Coastal Reclamation and Restoration in RO Korea

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1. Backgrounds: The Korean tidal flat system

Korean Tidal Flats: The West Pacific Mirror of the European Wadden Sea

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Introduction

The European Wadden Sea is not as unique in the world as we are used to believe. Along the entire West coast of Korea there is a long stretch of tidal flats up to 10 km in width. They are part of a mosaic of tidal flats along the banks of the south eastern part of the Yellow Sea. The South Korean Wadden Sea has a total area of 2850 km^2 and is exposed to a tidal range from 4 to up to 10 meters. Unlike its European counterpart, many small islands with rocky shores are scattered over the flats while mountains and hills of 150 to 800 meters height border its fringes. The tidal channels are up to 30 meters deep. Geologically, Korean tidal flats are young and were formed during the recent Holocene rise of the sea level less than 10,000 years ago. Their formation is supposed to be related with the large supply of sediments from the Hwanghe river. Salt marshes, which are common and typical in the European Wadden Sea, have mostly disappeared due to intensive land reclamation during the first decades of this century when the higher intertidal areas with their flourishing salt marshes were converted into agricultural land.

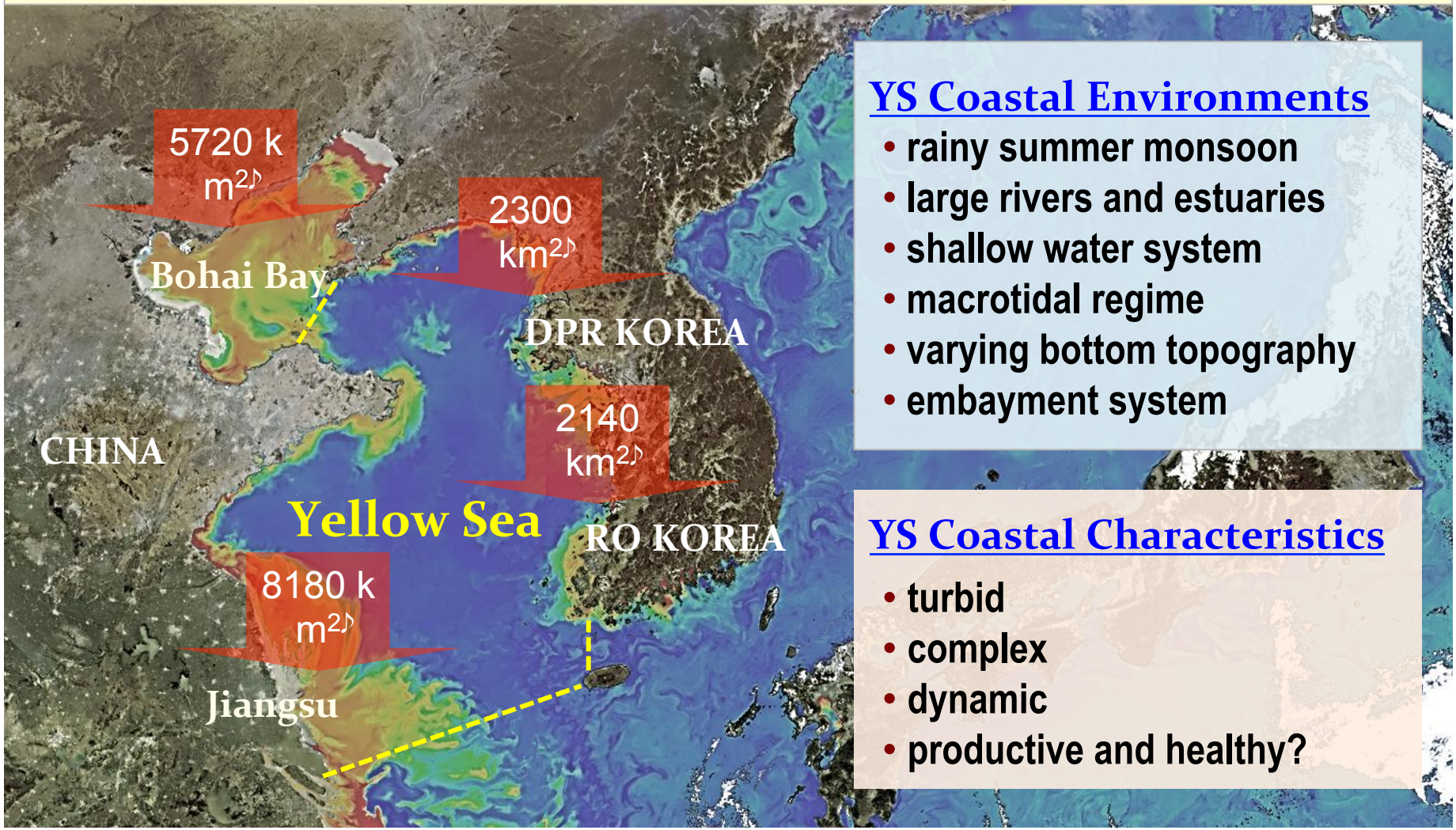
25 species of waterfowl were recorded in internationally important numbers in certain places, e.g., in the Saemankeum Bay which is amongst the highest number anywhere in East Asia. Among these birds, there are sibling species of common European Wadden Sea visitors or residents; Mongolian plover *Charadrius mongolus*, Nordmann's Greenshank *Tringa guttifer*, and Great Knot *Calidris tenuirostris*. But also some identical species such as Kentish plover *Charadrius alexandrinus*, Shelduck *Tadorna tadorna* or Dunlin *Calidris alpina* can be regularly observed.

