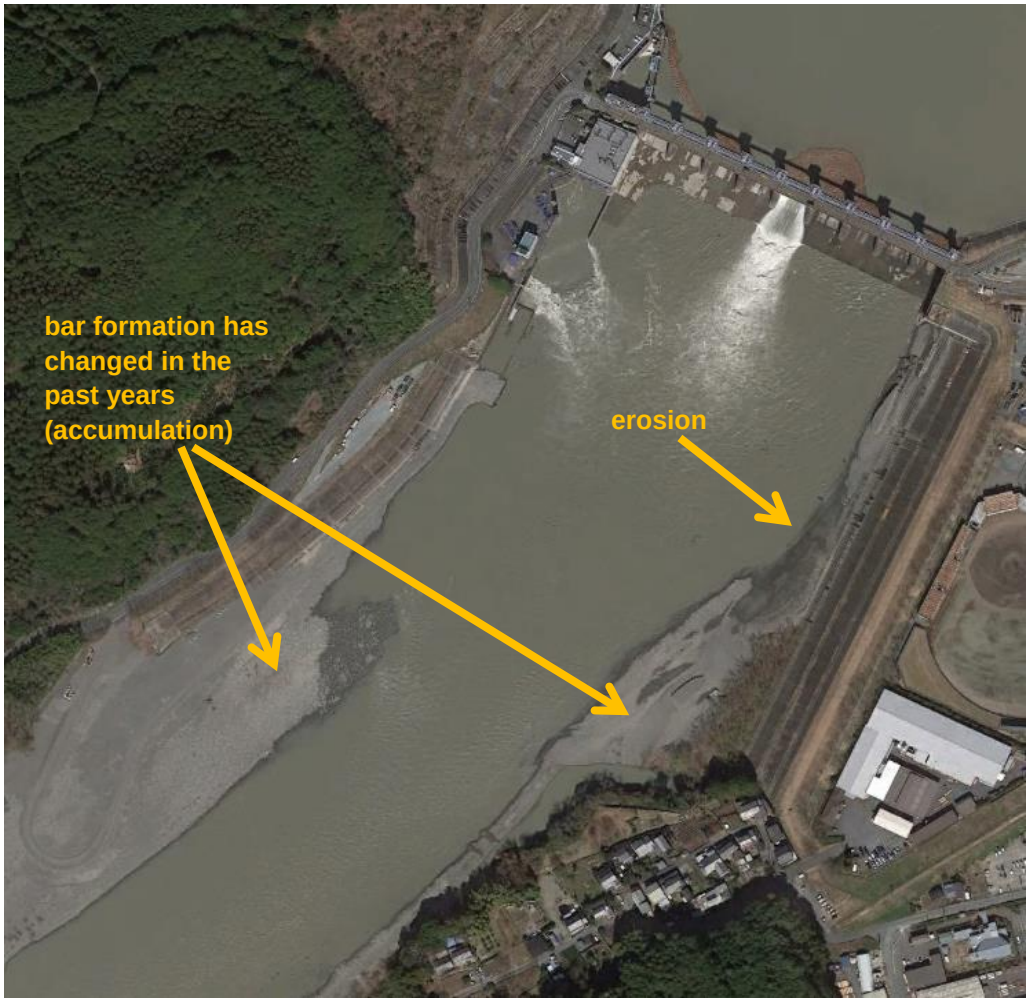
2. Inquires

- Two Gates operation patterns:
  - Pyramid shape pattern (old)
  - Equal shape pattern (new)
- Flushing Efficiency _ high flood peaks
- DS _ erosion/deposition.



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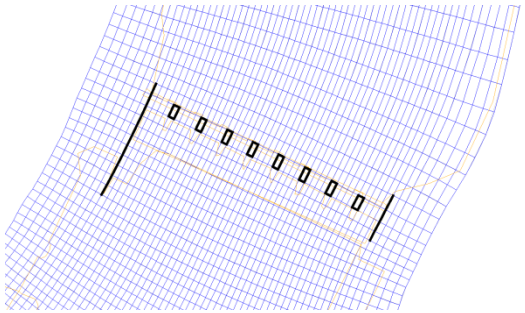
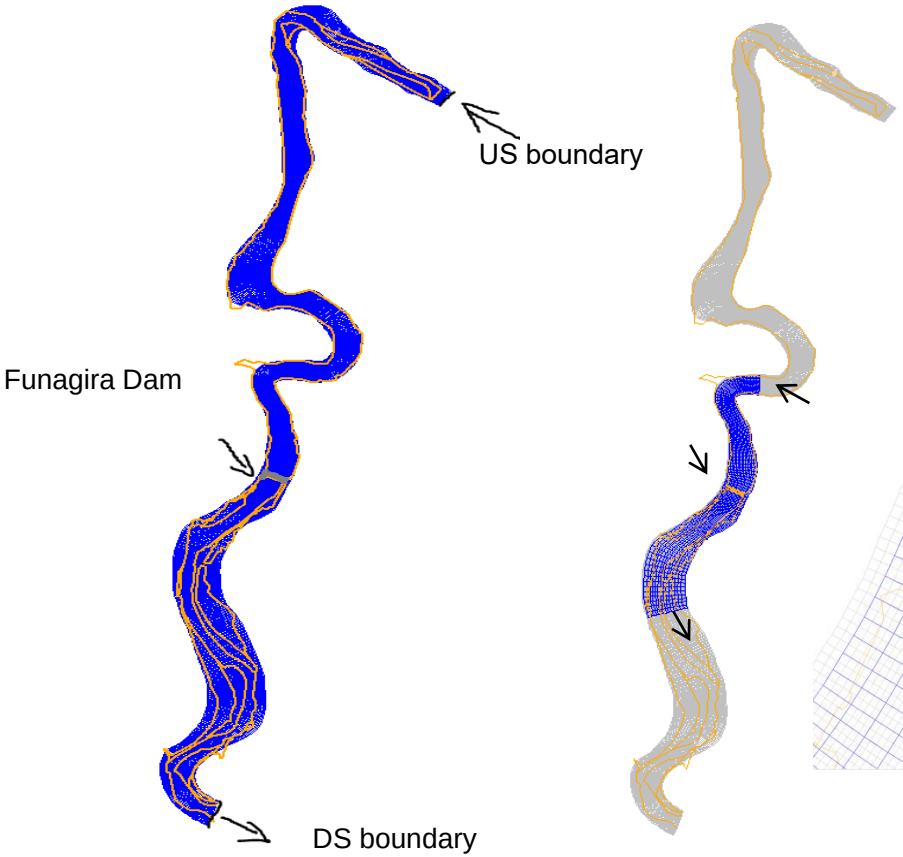
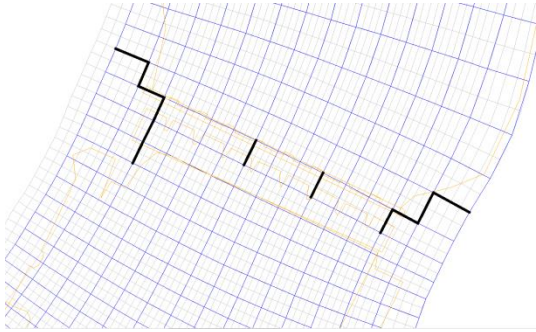
Exercise

