Numerical simulation of 2D flow and sediment transport at a river entrance

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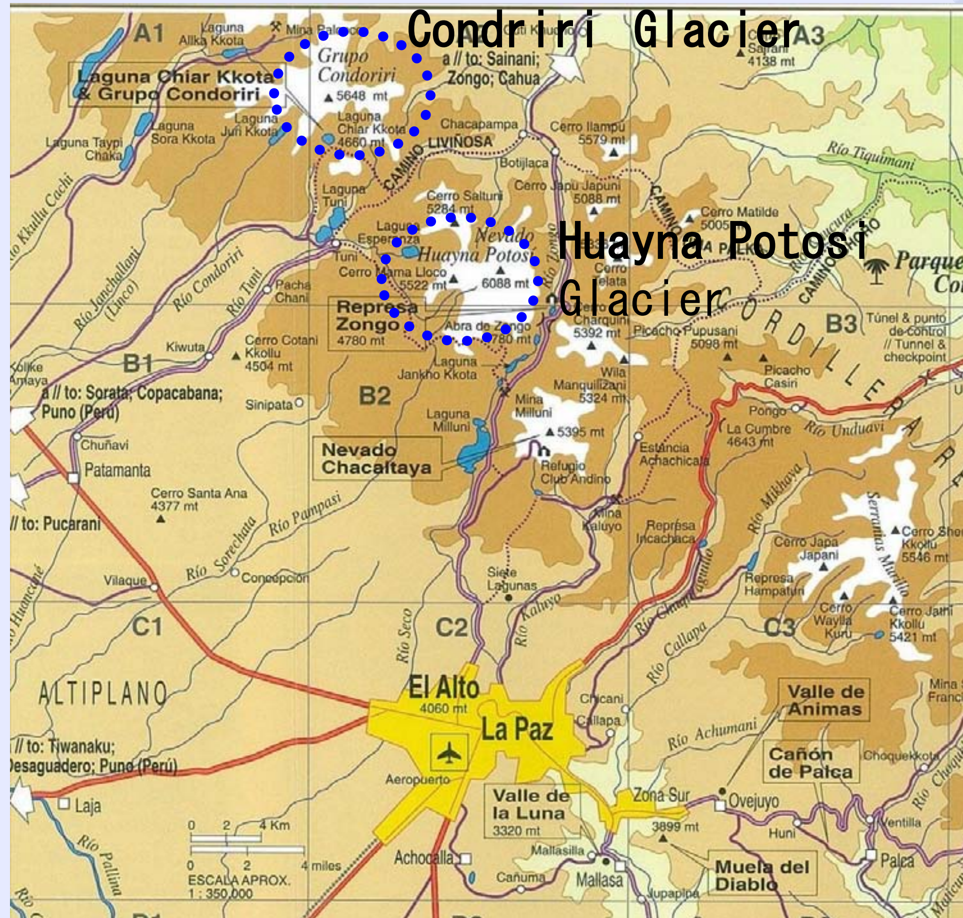
TOHOKU University

1. Introduction



Research Framework

Goup1 Snow and Ice	Group2Runoff	Group3 Sediment	Group4 Water Quality	Group5 Management

Instituto de Hidraulica e Hidrologia (IHH)
Universidad Mayor de San Andres (UMSA)

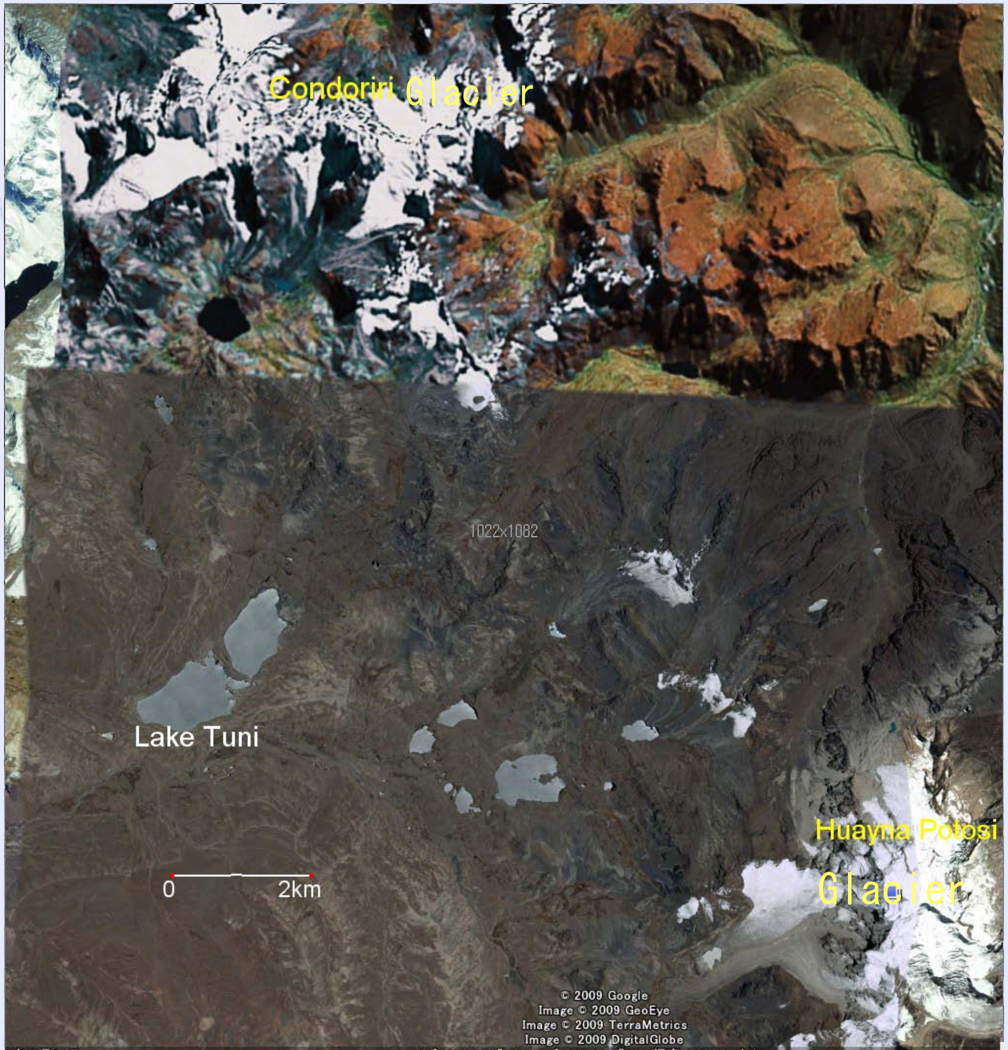
MC & Ph.D. students, researchers

Tohoku University (TU)