Man and Korean Tidal Flats – Benefits and Threats

The tidal flats of South Korea support considerable artisanal fisheries on bivalves, e.g. the razor clam *Sinonovacula constricta*, the Manila clam *Ruditapes philippinarum* and *Mactra veneriformis*, crustaceans and fish, e.g. Mullet *Mugil chelo*, are also the basis for aquaculture of shrimp and algae. Annual yields of clams and cockles may

1. Backgrounds: Yellow Sea & Korean tidal flats

Total area of tidal flats in the Yellow Sea: ~18,000 km²
(*cf.* Wadden Sea: ~4,700 km² or Australian mangroves: ~11,500 km²)



YS Coastal Environments

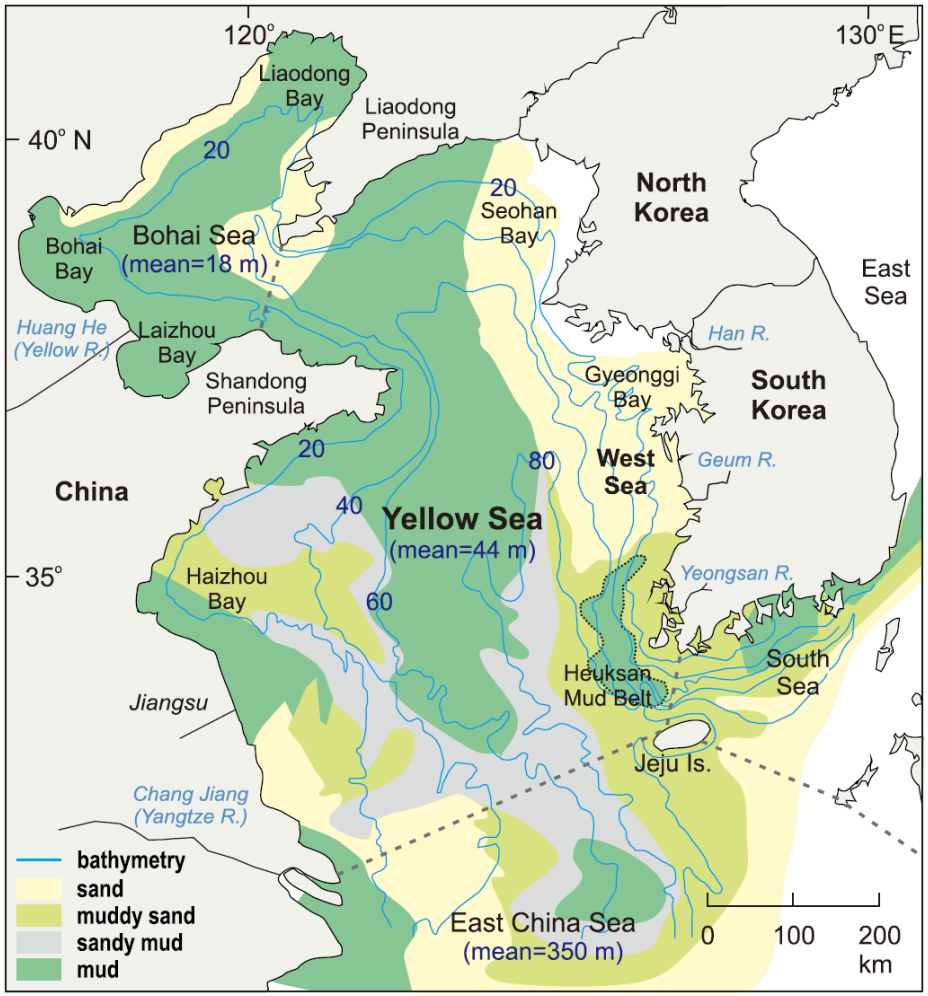
- rainy summer monsoon
- large rivers and estuaries
- shallow water system
- macrotidal regime
- varying bottom topography
- embayment system

