



Evaluating gain or loss of ecosystem services from the invasion of alien species to Korea's marine ecosystem

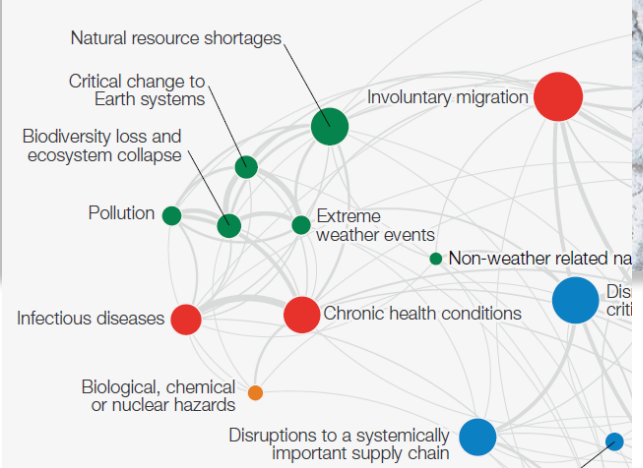
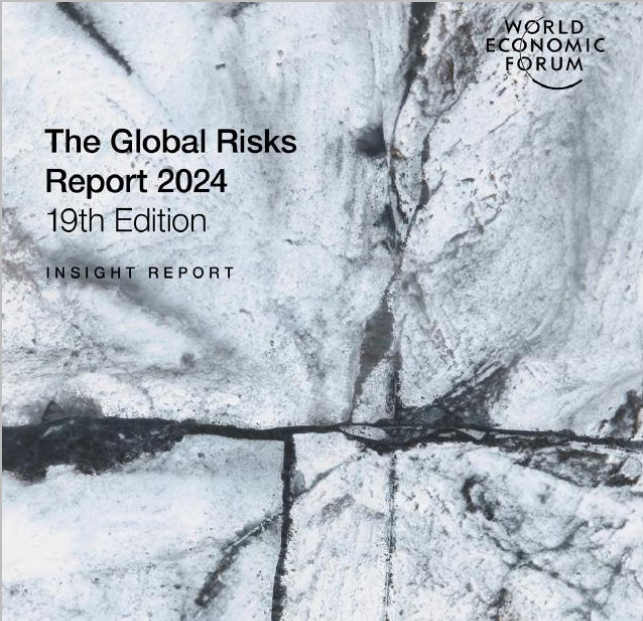
Session 6: Social-ecological systems thinking: From ecosystem services perspectives

Jungho NAM, Korea Maritime Institute



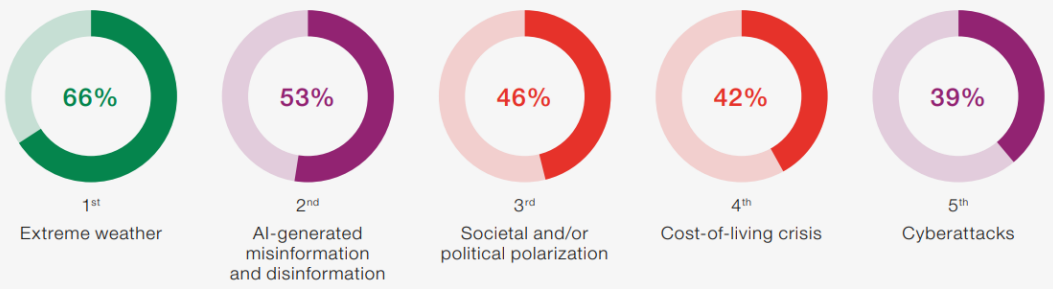
Jongseo Yim, National Institute of Green Technology

Backgrounds & Objective



Current risk landscape

Please select up to five risks that you believe are most likely to present a material crisis on a global scale in 2024.