Tokyo Institute of Technology

Fukushima University

SEDIMENTATION STUDY



Climate change

↓

Glacier retreat

↓

Runoff process

↓

Sediment yield

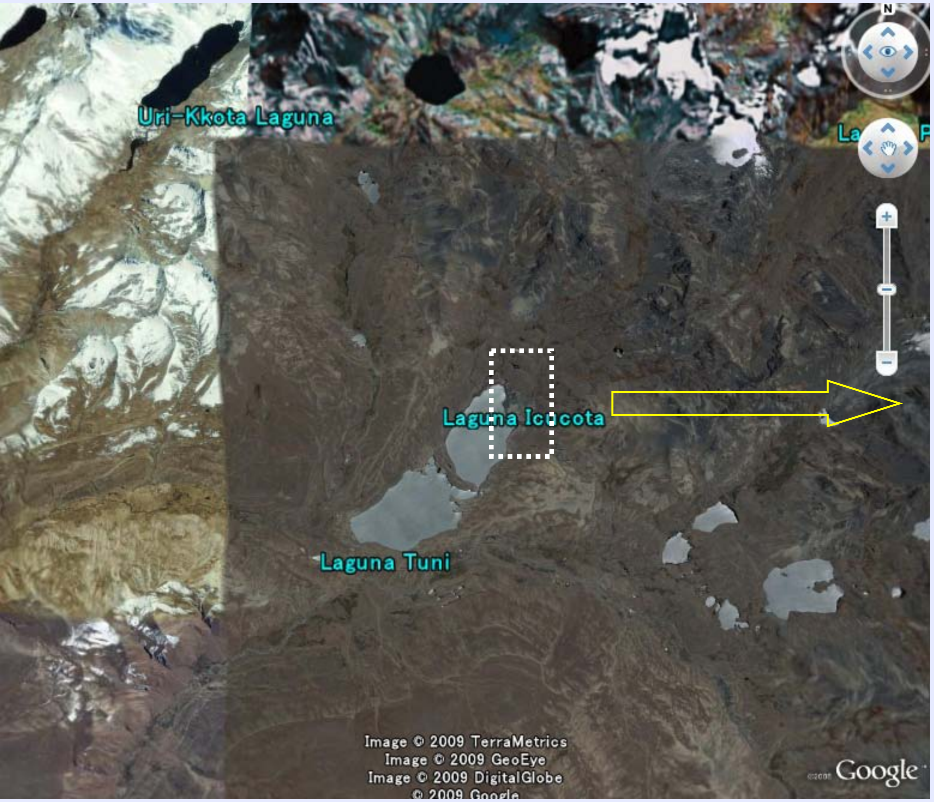
↓

Sediment transport

↓

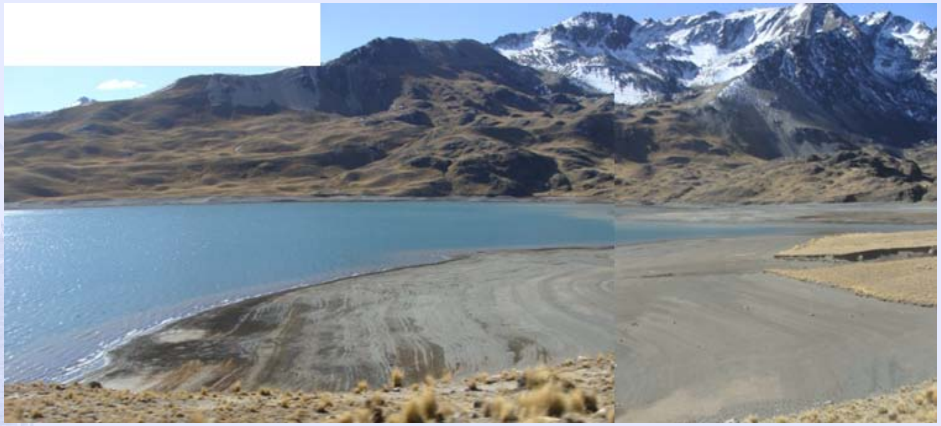
Sediment deposit

Sediment deposit in Lake Tuni(1)



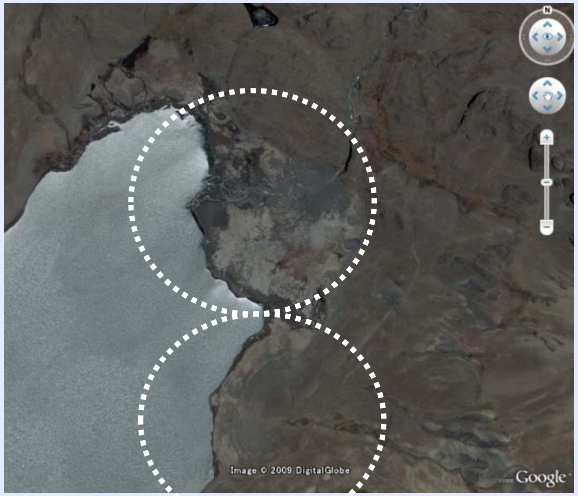
Objective:
Mathematical modeling of fluvial fan development in a reservoir -its modification due to climate change-

Sediment deposit in Lake Tuni(2)



Tuni River

Sediment deposit in Lake Tuni (1)



Sediment deposit in Lake Tuni (2)

Sediment deposit in a glacier lake

Huayna Potosi Glacier, Sep. 2010

Sediment deposit in a glacier lake

Sand terrace development in a lake (1)

