Methods Used to Predict the Impacts of Tidal Energy Exploitation on Environment

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Background

Energy demand

47 yrs

60 yrs

130 yrs

People ask ocean for help

Tidal energy

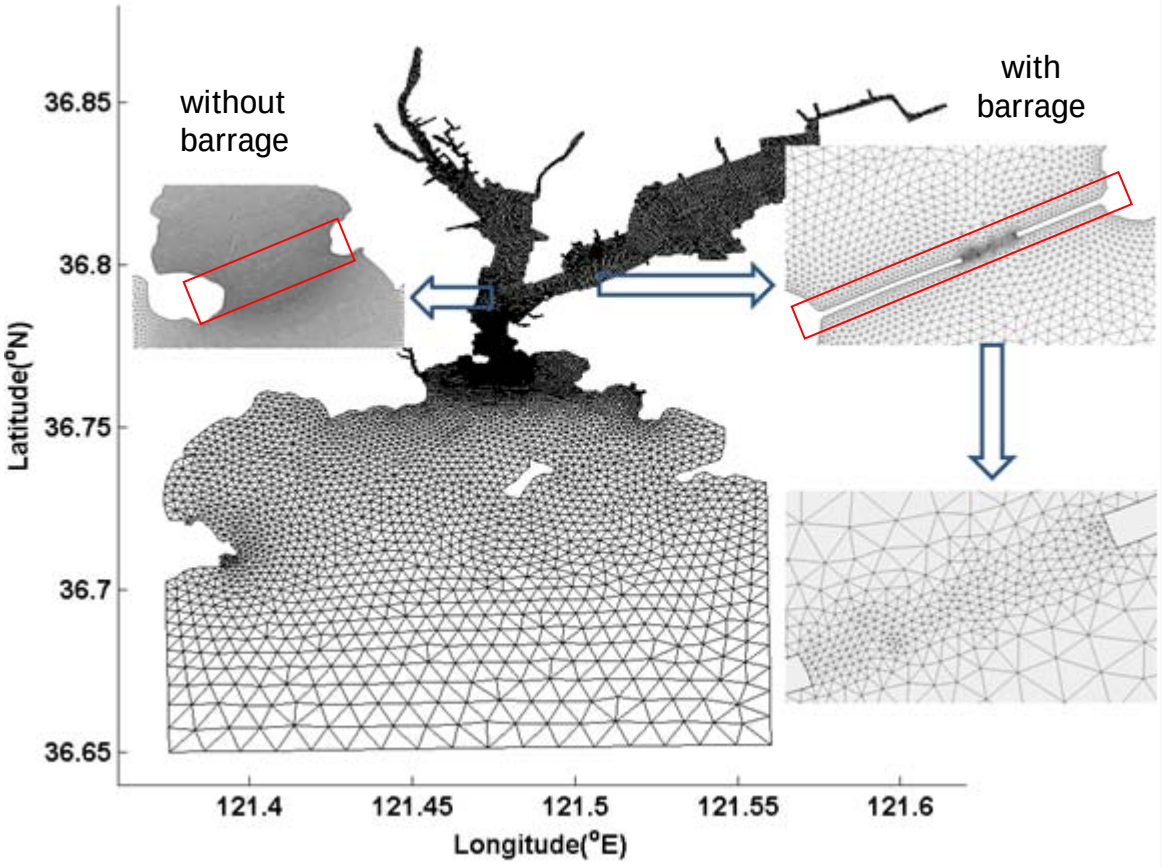
Source: google earth

The potential energy in the difference in head between high and low tides.

Proposed BCM tidal power station

Purpose: to find out an accurate way to simulate the impacts from the proposed BCM tidal power station.

Literature review (method 1)

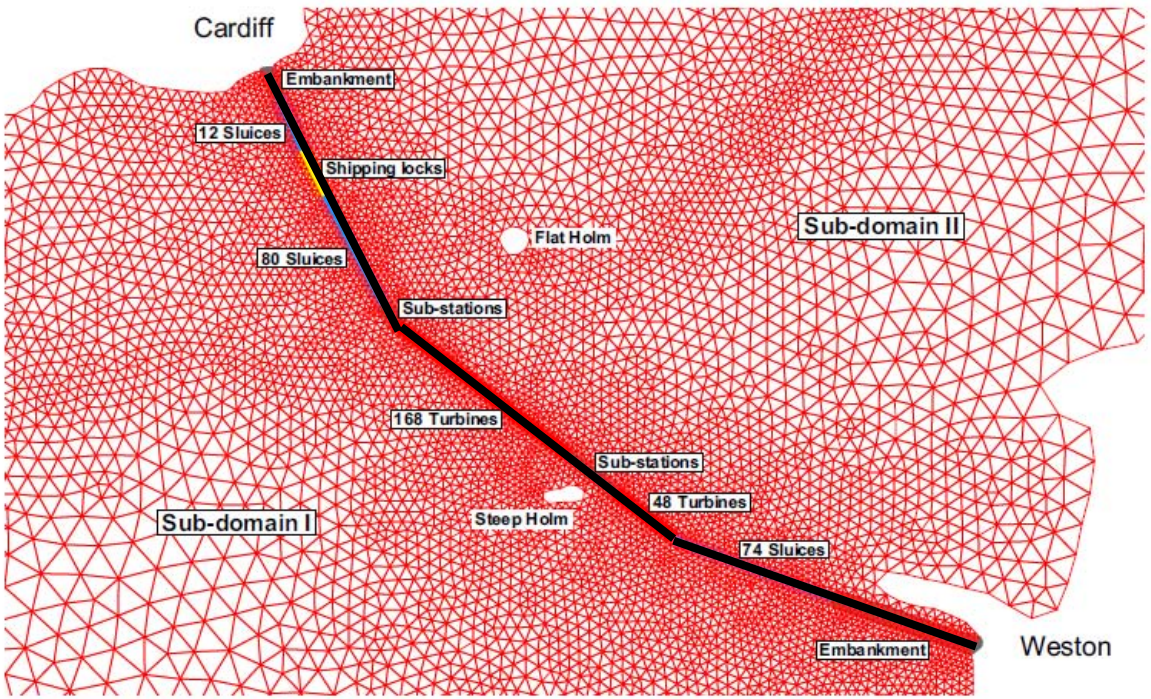


(Gao *et al.*)