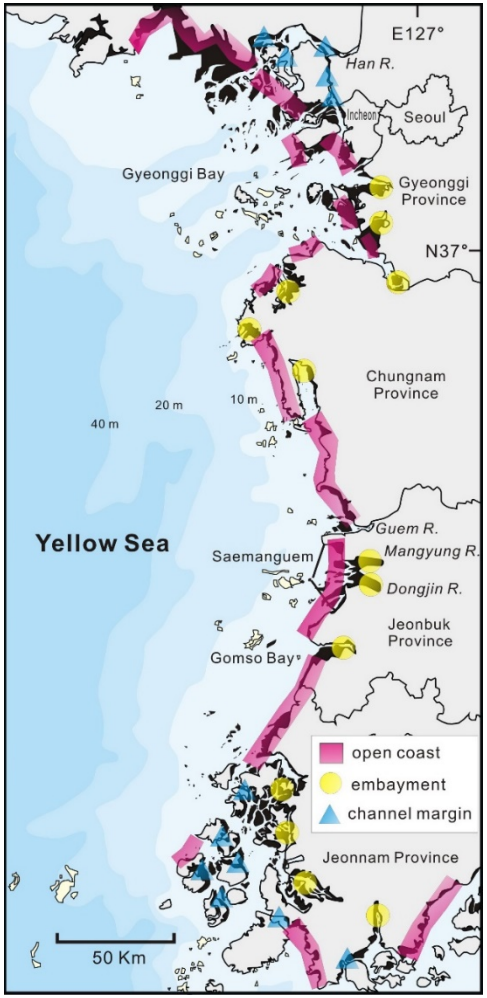
YS Coastal Characteristics

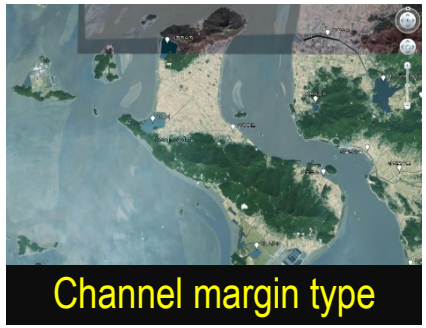
- turbid
- complex
- dynamic
- productive and healthy?

1. Backgrounds: Yellow Sea & Korean tidal flats

Geomorphology in the Yellow Sea and adjacent seas
Varying bottom topography & Embayment system in most estuaries







1. Backgrounds: Biodiversity

A census of marine biodiversity in the world oceans, *Costello et al., 2010*

# of species: Australia > Japan > China > Mediterranean > New Zealand

NRIC region	No. species	Seabed area km^2	Sea volume km^3	spp/area
Alaska[1]	5,925	3,654,304	8,666,714	1.6
Antarctica[3]	8,200	21,186,153	70,628,284	0.4
Atlantic Europe[4]	12,270	3,572,655	4,553,917	3.4
Australia[1]	32,889	6,819,501	15,272,583	4.8
Baltic[5]	5,865	411,218	26,353	14.3
Brazil shelves[2]	9,101	2,520,420	6,797,196	3.6
Canada Arctic[2]	3,038	3,233,113	2,769,789	0.9
Canada Eastern[2]	3,160	823,799	705,744	3.8
Canada Western[2]	2,636	317,363	271,883	8.3
Caribbean[3]	12,046	2,828,125	7,219,167	4.3
China[1]	22,365	831,966	66,825	26.9
Gulf of Mexico[3]	15,374	1,518,067	2,344,179	10.1
Hawaii[1]	8,244	2,459,609	11,212,445	3.4
Humboldt Current[2]	10,186	3,127,380	8,434,076	3.3
Japan[1]	32,777	3,970,743	14,721,516	8.3
Mediterranean[6]	16,848	2,451,059	3,833,673	6.9
New Zealand[1]	12,780	4,073,895	10,004,545	3.1
Patagonian Shelf[2]	3,776	2,693,614	7,264,273	1.4
SA Trop West Atlantic[2]	2,743	604,068	1,629,080	4.5
South Africa[1]	12,915	846,463	1,758,244	15.3
South Korea[1]	9,900	306,674	166,752	32.3
Trop East Pacific[2]	6,696	905,540	2,442,107	7.4
USA California[2]	10,160	1,053,172	1,933,718	9.6
USA Northeast[2]	5,045	692,073	1,270,708	7.3
USA Southeast[2]	4,229	624,984	1,147,525	6.8

Data sources cited in Methods. SA = South America (excluding Caribbean coasts); Trop = tropical. Spatial statistics based on (1) Exclusive Economic Zone, (2) portion of all EEZ for South America, USA, or Canada, (3) sea area, (4) combination of Norwegian, North, Irish, Greenland, and Celtic seas; Bay of Biscay; English, St. Georges, and Bristol channels; Inner Seas off West Scotland, (5) combination of Baltic Sea, Kattegat, Gulf of Bothnia, Gulf of Finland, Gulf of Riga, and (6) combination of Mediterranean Sea, Tyrrhenian Sea, Aegean Sea, Ionian Sea, Adriatic Sea, Ligurian Sea, Strait of Gibraltar, Alboran Sea [31].

