Impact of Dam Water Release Based on a Numerical Model of the Kangjin Bay, South Sea, Korea

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Physical Setting & Bottom Topography

- Location: 34°52’ N, 127°58’ E
- E-W: 10 km, N-S: 18 km
- Mean depth: 8.9 m, Max. depth: 20 m
- Area: 195.9 km²
- 3 straits: Noryang, Daebang, Changseon
Previous study
- Real-time monitoring of the environmental parameters in the Marine Large-Arc Shell Culture Bed (Ro, 2006)
- Tidal & sub-tidal current characteristic (Ro, 2007)
- Numerical modeling of tide & tidal current (Ro et al., 2007)

This study investigates current system in the Kangjin Bay by using numerical model
: Tidal & residual, Wind-driven and Density-driven current

How much salinity is diluted by fresh water dam discharge?
Flushing time?
Model Specification

- **Model code**
  - ECOM3D (Hydroqual, 2002)

- **Grid system**
  - 110 X 126
  - 100-400 m
  - 5 sigma levels

- **Time step**
  - Internal: 20 sec
  - External: 2 sec

- **Open boundary condition**
  - 4 major tidal constituents
  - M2, S2, K1, O1

- **Dam discharge**

- **Obs. Temp. & Salt. data**

- **Obs. Wind data**
Field Measurements & Datasets

- **Surface elevation**
  - Tide gauge at 2 stations (KJ1, EL1)

- **Current & direction**
  - RCM9 at 7 stations (KJ1, KJ2, NH2-6)
  - ADCP at 2 stations (DB, NR)

- **Water quality parameters**
  - Temp., Salt. and D.O. etc.
  - Real-time monitoring sys. (KJ1)

- **Meteorological data**
  - AWS (KJ1)

- **Surveys**
  - E-W and N-S cross section
- Dam Discharge Data by KWRC

- Aug.15~30, 2004 (15 days)
- Total discharge volume: $8.41 \times 10^8 \text{ m}^3$
- Total mass of KJ Bay: $1.96 \times 10^9 \text{ m}^3$
- Total mass of model domain: $3.54 \times 10^9 \text{ m}^3$
- 1\textsuperscript{st} peak discharge: 3,500 m\textsuperscript{3}/sec
- 2\textsuperscript{nd} peak discharge: 2,800 m\textsuperscript{3}/sec
- Skill analysis = (1-R.error)
- Between obs. & res. of harmonic analysis
- most scores : over 0.9

### Tidal Current

<table>
<thead>
<tr>
<th>Tidal Current (1-R.Error)</th>
<th>CNU(Obs.) Vs Model Results</th>
<th>NORI(Obs.) Vs Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KJ-1</td>
<td>KJ-2</td>
</tr>
<tr>
<td>U-comp. M2</td>
<td>0.93</td>
<td>0.93</td>
</tr>
<tr>
<td>S2</td>
<td>0.92</td>
<td>0.94</td>
</tr>
<tr>
<td>K1</td>
<td>0.81</td>
<td>0.98</td>
</tr>
<tr>
<td>O1</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>V-comp. M2</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>S2</td>
<td>0.97</td>
<td>0.95</td>
</tr>
<tr>
<td>K1</td>
<td>0.36</td>
<td>0.98</td>
</tr>
<tr>
<td>O1</td>
<td>0.35</td>
<td>0.99</td>
</tr>
</tbody>
</table>

### Tidal Elev.

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</tr>
</thead>
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<tr>
<td></td>
<td>KJ-1</td>
<td>Samcheonpo</td>
</tr>
<tr>
<td></td>
<td>Amp.</td>
<td>Phase</td>
</tr>
<tr>
<td>M2</td>
<td>0.94</td>
<td>0.95</td>
</tr>
<tr>
<td>S2</td>
<td>0.91</td>
<td>0.98</td>
</tr>
<tr>
<td>K1</td>
<td>0.89</td>
<td>0.96</td>
</tr>
<tr>
<td>O1</td>
<td>0.98</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Model Calibration & Verification (Salinity and Sigma-t)

- Salinity (0.895)
- Sigma-t (0.873)

Model performance is highly satisfactory !!!
Model Results (Salinity)

Case-TDW (Tide+Discharge+Wind)

Salinity

Dam discharge (m³/sec)

Salinity (psu)

Tide+RD+RW

Station: EH

Aug.15,2004 - Aug.23,2004

Real Discharge

Dam discharge

Salinity (PSU)

2004.08.15, 00:00, N-S Vertical Profile

Dam Water Release

South

Vertical distribution

North

Horizontal distribution
Net Volume Transports Variation
(after dam discharge)
**Flushing Time**

1\(^{st}\) peak discharge (3,500 m\(^3\)/sec) : 4.2 days
2\(^{nd}\) peak discharge (2,800 m\(^3\)/sec) : 5.7 days
To understand the Circulation of Kangjin Bay by using numerical model

Model results are found to compare well with the Obs. Data

**Surface salinity**
- 1st peak discharge → 15 (psu)
- 2nd peak discharge → 10 (psu)

**Flushing time**
- 1st peak discharge (3,500 m³/sec) : 4.2 days
- 2nd peak discharge (2,800 m³/sec) : 5.7 days
Summary

- **3 channels are very narrow**: bottle-neck effect

- **Large amount dam discharge in the summer season**
  
  → Increase of the volume of traffic into bay

  → Thick fresh water covers sea water surface for a long time

  → **Stratification** between surface & bottom by strong density current

  → **Ecosystem will be seriously affected by fresh water**
Thank you