Narrow the discharge area at where the barrage will be constructed to simulate the existance of the barrage

Literature review (method 2)

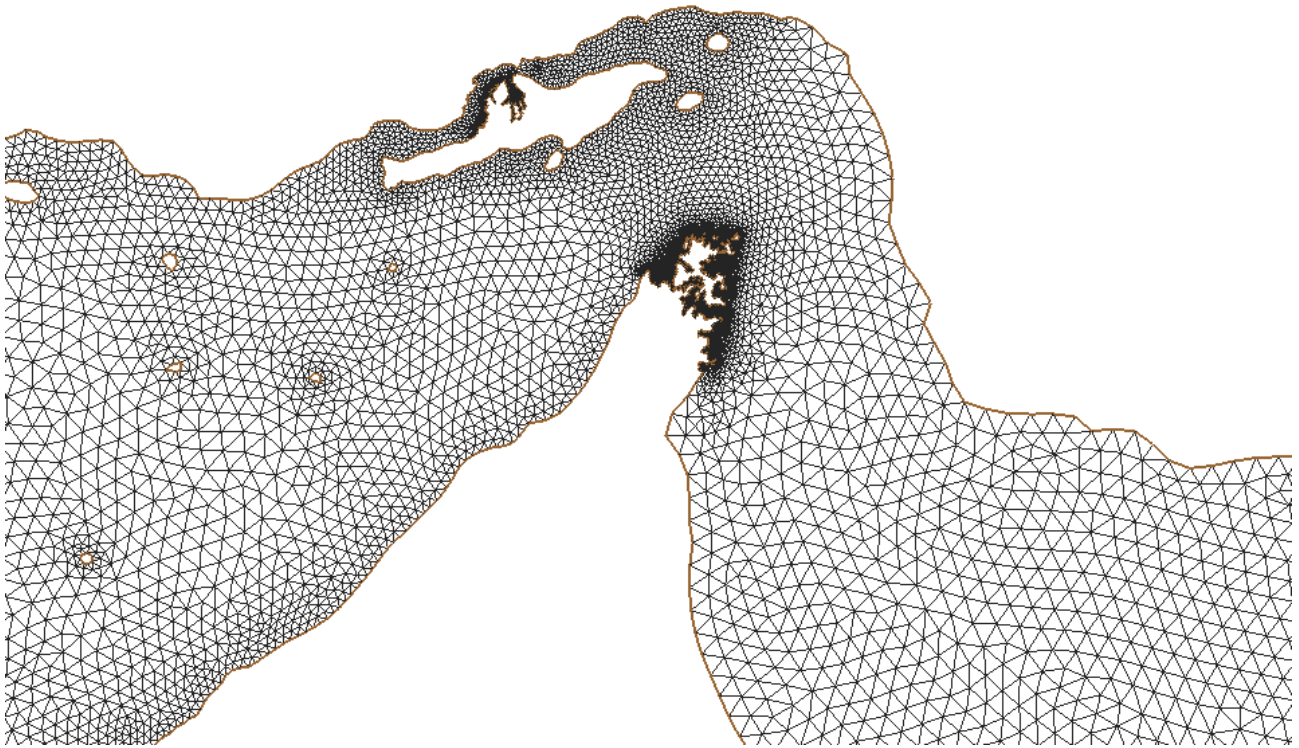
Domain decomposition technique



(Xia *et al.*)

Foundation——
Finite Volume Coastal Ocean Module (FVCOM)

Unstructured Triangle Grid Mesh




Doha, Qatar
West Bay Lagoon
Image © 2012 GeoEye
Image © 2012 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Google
多哈
影像拍摄日期：2011/5/7
25°25'37.58" 北 51°32'48.03" 东 海拔 0 米
视角海拔高度 13.46 公里
Google earth


West Bay Lagoon
Image © 2012 GeoEye
Image © 2012 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Three cases