Australia
1st ranked
# of species

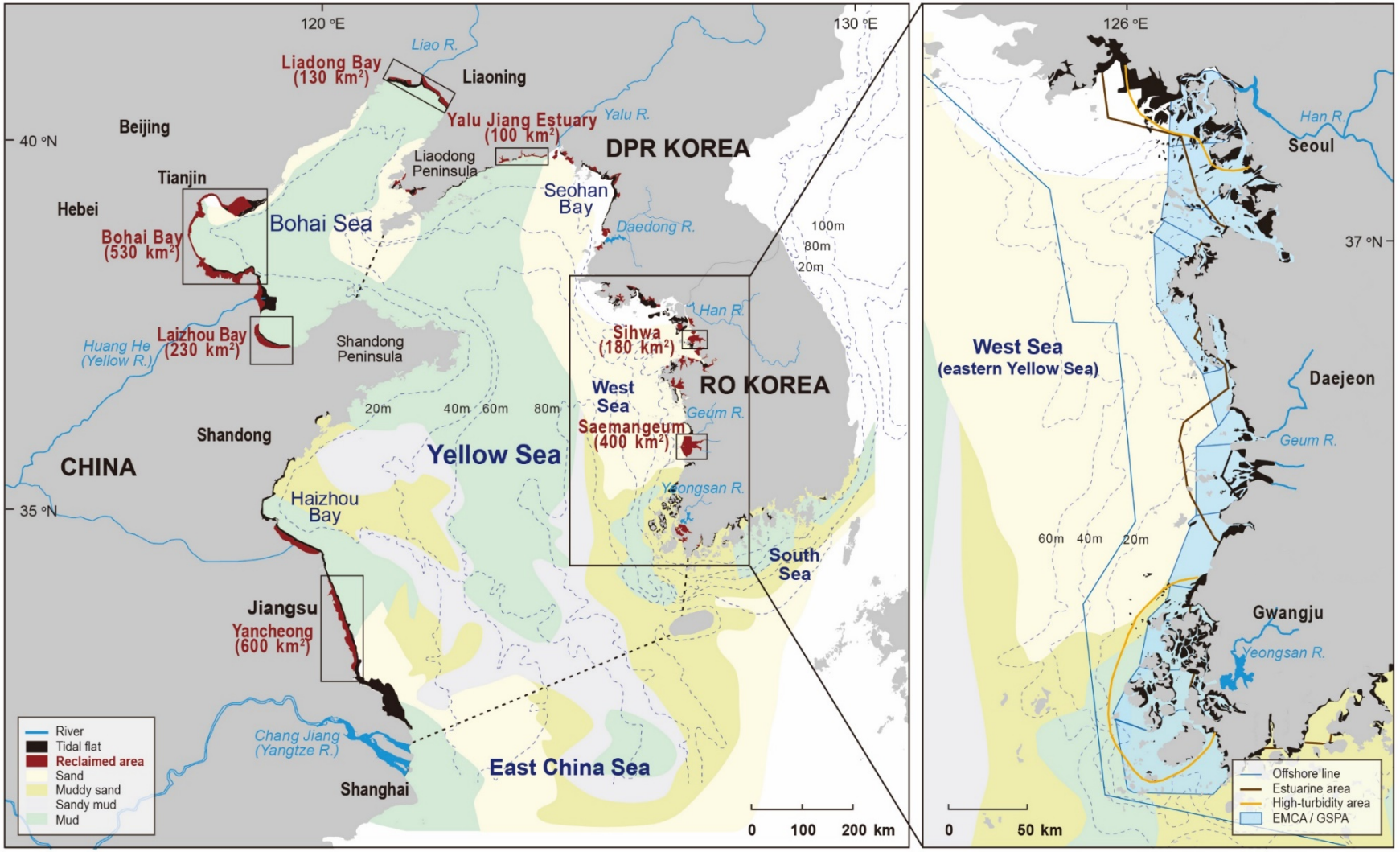
China
2nd ranked
spp/area

South Korea
1st ranked
spp/area

1. Backgrounds: The Korean tidal flat systems

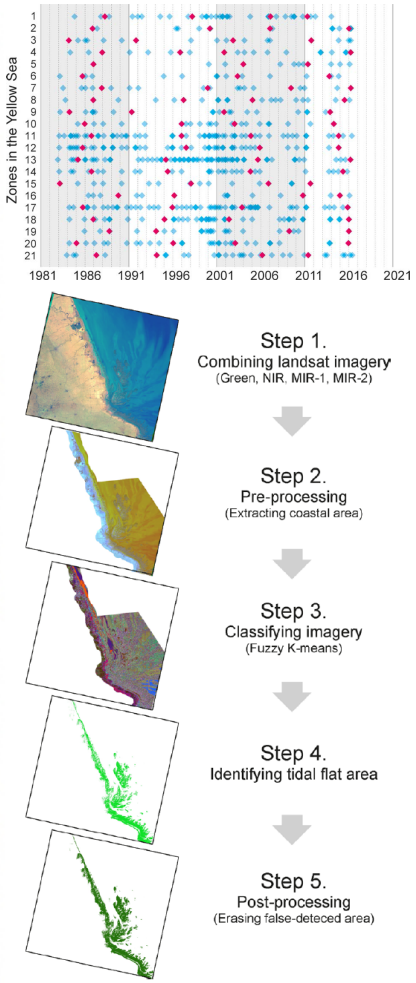
Status quo of coastal reclamation in the East Asia