Twin Crisis

Risk categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

2 years



10 years

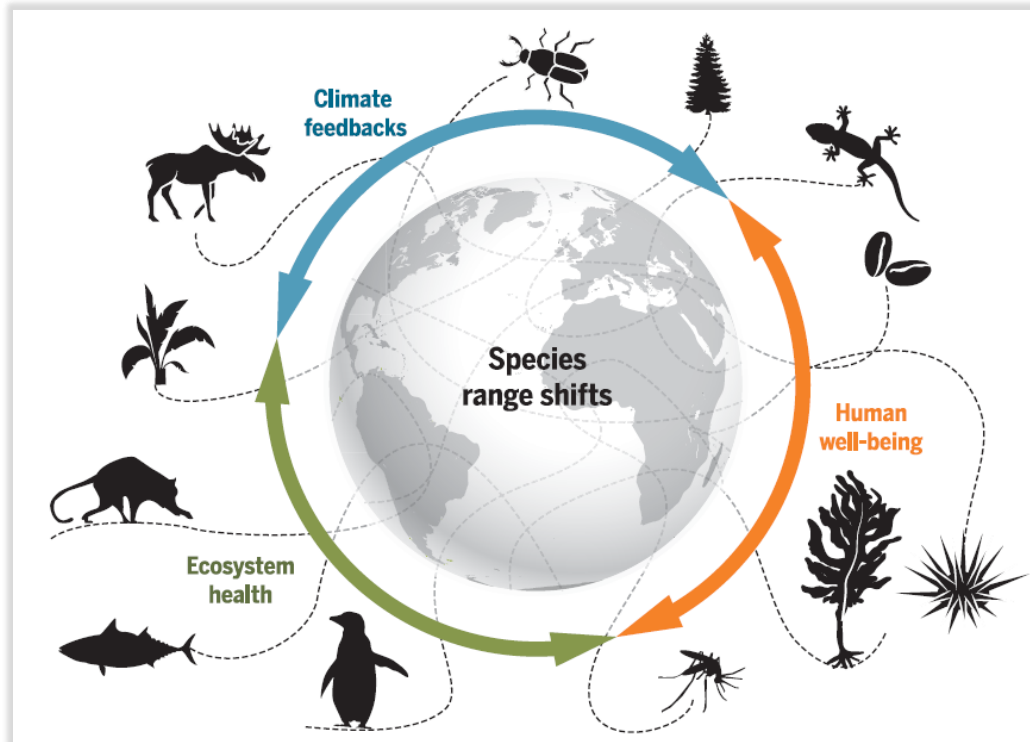


Source: World Economic Forum Global Risks Perception Survey 2023-2024.

➔ Natural ecosystems: past the point of no return

Backgrounds & Objective

Climate change & Biodiversity : opportunities in ecosystem services?



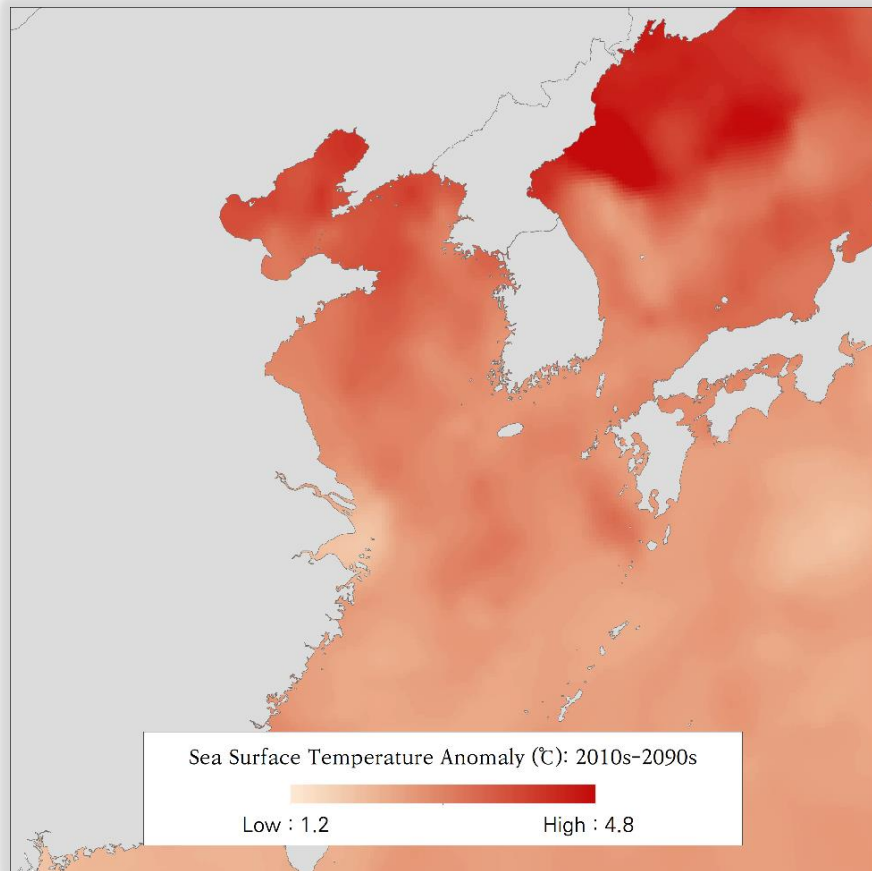
- Provisioning
- Regulating
- Cultural
- Supporting Services