1. without the barrage

   validate the model

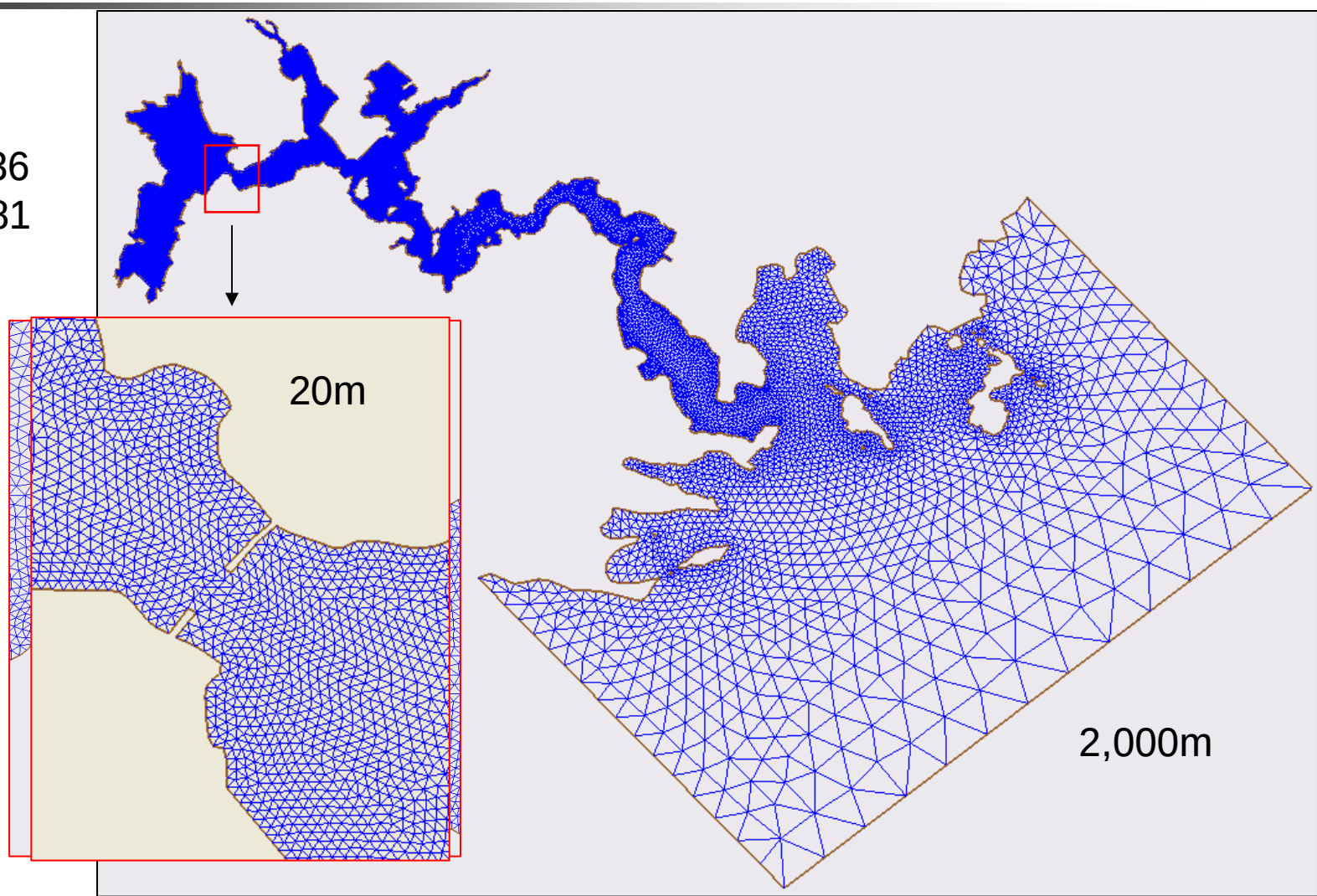
   obtain the current hydrodynamic state in Shacheng Bay

2. with the barrage (method 1)

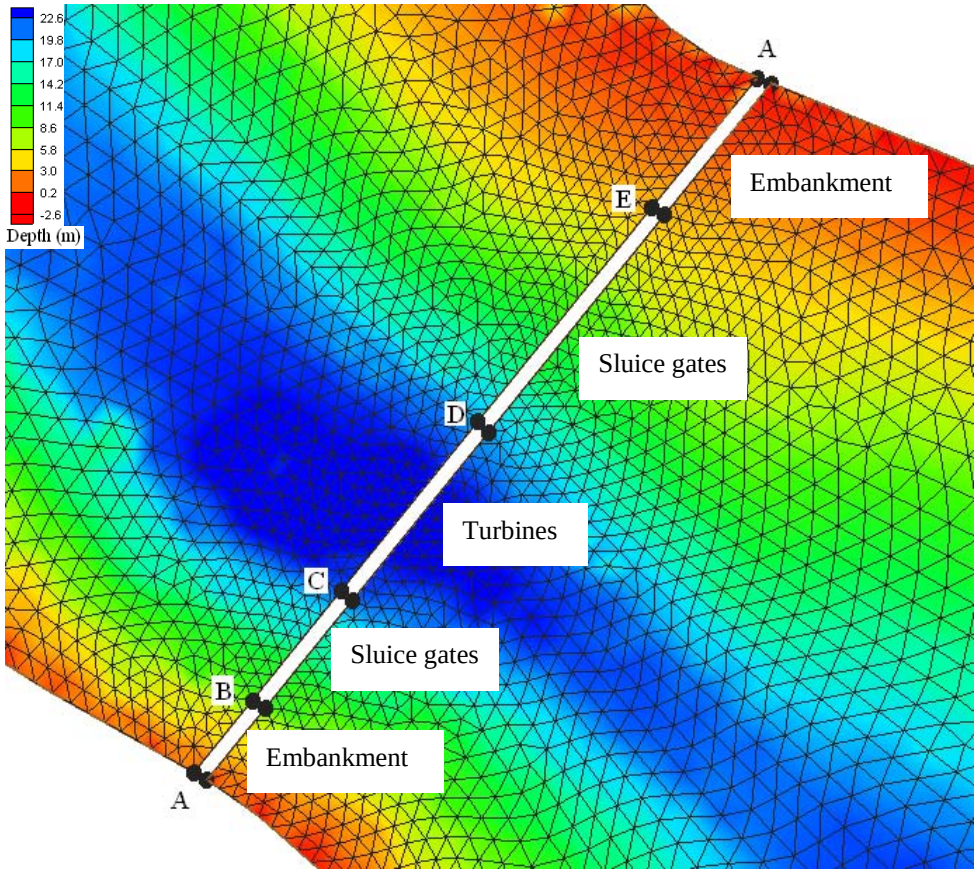
3. with the barrage (method 2)