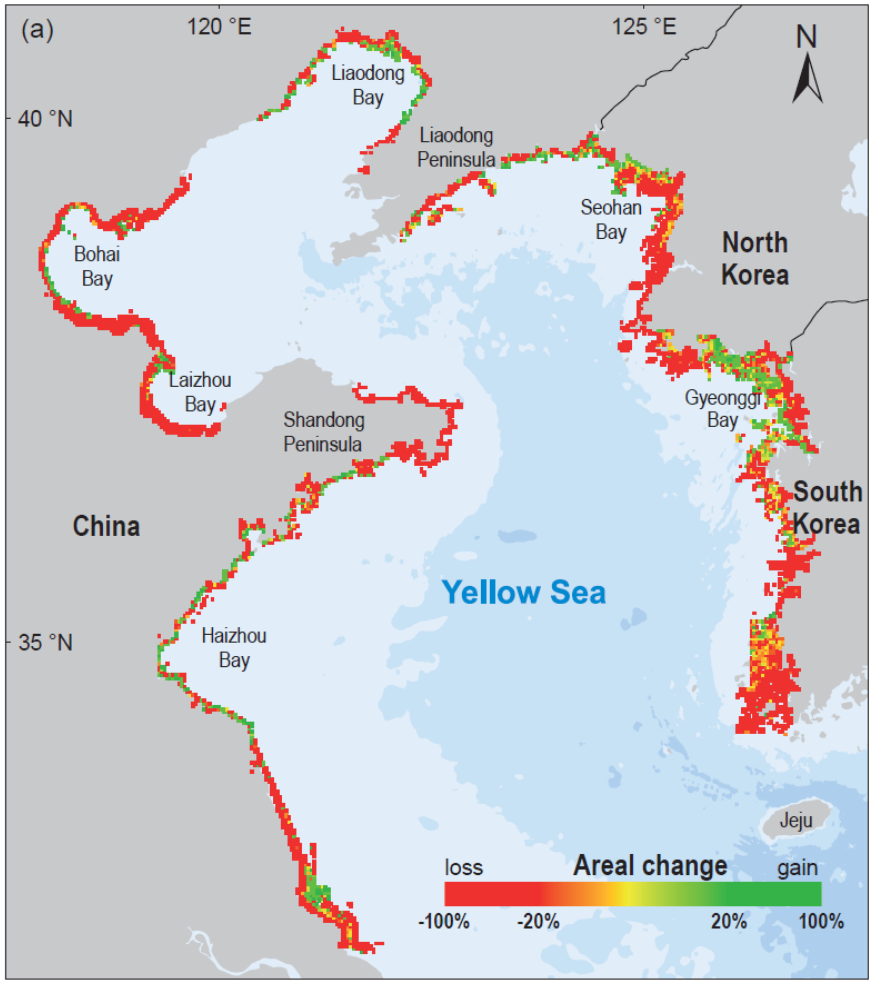
China : Korea : Japan ≈ 50 : 10 :1

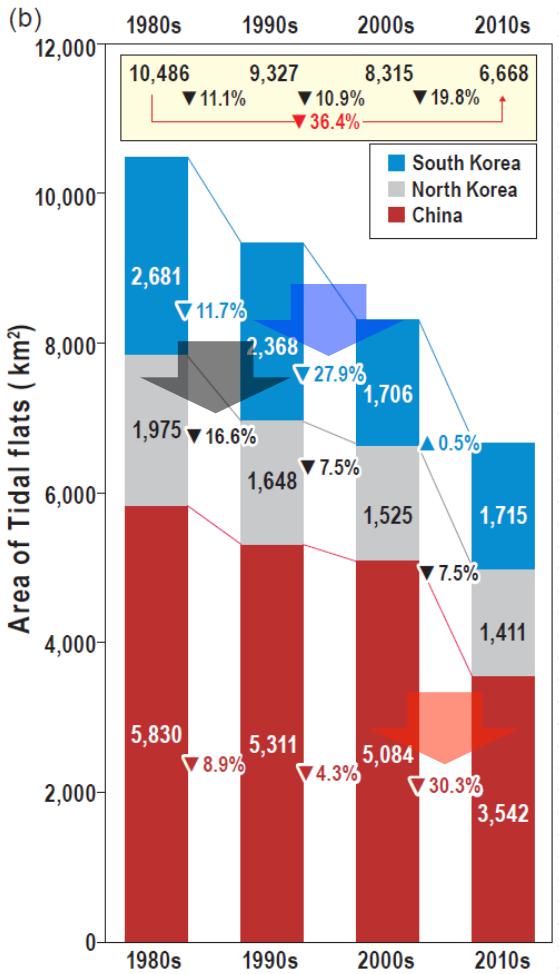


2. Reclamation of Coastal Wetland

40 years long changes in coastal land use (cover) of the YS
1% annual loss of tidal flats; ~9,700 km² loss expected in the 2020s

