66th IEC Meeting and 26th European regional conference

Estimation of temporal and spatial distribution of salinity and desalinization time according to internal development scenarios in the Saemangeum Reservoir

Junghoon Choi · Chansung Oh · Jeongryeol Jang

Rural Research Institute, Korea Rural Community Corporation

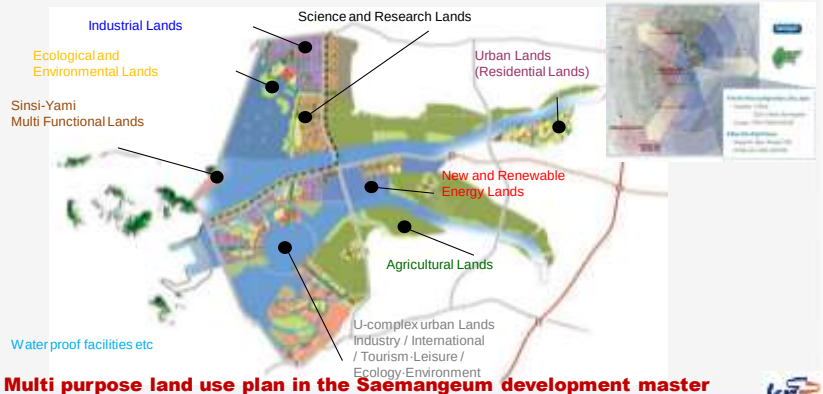
Internal Workshop of WG-SDTA, 13 October 2015

CONTENTS

INTRODUCTION

Saemangeum Development Project

- To construct an ecological and environmental friendly tidal land reclamation and development project
- Groundbreaking history in tidal land development project histories as preparing multi-purposes land use development including not only agriculture but also city, industry, science, etc

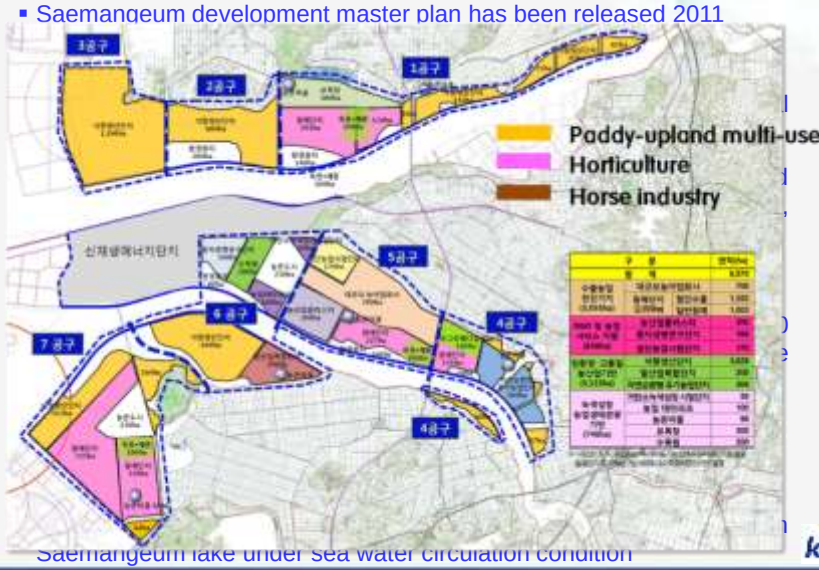


Multi purpose land use plan in the Saemangeum development master plan(2011)

INTRODUCTION

Agricultural land development

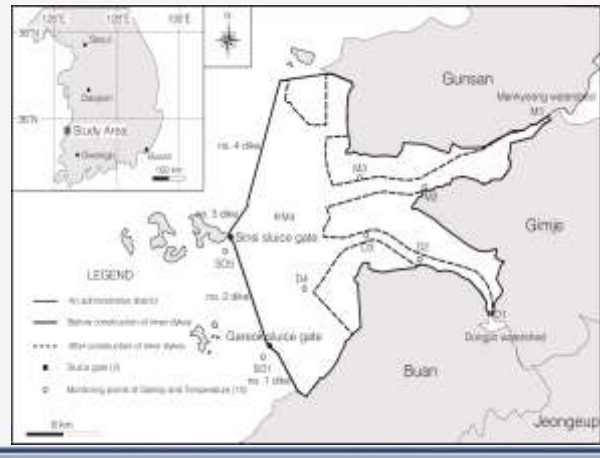
- Saemangeum development master plan has been released 2011