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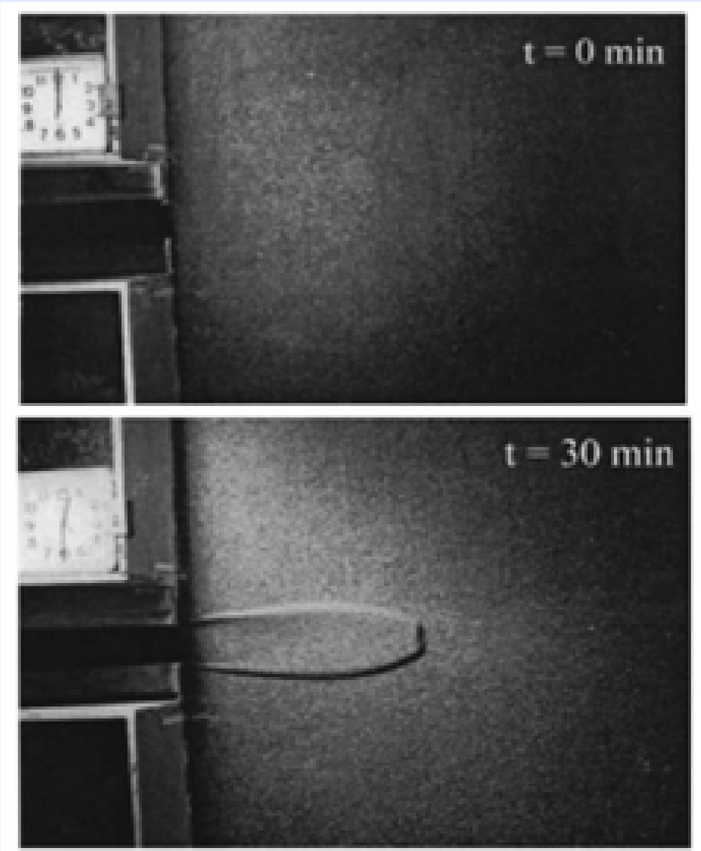
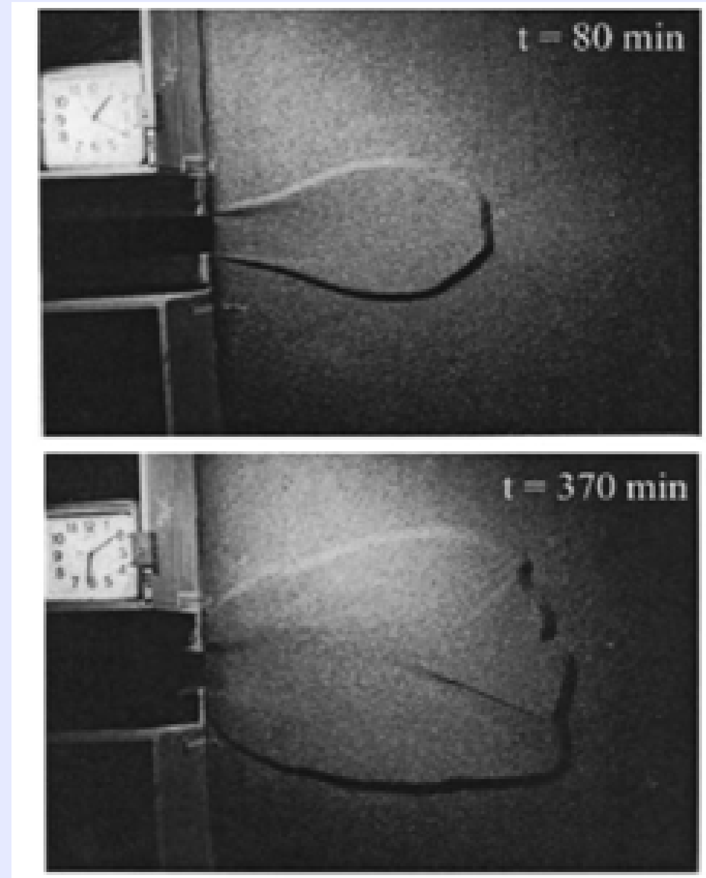


(1)

(2)

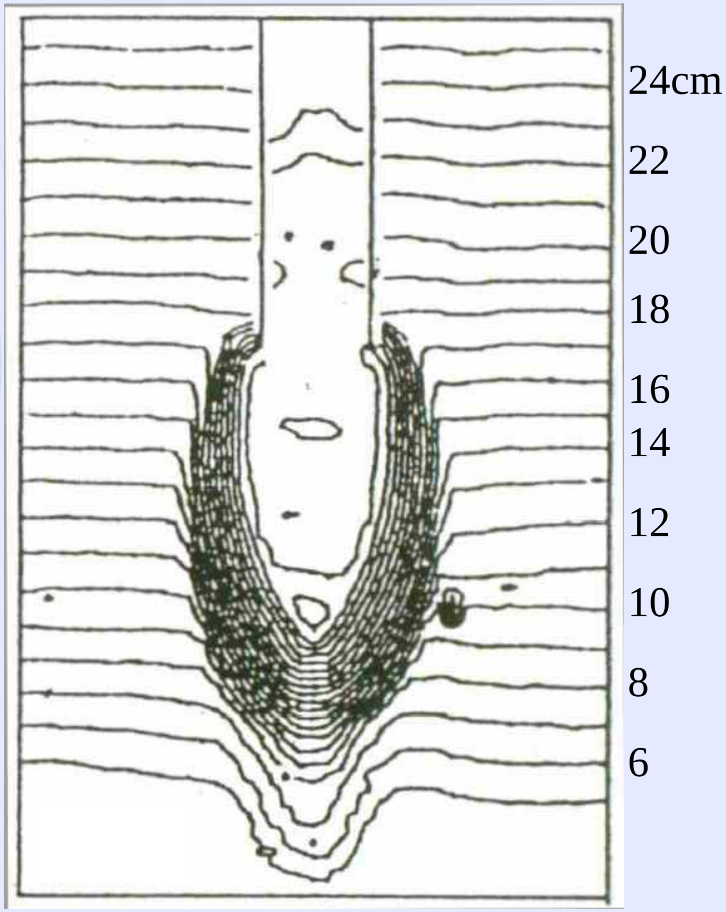


(3)

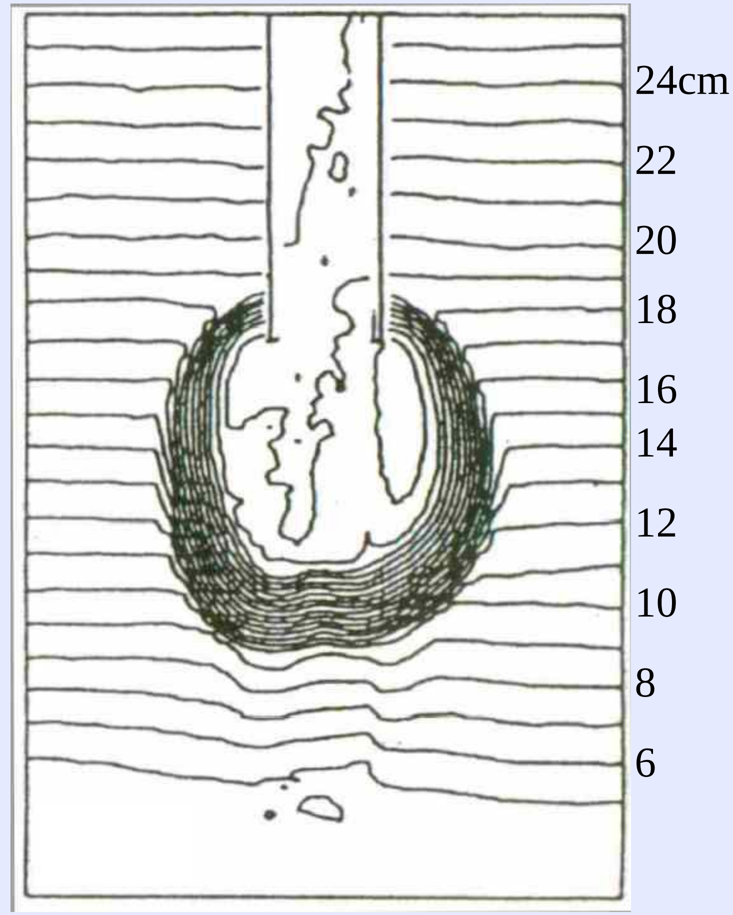
(4)