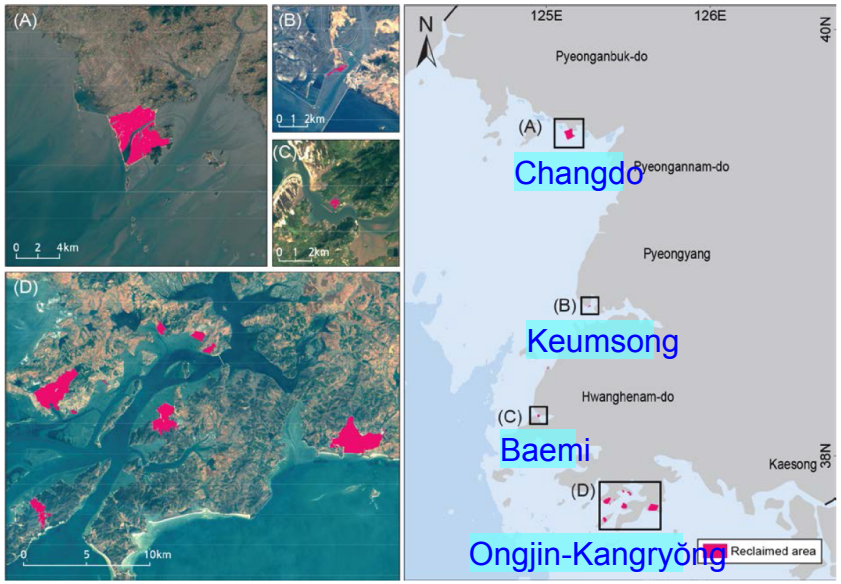




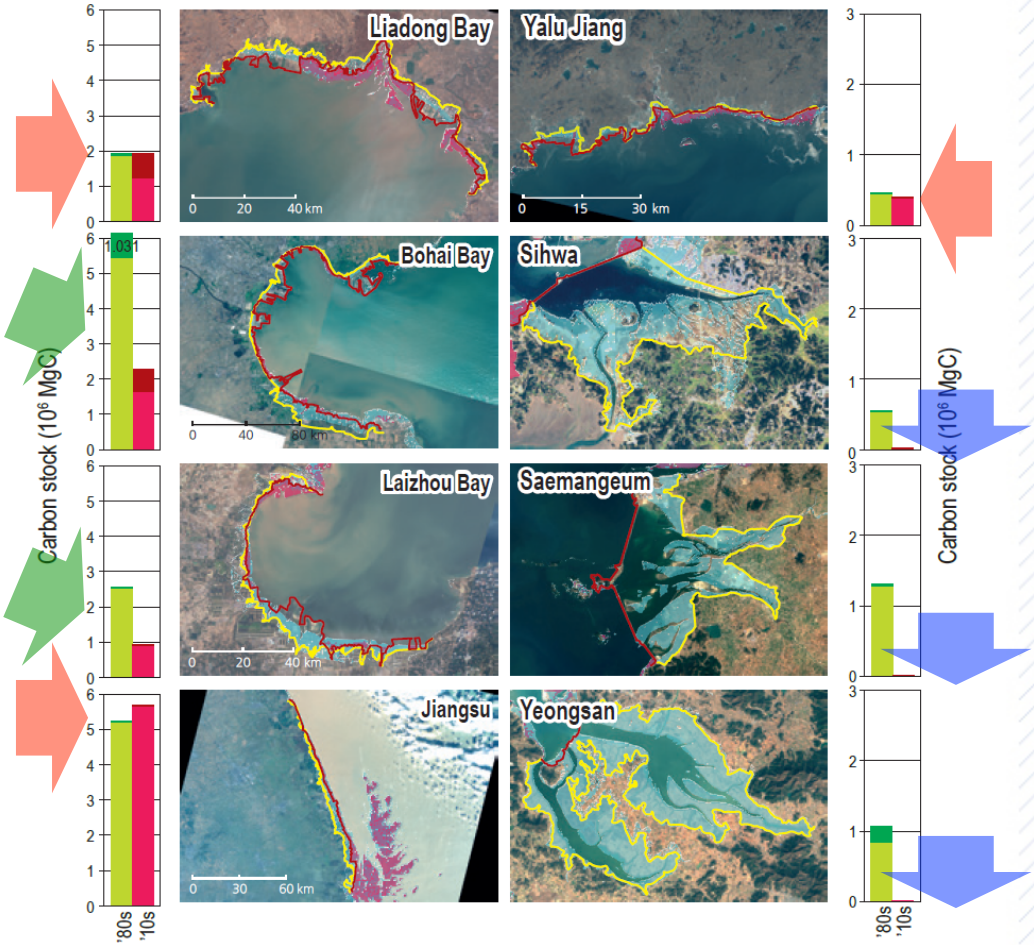


2. Reclamation of Coastal Wetlands

Newly updated for North Korea: ~30 km² reclaimed in the 2010s
A huge loss of total ESVs in the Yellow Sea: ~8 Billion USD for 40 years



Region	Total ESVs (Billion USD yr^{-1})		
	1980s	2010s	%-change
CHINA	12.4	7.5	▼ 39
RO KOREA	5.2	3.3	▼ 36
DPR KOREA	3.8	2.7	▼ 29
Yellow Sea	21.4	13.5	▼ 37

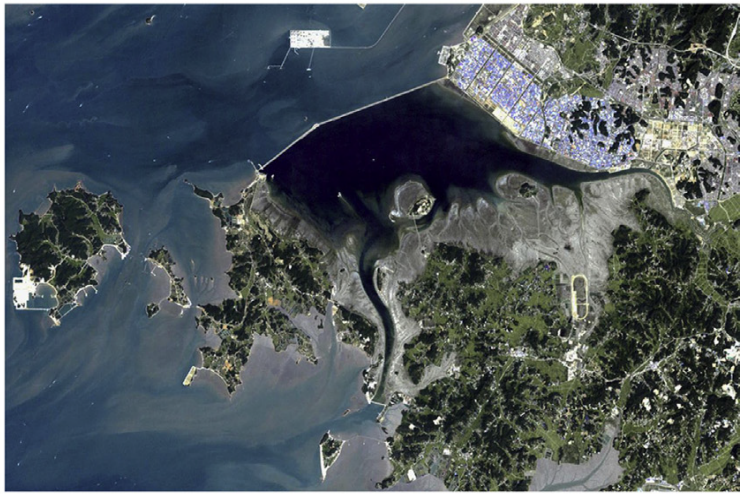


2. Reclamation of Coastal Wetlands

(a) Sihwa reclamation

Before (1990)

After (1995)



Tota

~2,5C

(b) Saemangeum reclamation

Before (1991)

After (2002)