Mesh——case 2

Node: 23, 836
Element: 44, 281

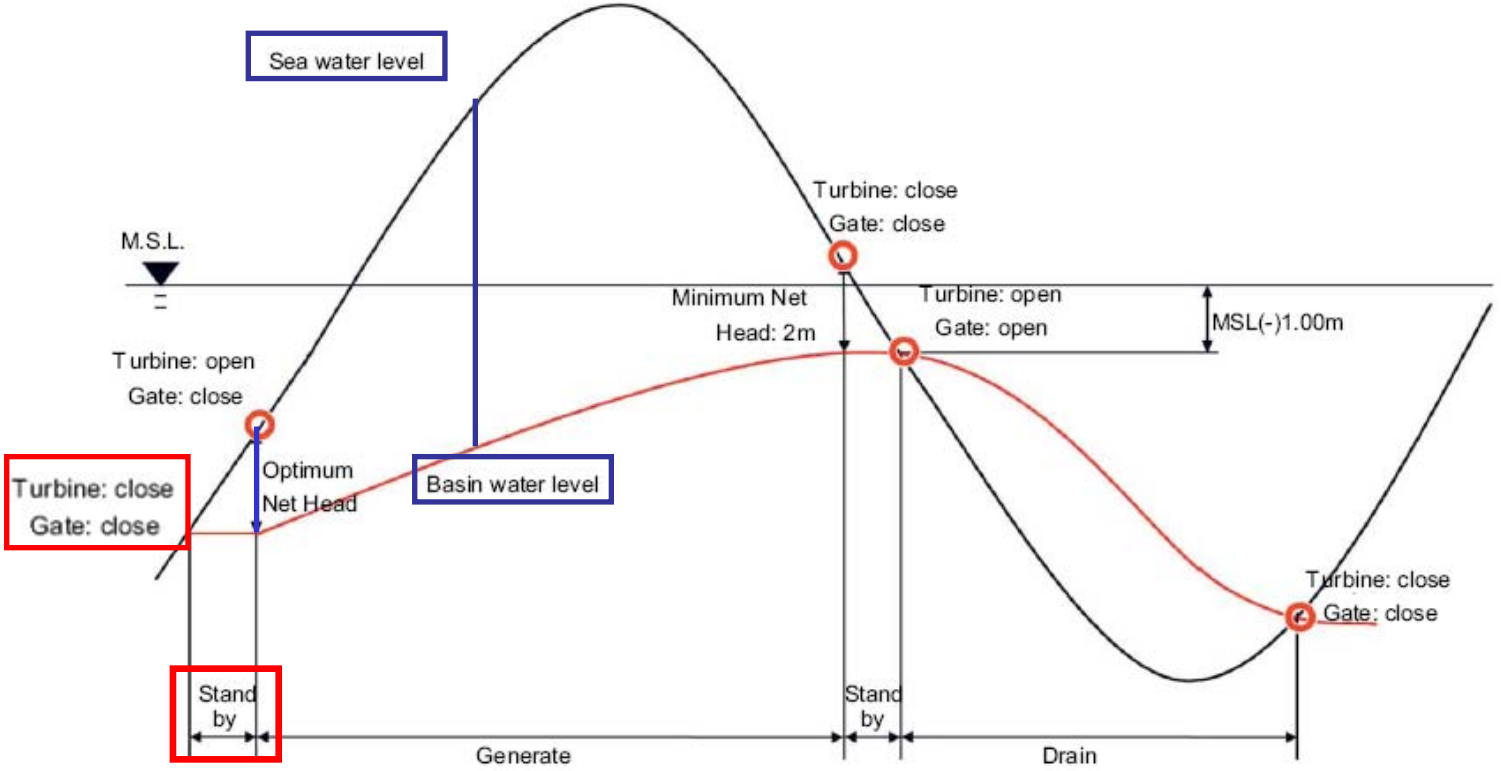


BCM tidal power station



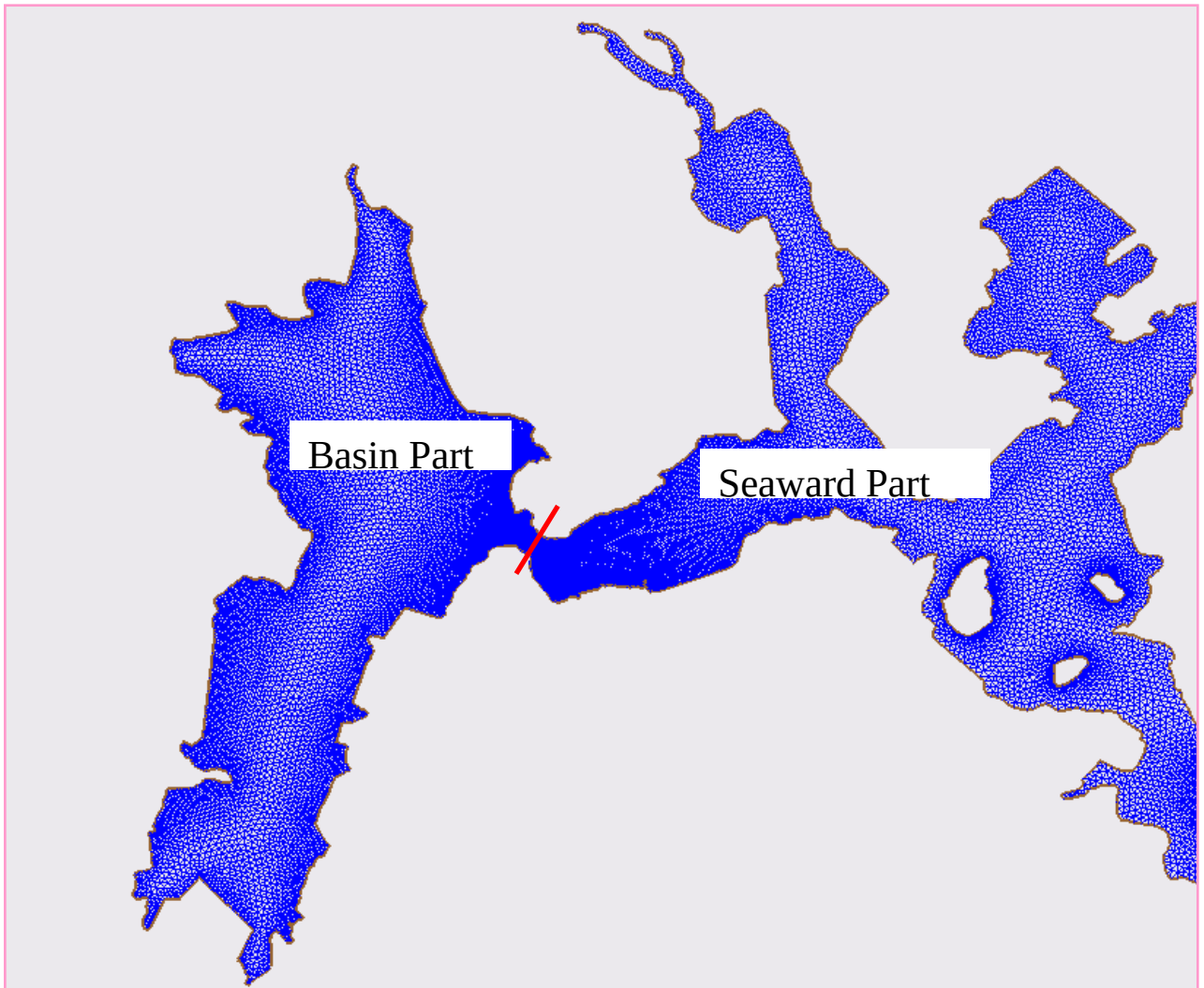