Benefits from carbon sequestration, natural disaster prevention, tourism etc

- Pole-ward movement of marine taxa, **4 times faster** (72 km/10yrs) than terrestrial taxa (17 km/10yrs) Pecl et al., 2017, Science

To understand variability of marine ecosystems services under twin-crisis: climate change and biodiversity

- ✓ **Geographic scope:** Korean Peninsula's coastal ecosystems, focusing on tidal wetlands
- ✓ **Climate change scenario analysis**
 - RCP 8.5 Scenario, MPI-ESM-MR (WCRP CMIP5)
 - Temporal scope: 2011~2100
 - Climate data: surface air & sea temperature



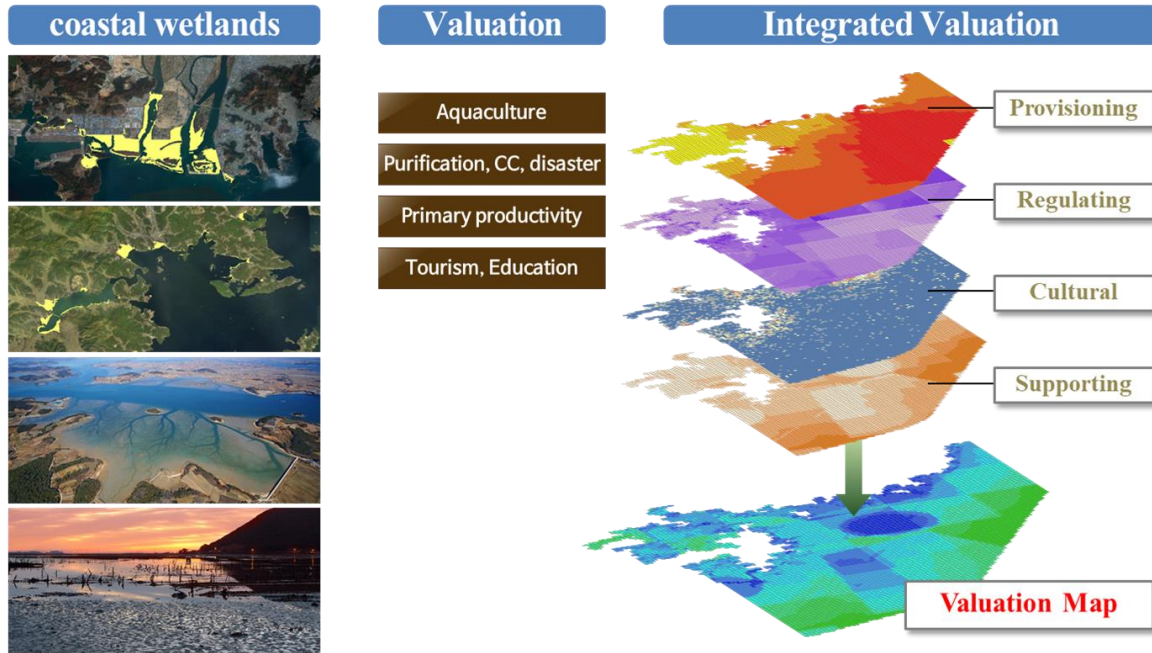
- ✓ **Target mangroves**
 - *Kandelia obovata*
 - *Avicennia marina*
 - *Rhizophora stylosa*