(Tseng et al., 2007)

Sand terrace development in a lake (2)



(a) Case J



(b) Case K

(Tanaka, 2010)

2. Numerical simulation method

- Conservation equations for mass and momentum

$$\frac{\partial \eta}{\partial t}+\frac{\partial M}{\partial x}+\frac{\partial N}{\partial y}=0$$

$$\frac{\partial M}{\partial t}+\frac{\partial}{\partial x}\left(\frac{M^2}{D}\right)+\frac{\partial}{\partial y}\left(\frac{MN}{D}\right)+gD\frac{\partial \eta}{\partial x}+\frac{\tau_x}{\rho}=0$$

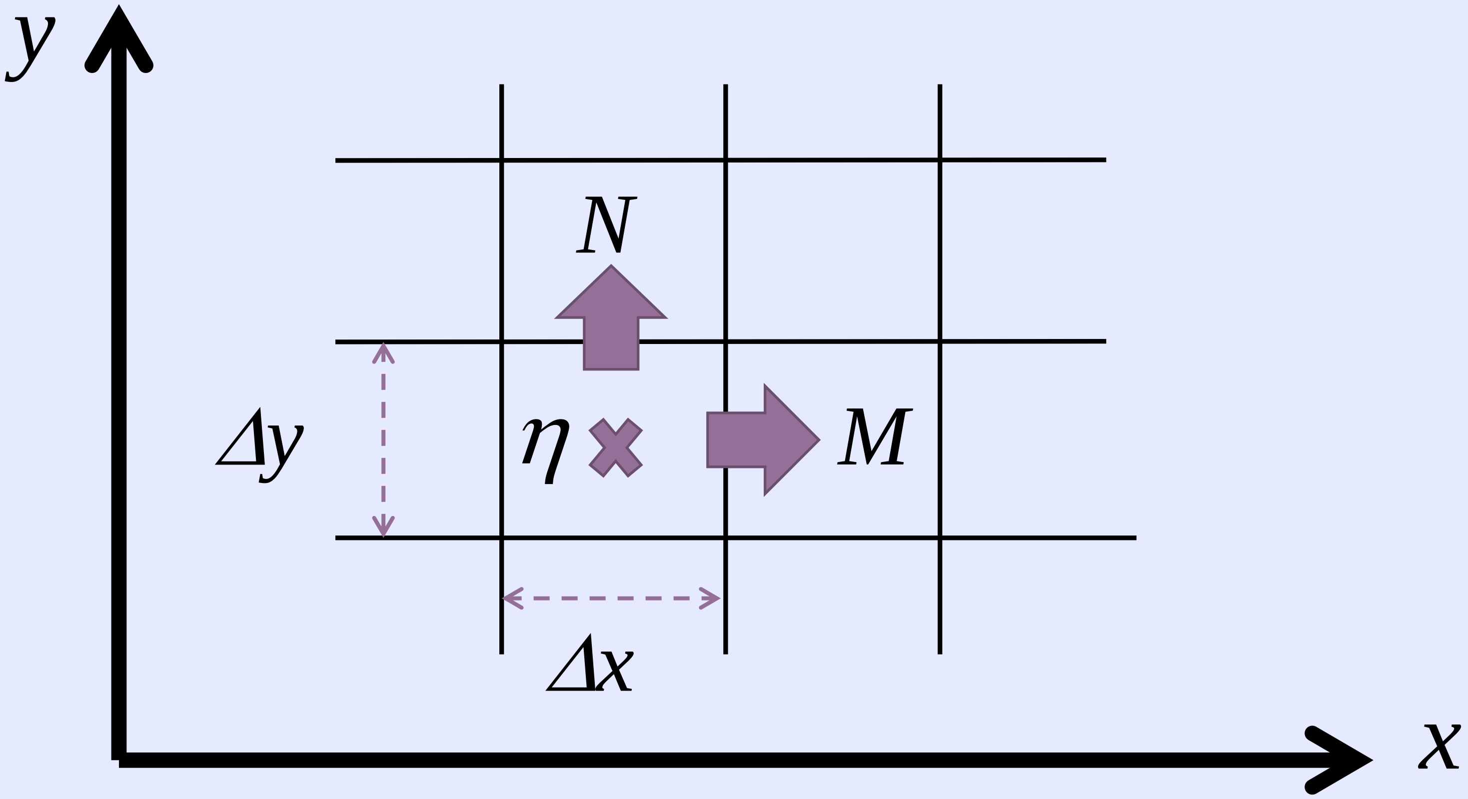
$$\frac{\partial N}{\partial t}+\frac{\partial}{\partial x}\left(\frac{MN}{D}\right)+\frac{\partial}{\partial y}\left(\frac{N^2}{D}\right)+gD\frac{\partial \eta}{\partial x}+\frac{\tau_y}{\rho}=0$$

η : the water level above the still water elevation, t : the time, x and y the horizontal coordinates, M and N the flow flux per unit width in x- and y-direction, respectively, g the gravitational acceleration, D the total water depth ($D=h+\eta$, h: still water depth), and n is Manning' s friction coefficient. Using M, N and η

- Bottom shear stress

$$\frac{\tau_x}{\rho} = \frac{gn^2}{D^{7/3}} M \sqrt{M^2 + N^2}$$

$$\frac{\tau_y}{\rho} = \frac{gn^2}{D^{7/3}} N \sqrt{M^2 + N^2}$$



◆ Sediment transport rate

Meyer-Peter-Muller formula with bed slope correction

$$q_B^* = 8\left(\tau^* - \tau_{cr}^*\right)^{1.5}$$

$$q_{BI}^* = q_B^* / C_I$$

$$C_I = \cos\theta\left(1 - \frac{\sigma}{\sigma - \rho}\frac{\tan\theta}{\mu_s}\right)$$