BCM tidal power station

Single effect operation only during flooding tides.

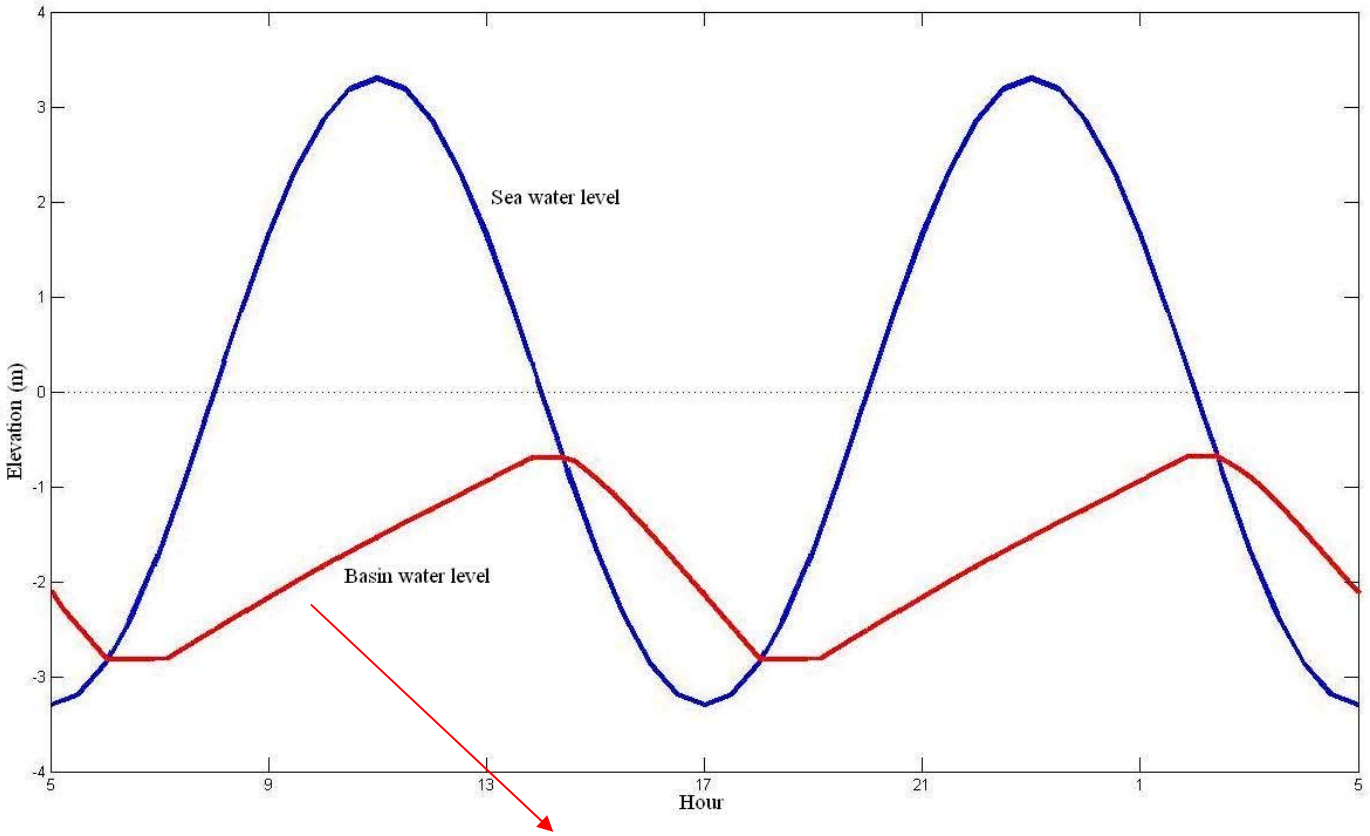


(Source: Shiwa Lake tidal power station)