- Saemangeum lake under sea water circulation condition

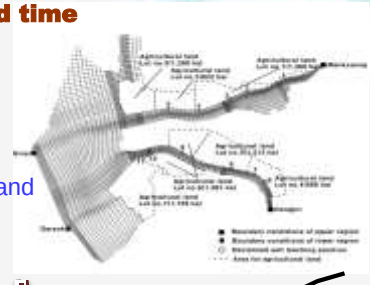
MATERIALA & METHODS

- **Scenarios for temporal and spatial distribution**
  - CASE 1 : Current condition (storage 5.89 *$10^8 m^3$)
  - CASE 2 : Completing inner dike construction (storage 5.92 *$10^8 m^3$)
  - CASE 3 : CASE 2 + additional bottom dredging (storage 1.07 *$10^9 m^3$)

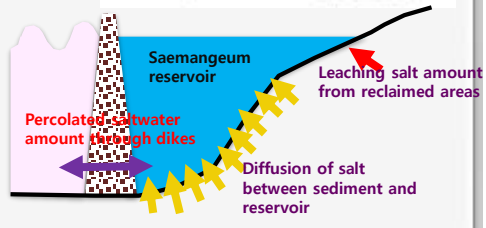


MATERIALA & METHODS

- **Scenarios for desalinization required time**
  - Based on CASE 3
  - SN 1 : No salt input
  - SN 2 : Intrusion through sea dike
  - SN 3 : Leaching from internal developed land
  - SN 4 : Elusion from benthic layer
  - SN 5 : SN 2 + SN 3 + SN 4



- **Estimation model : EFDC**
  - Calibration : measured data 2008
  - Verification : measure data 2009



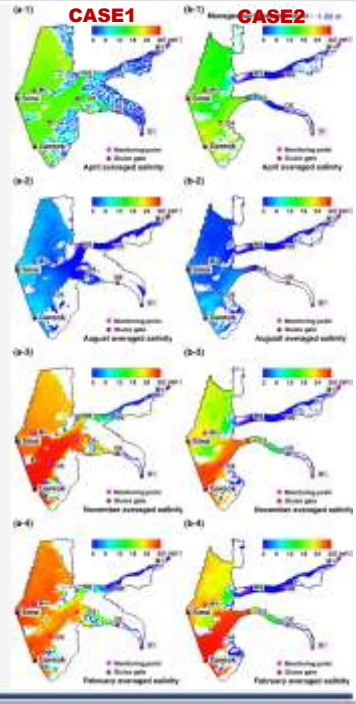
RESULTS & DISCUSSIONS

Numerical model calibration and verification

Monitoring point	Validation parameter					
	%difference (ASCE, 1993)		RMSE (°C / ppt)		AME (°C / ppt)	
	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity
M1	4.16	3.36	3.97	0.04	2.89	0.03
M2	4.50	7.28	4.32	3.00	2.75	2.07
M3	8.82	10.73	4.32	5.28	2.84	3.68
M4	4.84	5.58	2.49	3.29	1.52	2.29
D1	18.84	8.20	5.57	0.02	4.56	0.02
D2	8.23	14.04	3.93	7.72	2.94	3.91
D3	7.01	12.75	3.33	3.90	2.13	3.03
D4	4.69	1.09	1.89	1.77	1.10	1.12
Average	7.64	7.88	3.73	3.13	2.59	2.02

Change in salinity under CASE1 and 2

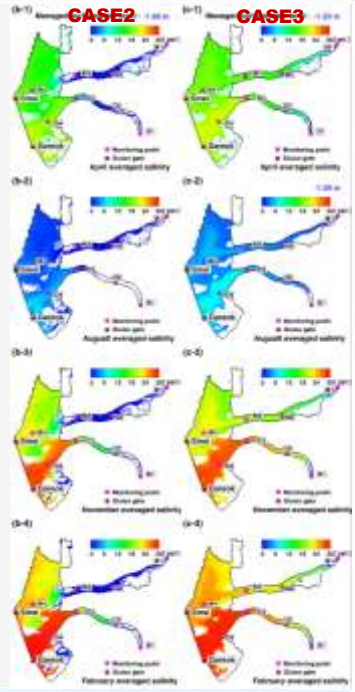
- The distribution of salinity show similar trends regardless of whether or not inner dike
  - Maximum averaged salinty of 21 psu and 8 psu are calculated in April and August, respectively.
  - The salinity in November and February increases up to initial salinity conditions around 30 psu
  - Mankyeong reservoir(MK) shows a lower salinity distribution than Dongjin's(DJ) under CASE2
    → 1) The seawater transport from two sluice gates is retarded because of a low hill located near M3
    2) In this case, the freshwater from MK estuary gets to push the salt water further
    3) The total inflow amount of MK estuary is greater about 1.3 times than Dongjin's
  - The salinity of 1 psu or less has been maintained at M1 and D1 of the year
  - The salinity at M2, M3, D2 and D3 are getting reduced by about 2 ~ 5 psu under CASE2