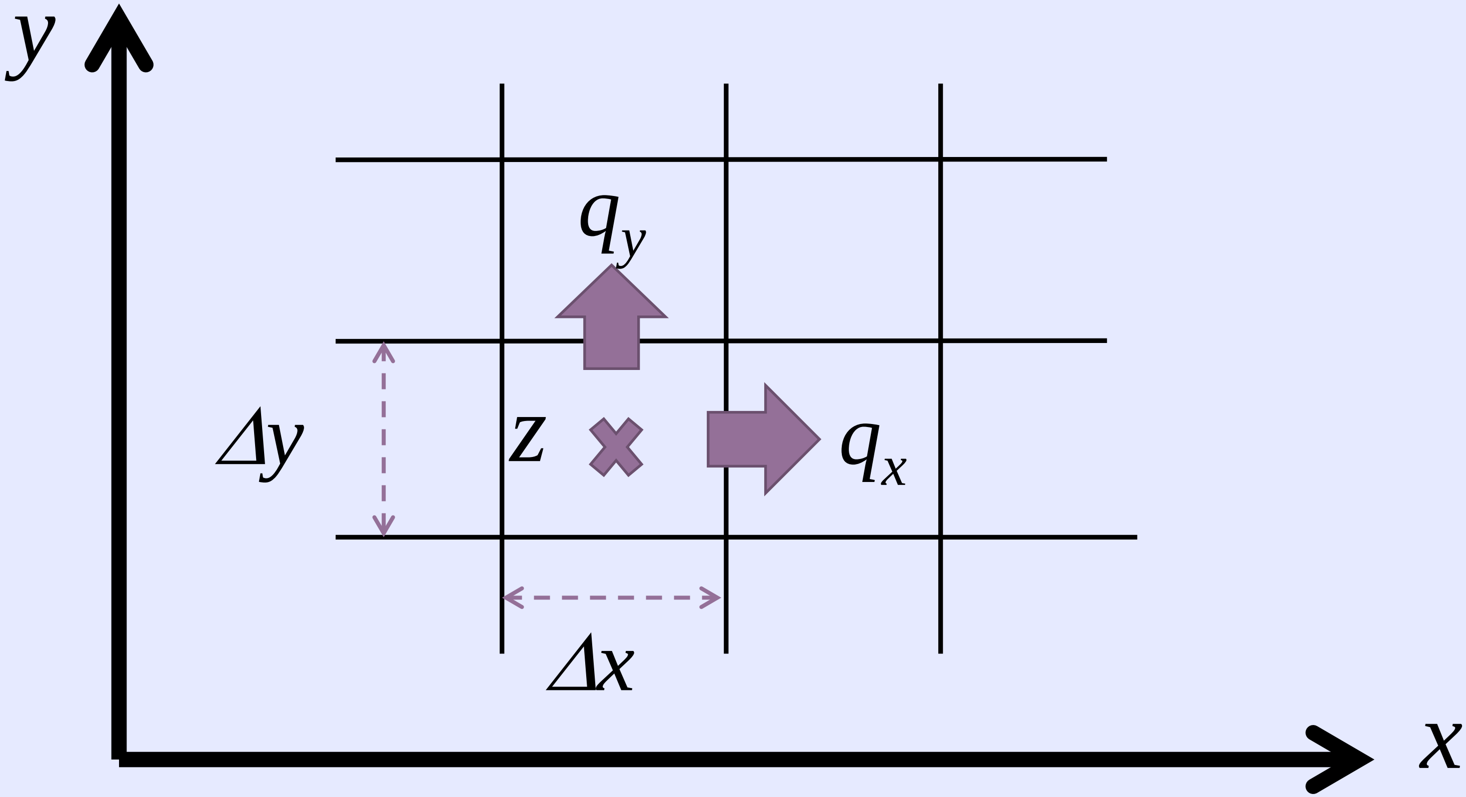
θ :bed slope, σ :density of sand particle,
μs:coefficient of static friction

◆ Conservation of sediment mass

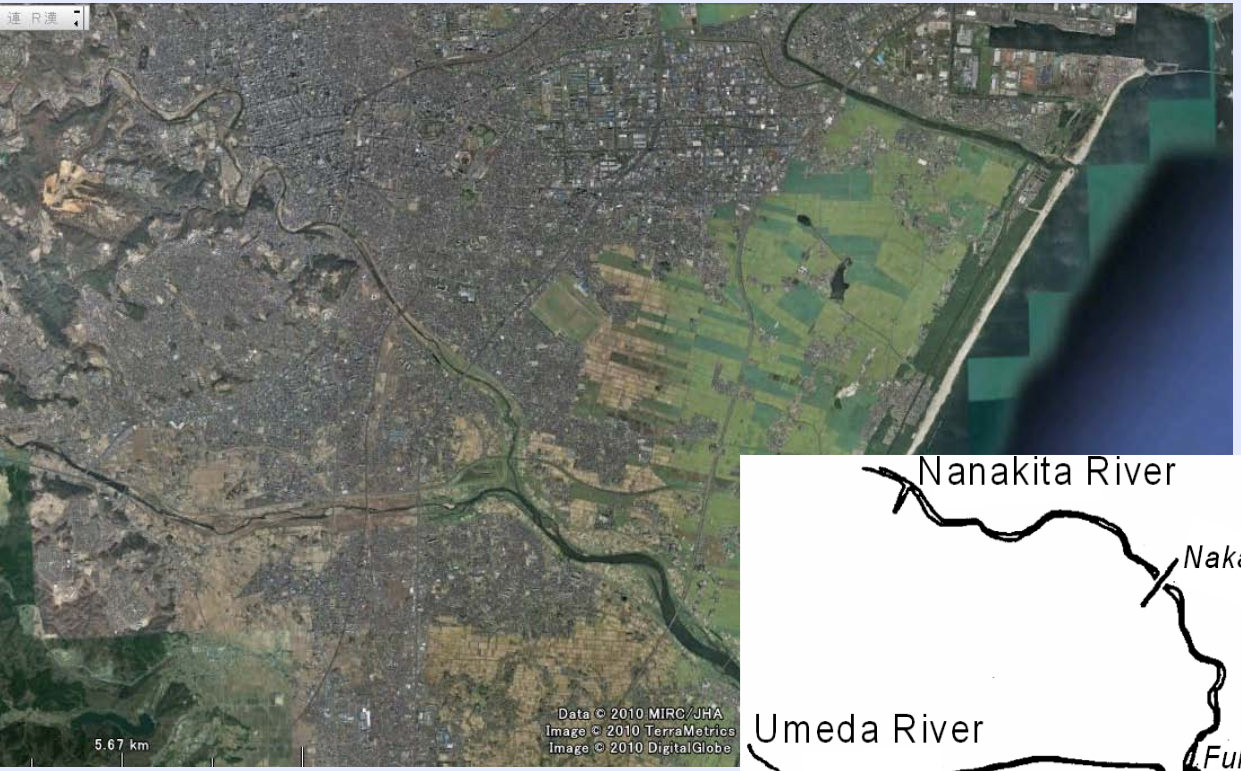
$$\frac{\partial z}{\partial t} + \frac{1}{1-\lambda}\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y}\right) = 0$$