Case 3—— method 2

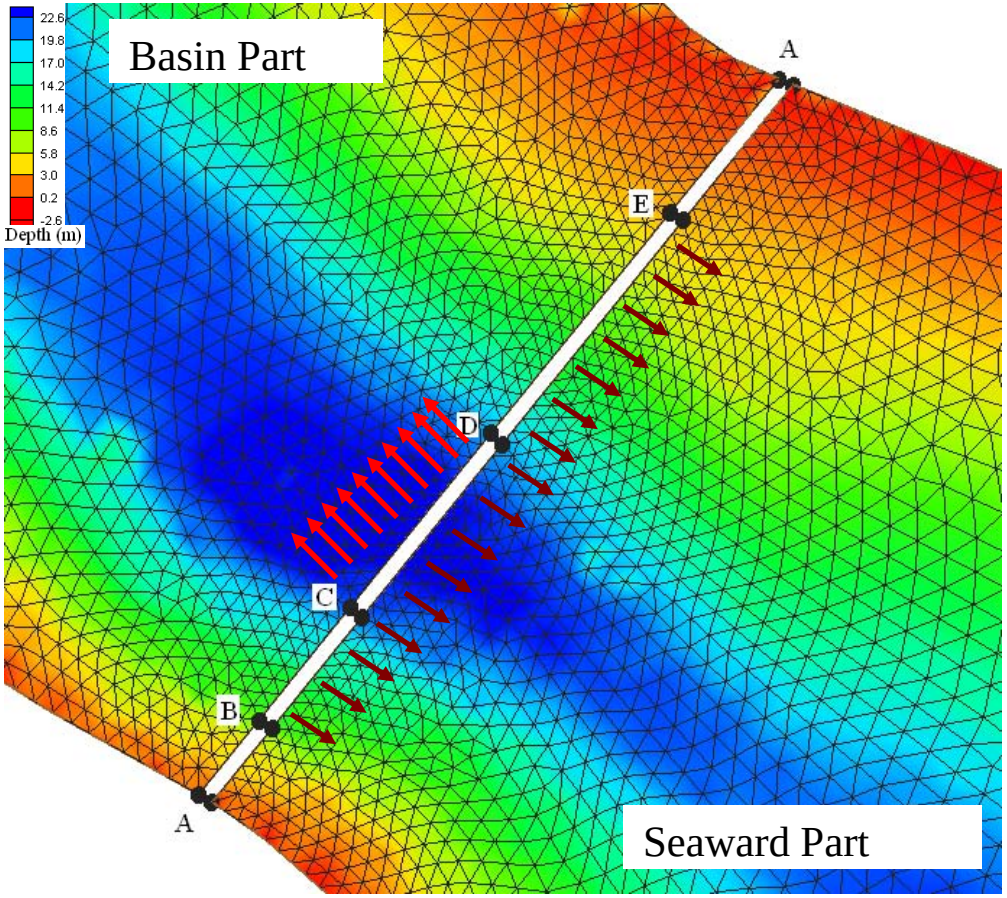


Case 3



The basin part was at first calculated driven by a designed and daily kept basin water level curve.

Case 3



→ Water flux during generation stage

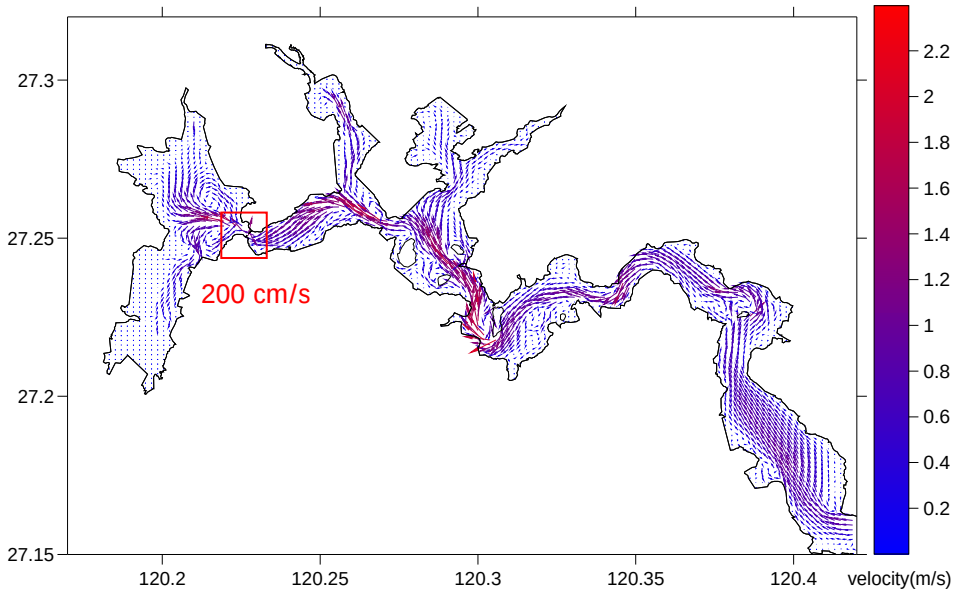
→ Water flux during draining stage

No water flux during stand by stage

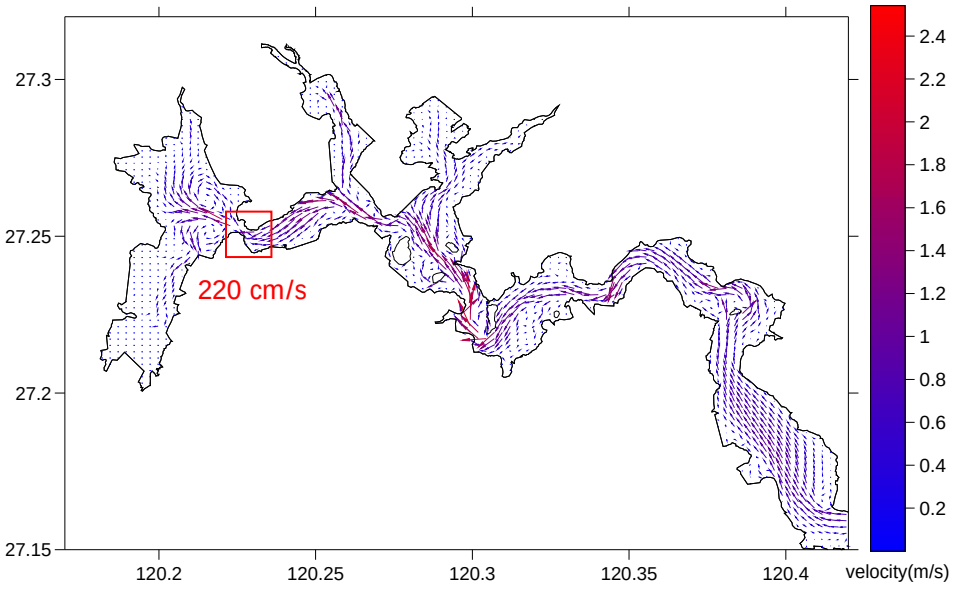
Results——differences

- Velocity field
- Water level change in the basin
- Tidal prism, Theoretical energy potential and Theoretical installed capacity