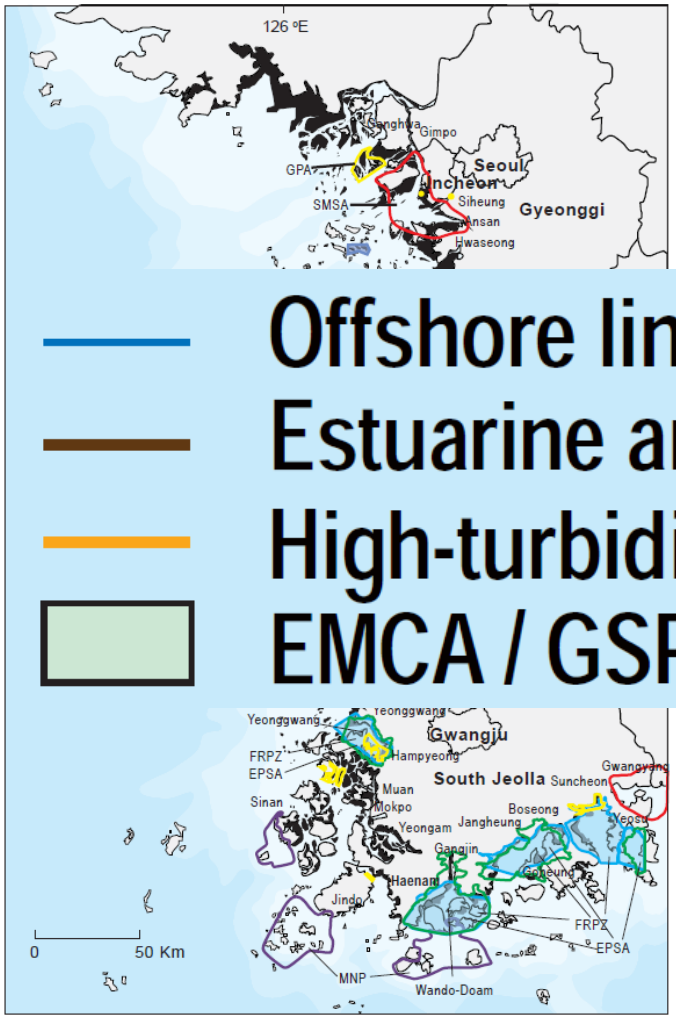
3. Restoration of Coastal Wetlands

Procession of 400 km from Saemangeum to Seoul
by Three Steps and One Bow & Save Our Saemangeum Campaign

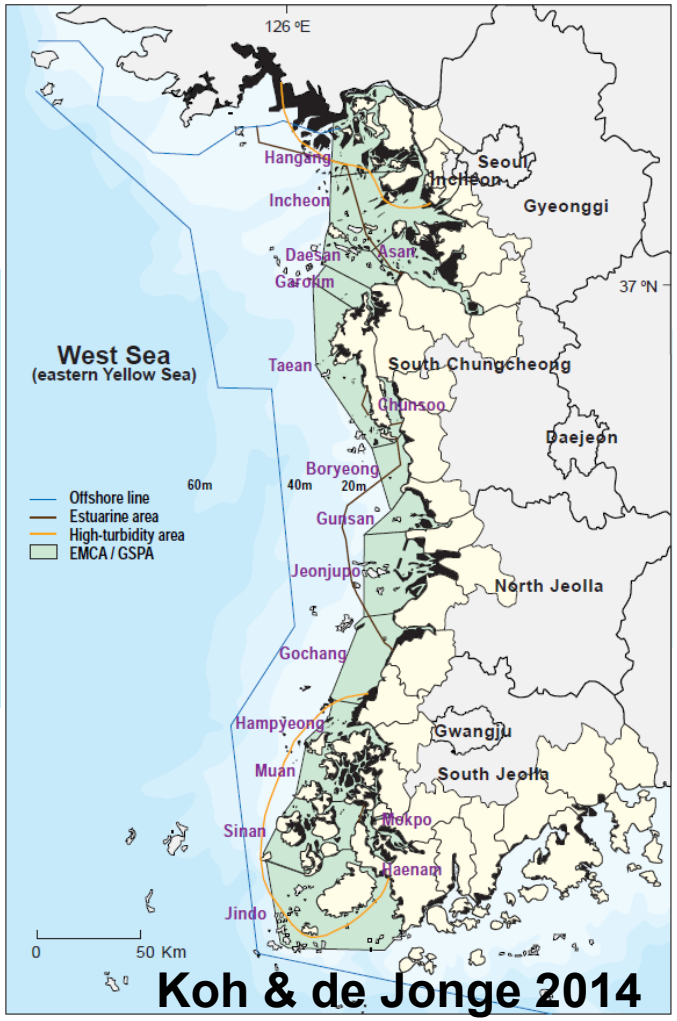
3. Restoration of Coastal Wetlands

Various protected areas: So complex → Why not simplifying?