◆ Computation of river bed evolution

$$\frac{\partial z}{\partial t}+\frac{1}{1-\lambda}\left(\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial y}\right)=0$$



3. Computation results



Nanakita River

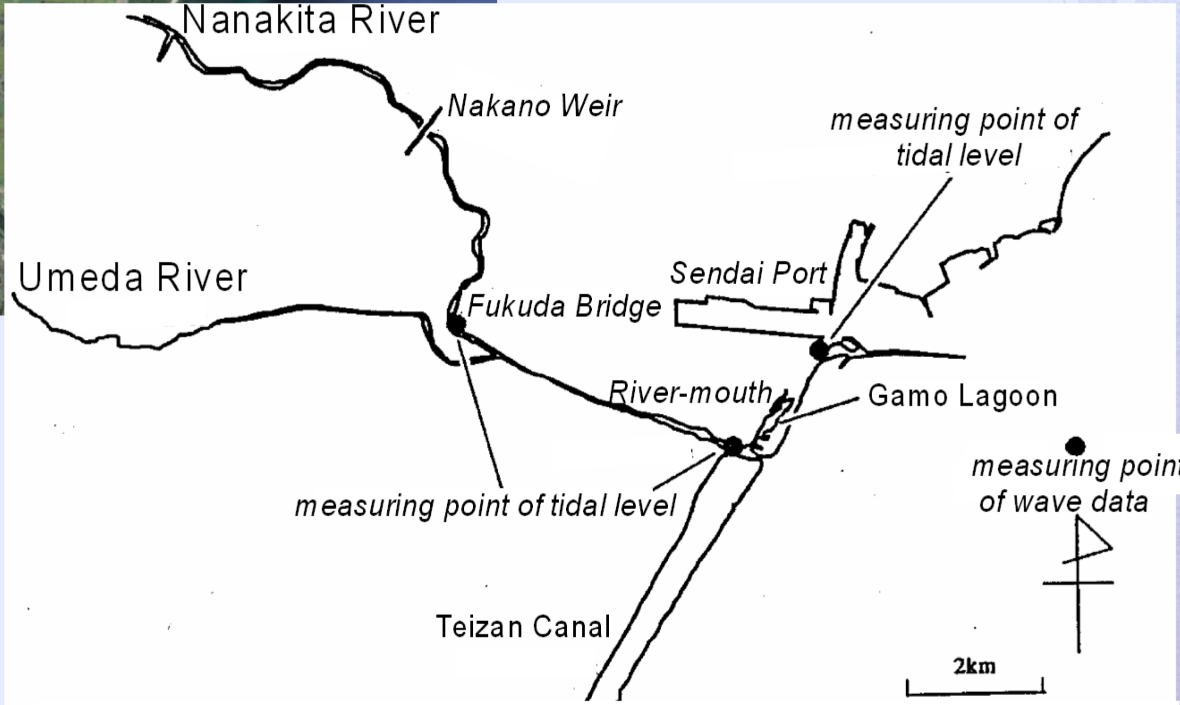
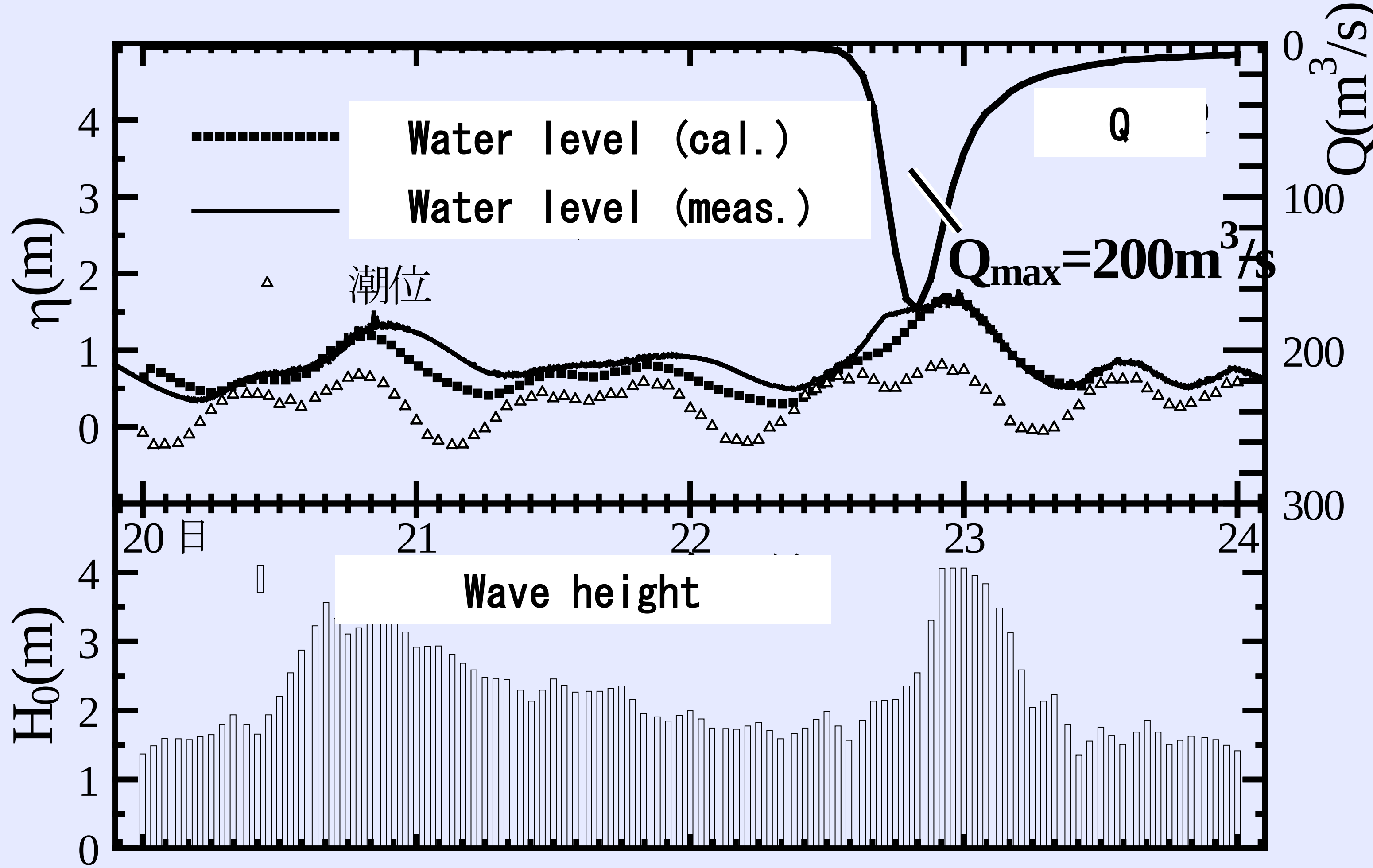
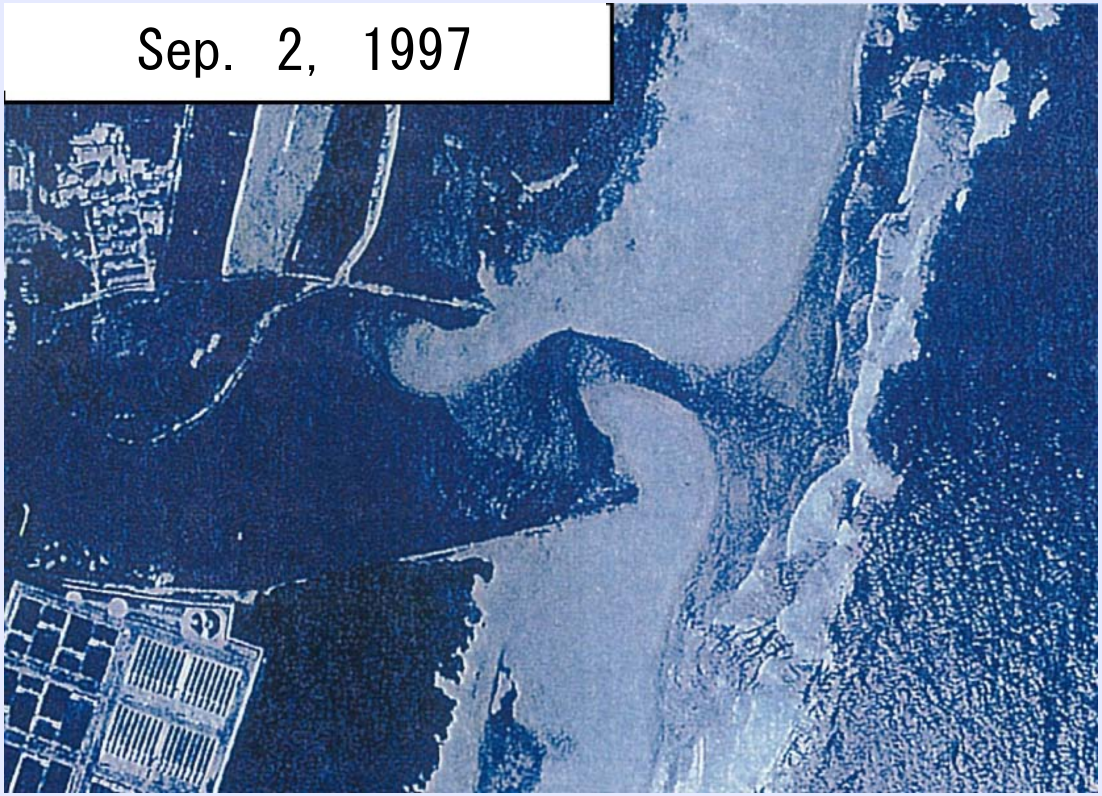