Results—Velocity field 1



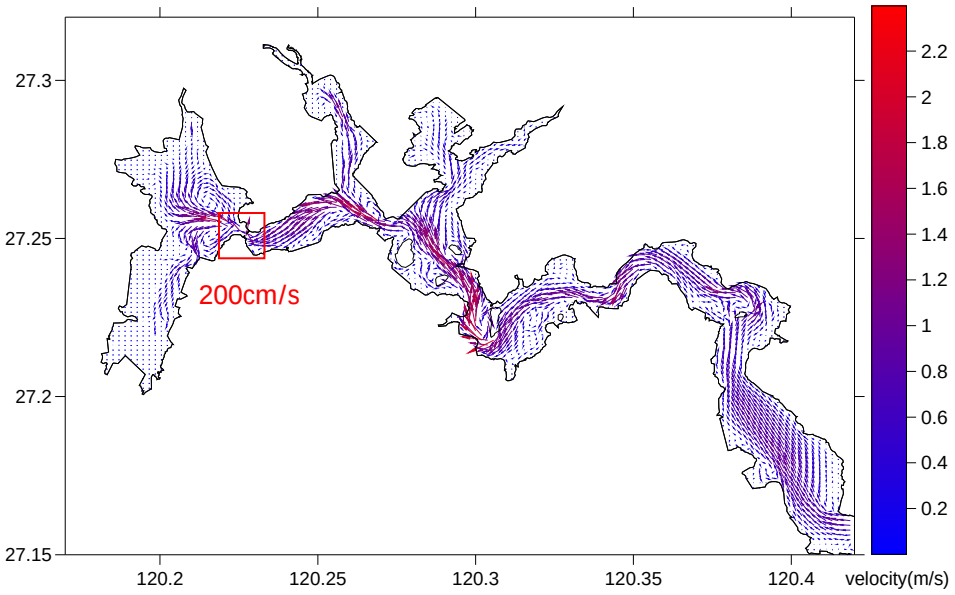
Without barrage



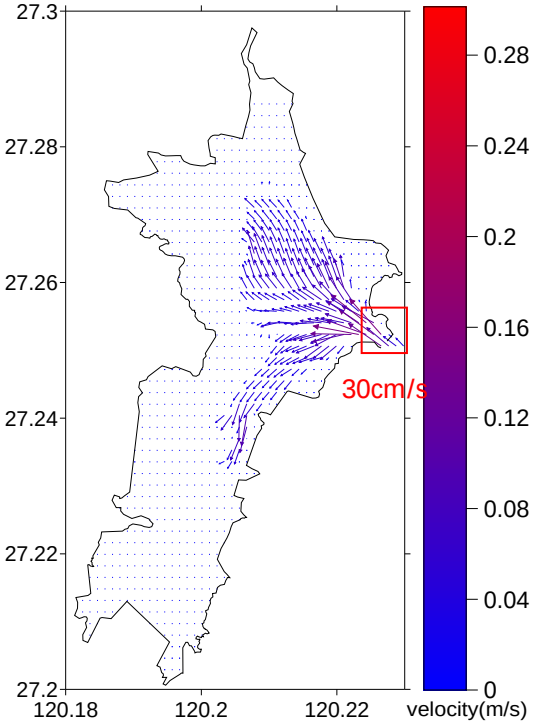
With barrage—method 1

Velocity directions are similar;
Velocity at BCM increased from 200 cm/s to 220 cm/s.