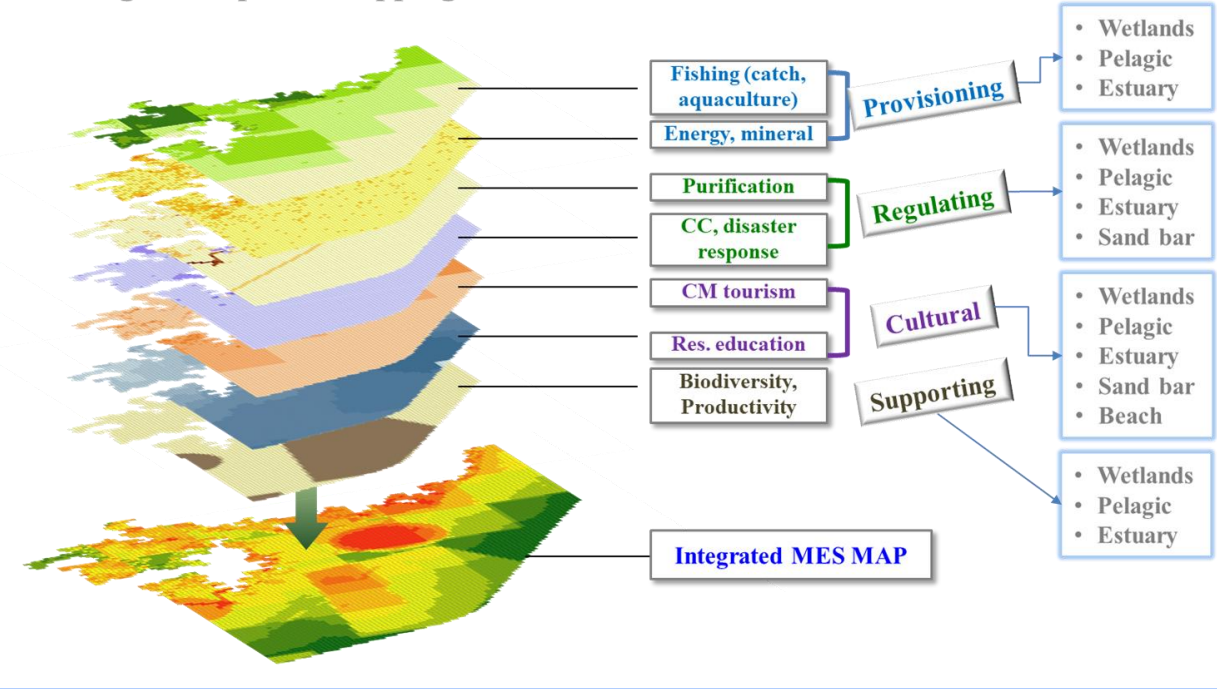
✓ MES assessment & valuation

- Assessment: scientific survey, numerical modeling, mesocosm study, big-data analysis
- Valuation: willingness-to-pay (CVM, conjoint), market price, replacement methods, meta-analysis (only for mangroves MEV)

MES Valuation (case of tidal wetland)

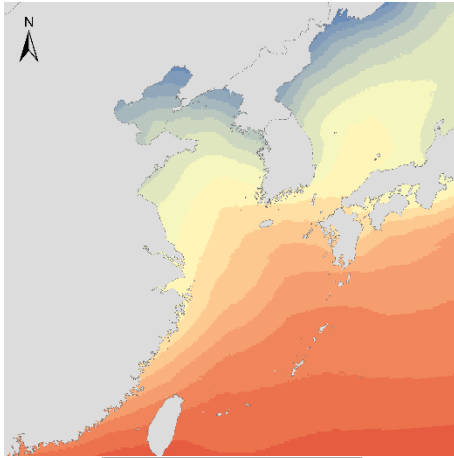


Integrated Spatial Mapping

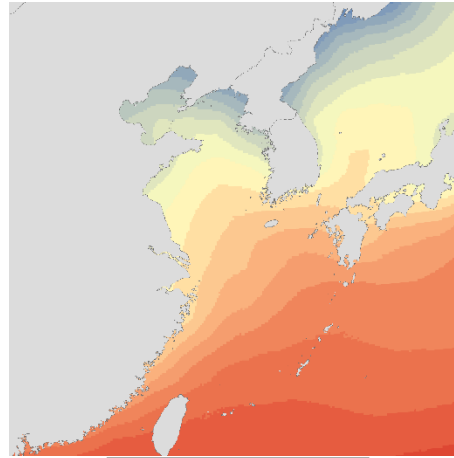


Annual & winter mean temperature change (10 year-average)