(a)

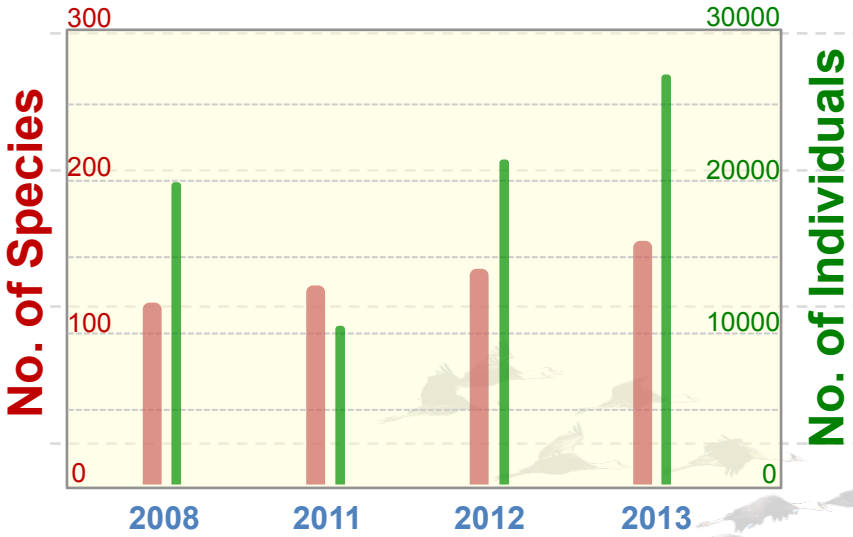


(b)



3. Restoration of Coastal Wetlands

<Waterbirds in Suncheon Bay>



No. of Red-crowned Crane observed in Suncheon Bay rapidly increased since 2007

3. Restoration of Coastal Wetlands

2008 Tidal Flats Restoration planned

2009 17 Target Restoration Areas selected

2010 Suncheon, Gochang,& Sacheon Pilot Projects
(1.6, 13, & 1.7 million USD)

2012 Sinan P… USD)

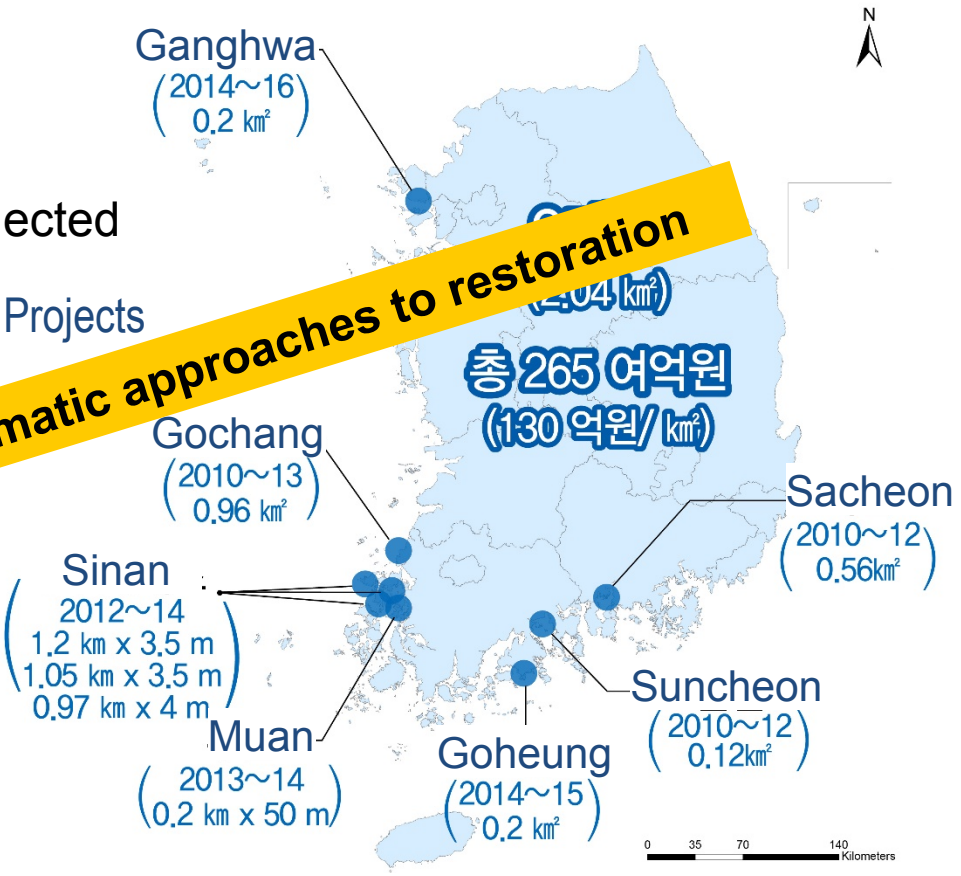
2013 Muan Project
(0.4 million USD)

2014 Goheung & Ganhwa Project
(0.4 & 3.9 million USD)

2015 Tidal Flat Resources Master Plan
(prioritizing target restoration area, guidelines)

2016

Arbitrary, occasional & unsystematic approaches to restoration



Economic value of Korean tidal flats
5.5 million USD/km²/yr

Launching a Policy Project by the Ministry of Oceans & Fisheries
for the National Tidal Flat Restoration Master Planning

3. Restoration of Coastal Wetlands

Despite of many efforts and trials, the Korean society is at the first generation in terms of readiness for the restoration

1. re-arranging legal and institutional mechanism
2. establishing multidisciplines- and convergence– based R&D system
3. linking spatial management and local development to the restoration
4. building a community-based restoration planning and management sy stem
5. Incorporating marine ecosystem services into decision-making and evaluation of restoration

Thank You Very Much!

谢谢

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