1. Exercise (1) Model Set up: Grid







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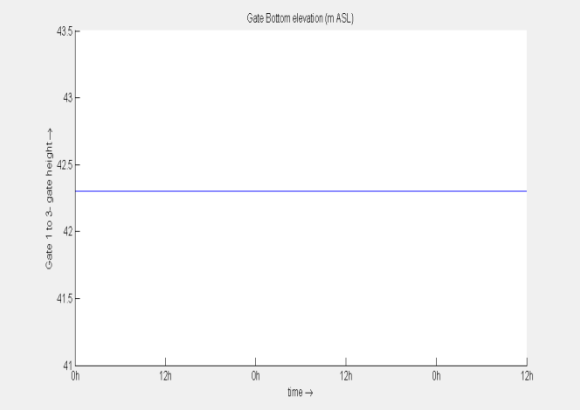
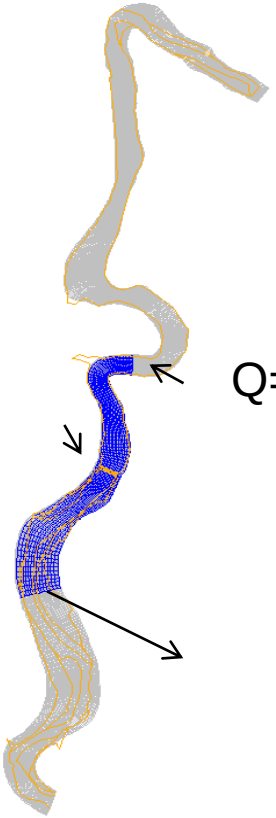
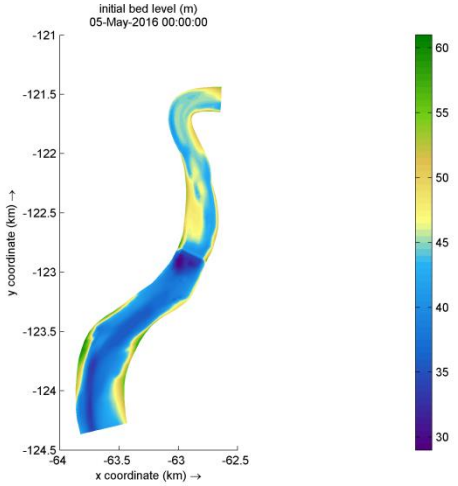
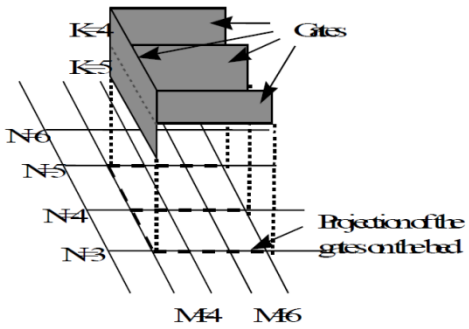
1. Exercise (1) Model Set up: Boundaries

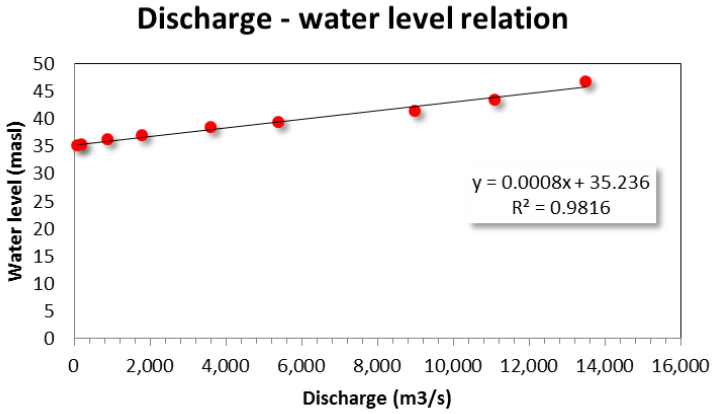




Q= 3100 m3/s







Let us set the ball rolling

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