図-1　七北田川流域概要図

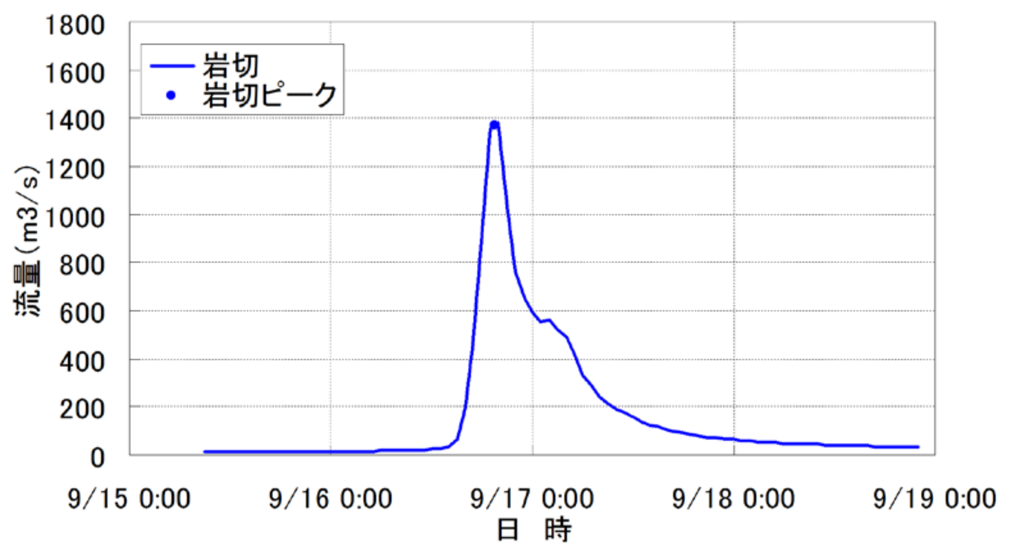
Calibration against 1996 flood event



Initial condition

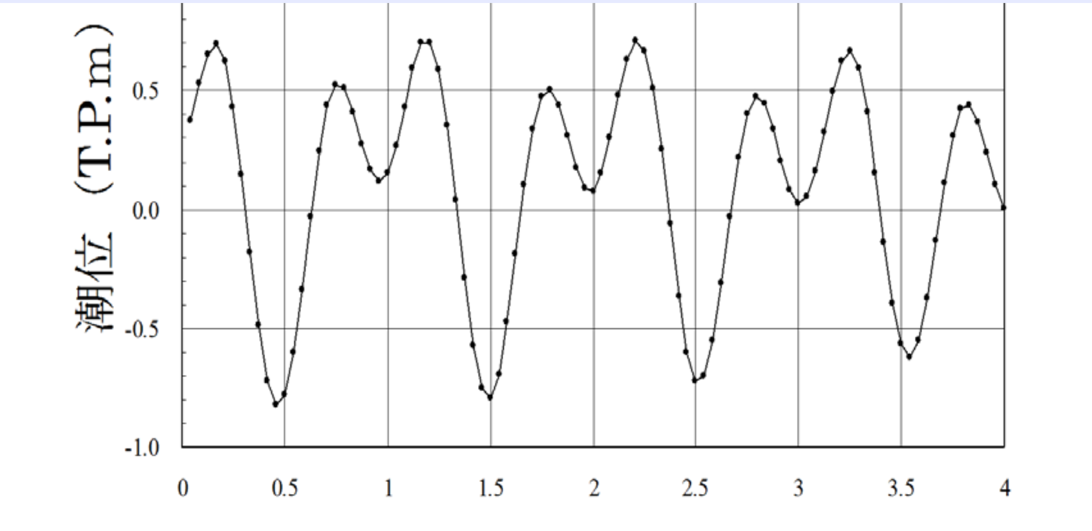


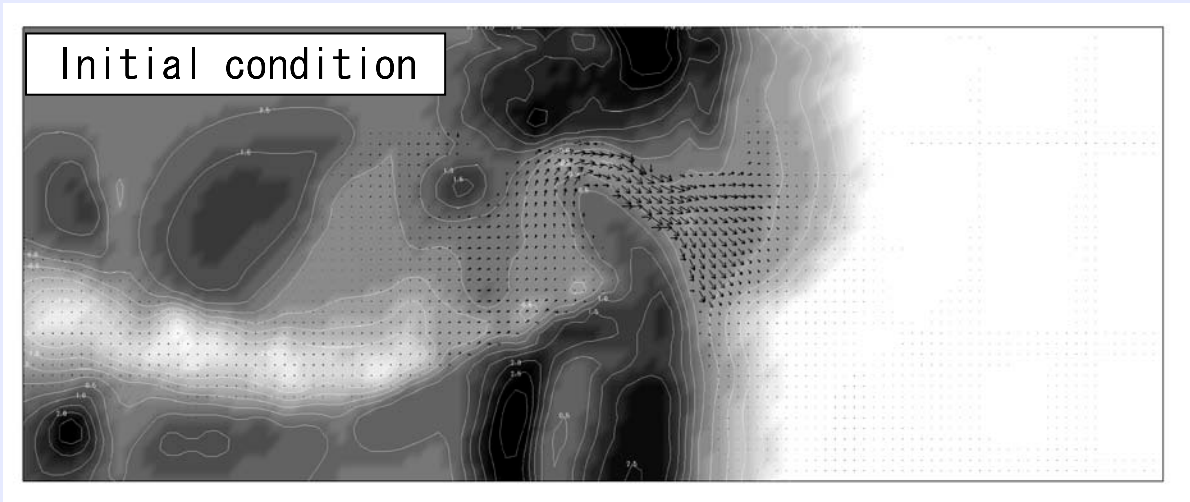
Computation for a design flood

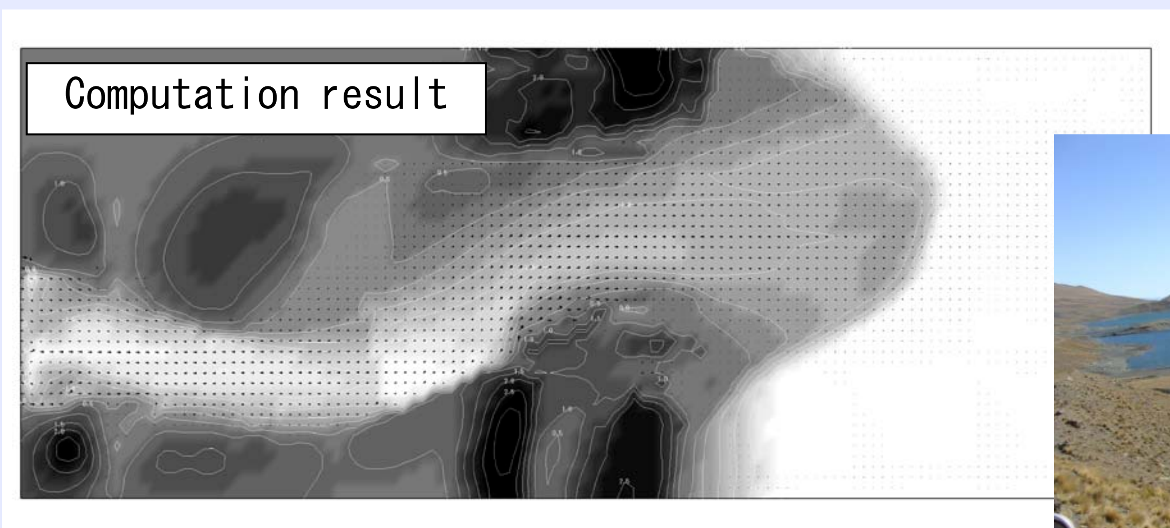


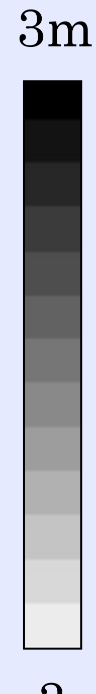