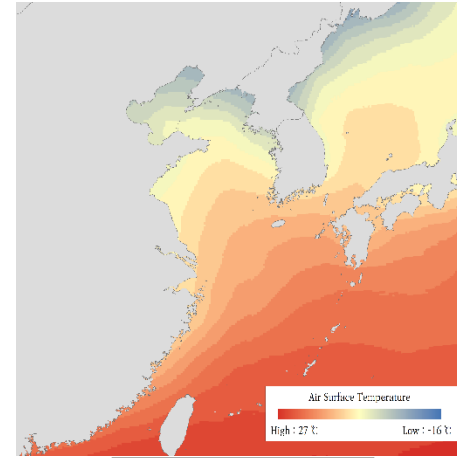
Surface Air



2011-2020

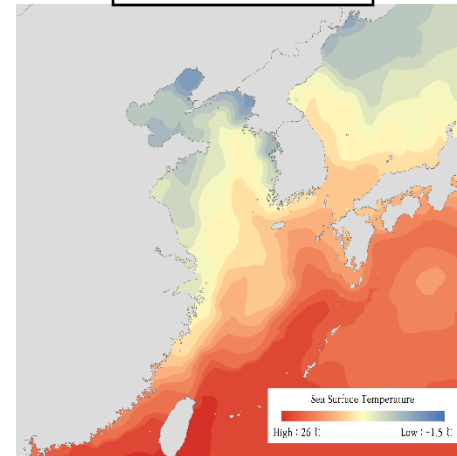
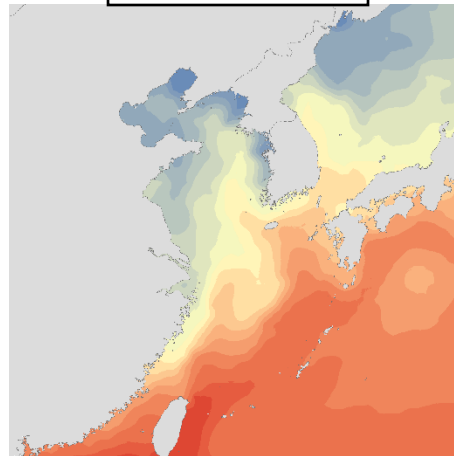
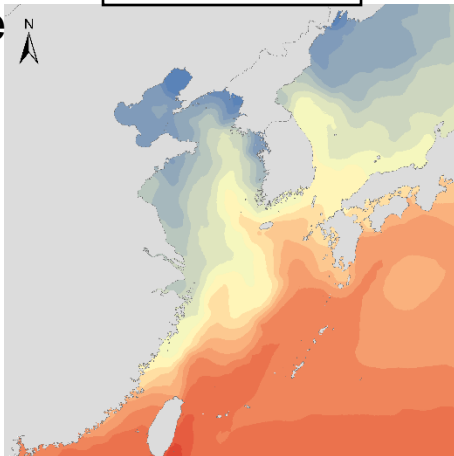