RESULTS & DISCUSSIONS

Change in salinity under CASE2 and 3

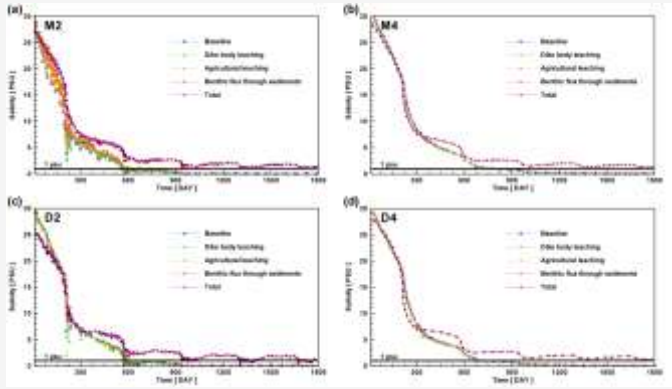
- The salinity increases in the vicinity of M3, northern part of M4 and Sinsi gate in all seasons compared with CASE2
  → Because the increasing of water storage capacity together with the increase in water depth and the resulting vertical stratification which induce to increase in stagnant time of water in botttom layer
  - The salinity of 0.03 to 2.88 psu is simulated under CASE3 around M1, while the salinity of 0.04 to 0.31 psu is simulated under CASE2
  - The salinity at M2, M3, D2 and D3 under CASE3 more increases to close to 10 psu
  - The salinity at M4 and D4 under all cases shows almost irrelvant with dredging operations
    → Because the water depth in the vicinity of the two sluice gates is similar in all cases



RESULTS & DISCUSSIONS

Desalinization time

- A series of required time for desalination are calculated when the salt concentration for each scenario at points M2, M4, D2, and D4 becomes less than 1 psu
  - A group of scenarios including SN1, SN2, and SN3 and the remaining group of scenarios including SN4 and SN5 show similar trends within each group



The temporal changes in salinity at the bottom layer

CONCLUSIONS

- 87.5 ㎢ of new agricultural land resource will be developed by end of 2020 through Saemangeum project
  - 150 million ㎥/yr of fresh water is needed to supply irrigation water for those land
  - Especially, cash crops and horticulture are required over 40 million ㎥/yr fresh water which slat concentration is lower than 0.3psu

- Through this study,
  - to estimate spatial and temporal salinity distributions of Saemangeum lake under sea water circulation condition like current situation according to internal development scenarios
  - to calculate desalinization time when salinity concentration becomes under 1psu.

12/14

CONCLUSIONS

- 87.5 ㎢ of new agricultural land resource will be developed by end of 2020 through Saemangeum project
  - 150 million ㎥/yr of fresh water is needed to supply irrigation water for those land
  - Especially, cash crops and horticulture are required over 40 million ㎥/yr fresh water which slat concentration is lower than 0.3psu

- Through this study,
  - to estimate spatial and temporal salinity distributions of Saemangeum lake under sea water circulation condition like current situation according to internal development scenarios
  - to calculate desalinization time when salinity concentration becomes under 1psu.

CONCLUSIONS

- Under current condition like sea water circulation, only surface layer within 0.5m at M1 and D1 points sustains below 1 psu whole the year round
- However, under CASE3, the salinity increases to approximately 10 psu at construction segments of inner dike Mangyeong and Dongjin lake
- Desalinization required time are calculated 2.0-2.5 years considering sea water intrusion from sea dike and leaching from farmland
- While considering additional bottom dredging(SN4), the required time is expected to take more than 5 years
- It is high time to decide desalinization process to be started if fresh irrigation water will be supplied without any problem by the end of 2020

ICID2015

kr

ICID2015

THANK YOU FOR YOUR ATTENTION