discharge(m^3/s)

tidal variation




Initial condition


Computation result


3m

Thank you for your kind attention!
Gracias!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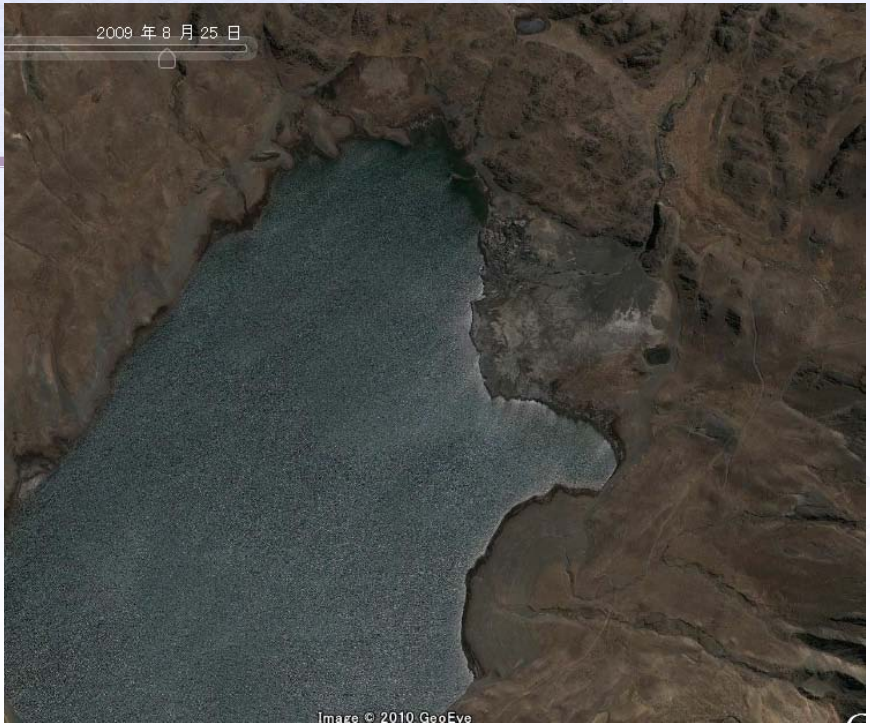
2005 年 11 月 2 日


2009 年 8 月 25 日
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