Results—Velocity field 2

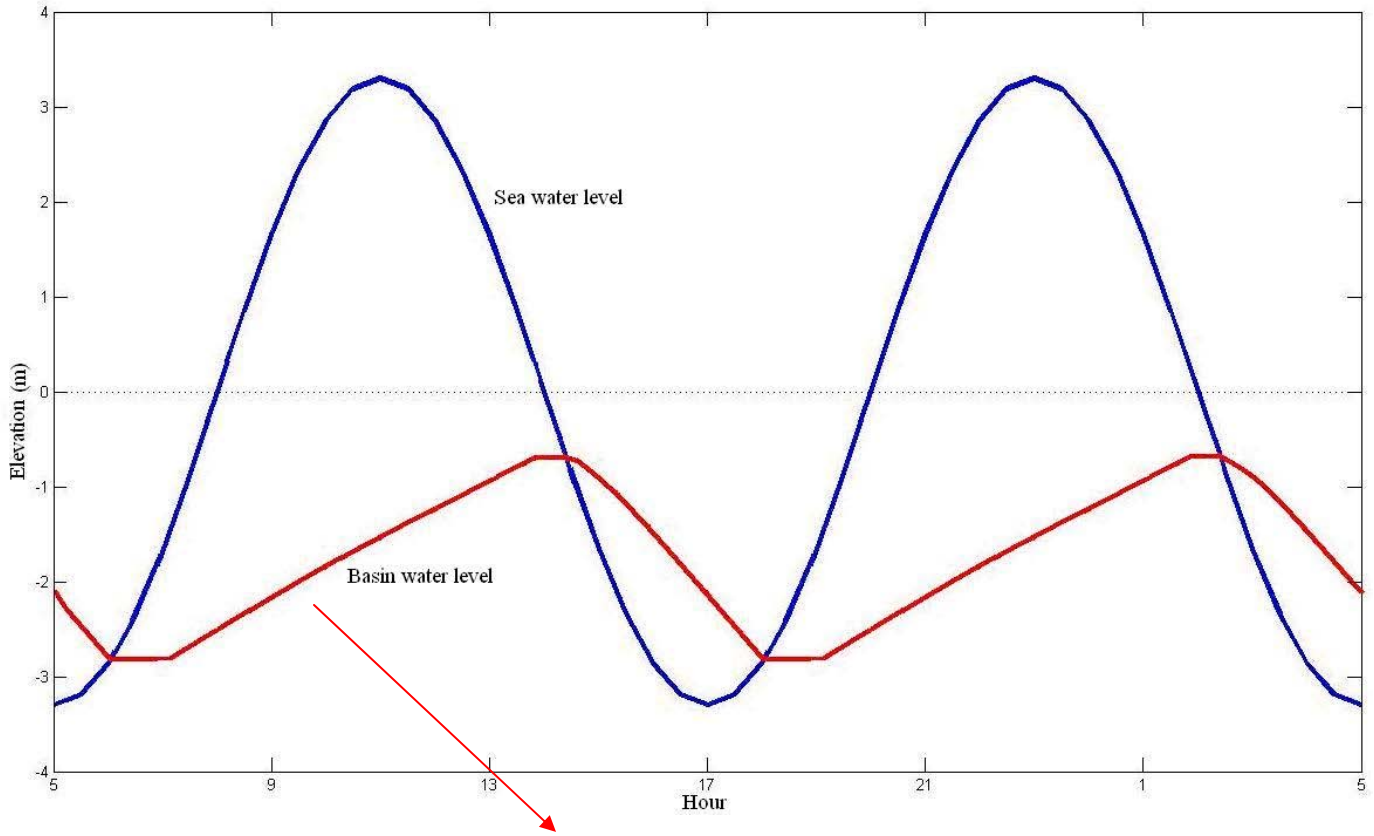


Without barrage



With barrage—method 2

Velocity at BCM decreased from 200 cm/s to 30 cm/s.

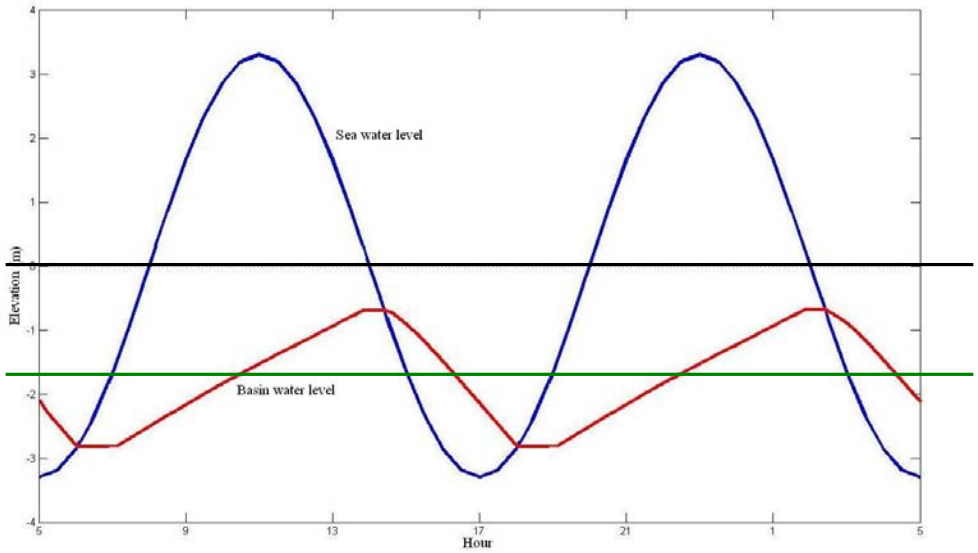


The tide range of the driven water level curve was smaller.

Results ——differences

- Velocity field
- Water level change in the basin
- Tidal prism, Theoretical energy potential and Theoretical installed capacity

Results—Water level change



1.7m

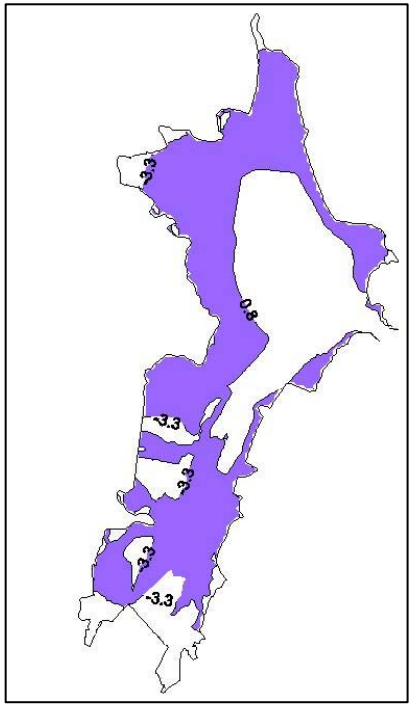
Average sea water level

Average basin water level

sea water level

basin water level

Mud flat contraction



Area become permanent dry land after the operation of the power station

Results ——differences

- Velocity field
- Water level change in the basin
- Tidal prism, Theoretical energy potential and Theoretical installed capacity

Results—Tidal prism, Theoretical energy potential and Theoretical installed capacity

	Without barrage	With barrage (method 1)	With barrage (method 2)
Tidal prism	$2.14\times10^{7}m^{3}$	$1.05\times10^{8}m^{3}$	$1.04\times10^{6}m$
Theoretical energy potential	$2.78\times10^{8}KWh$	$1.36\times10^{9}KWh$	$1.35\times10^{7}KWh$
Theoretical installed capacity	$3.17\times10^{4}KW$	$1.56\times10^{5}KW$	$1.54\times10^{3}KW$

Method 1 → Tidal prism, theoretical energy potential and theoretical installed capacity were increased → Method 1 cannot present the energy consumption process of the power station which method 2 can

Method 2 → Tidal prism, theoretical energy potential and theoretical installed capacity were decreased

I am expecting comments and suggestions from you.

Thank you