2051-2060



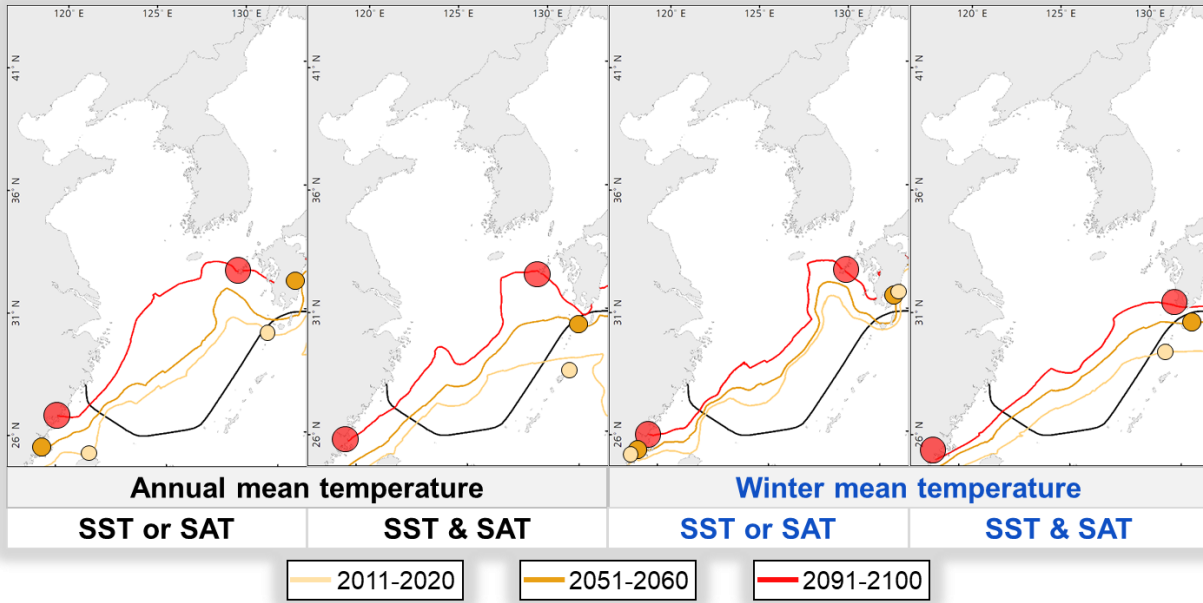
2091-2100

Sea Surface

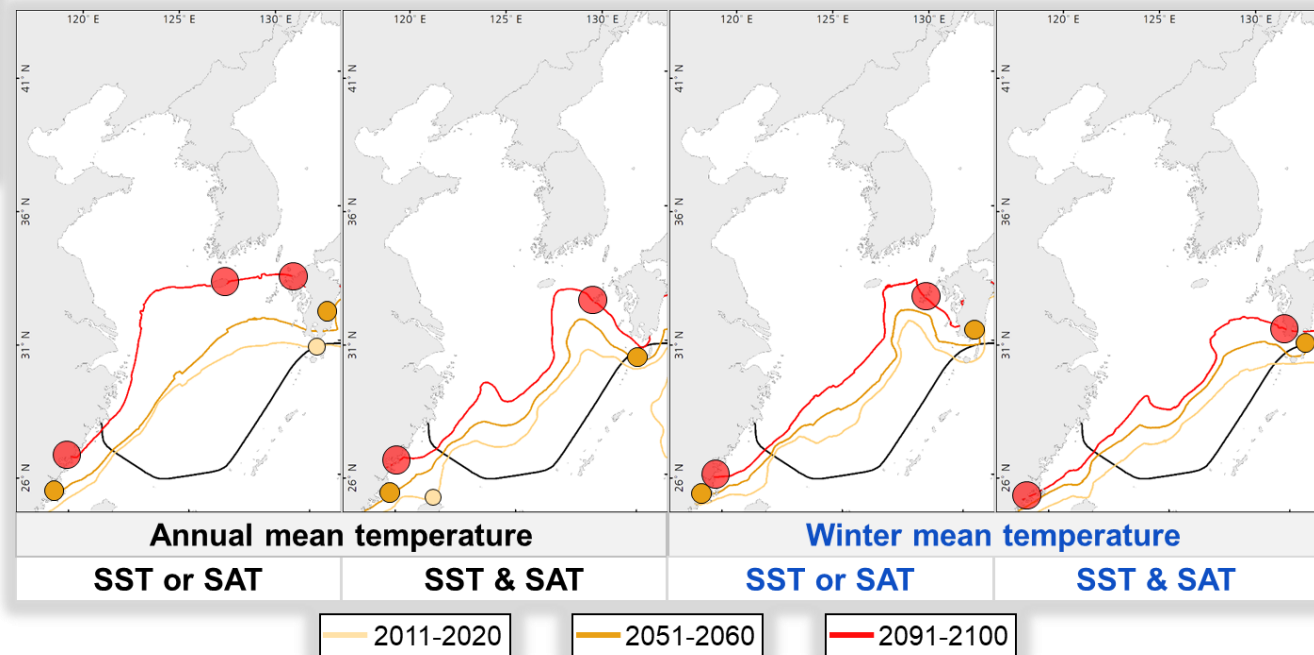


Northern habitat margins of

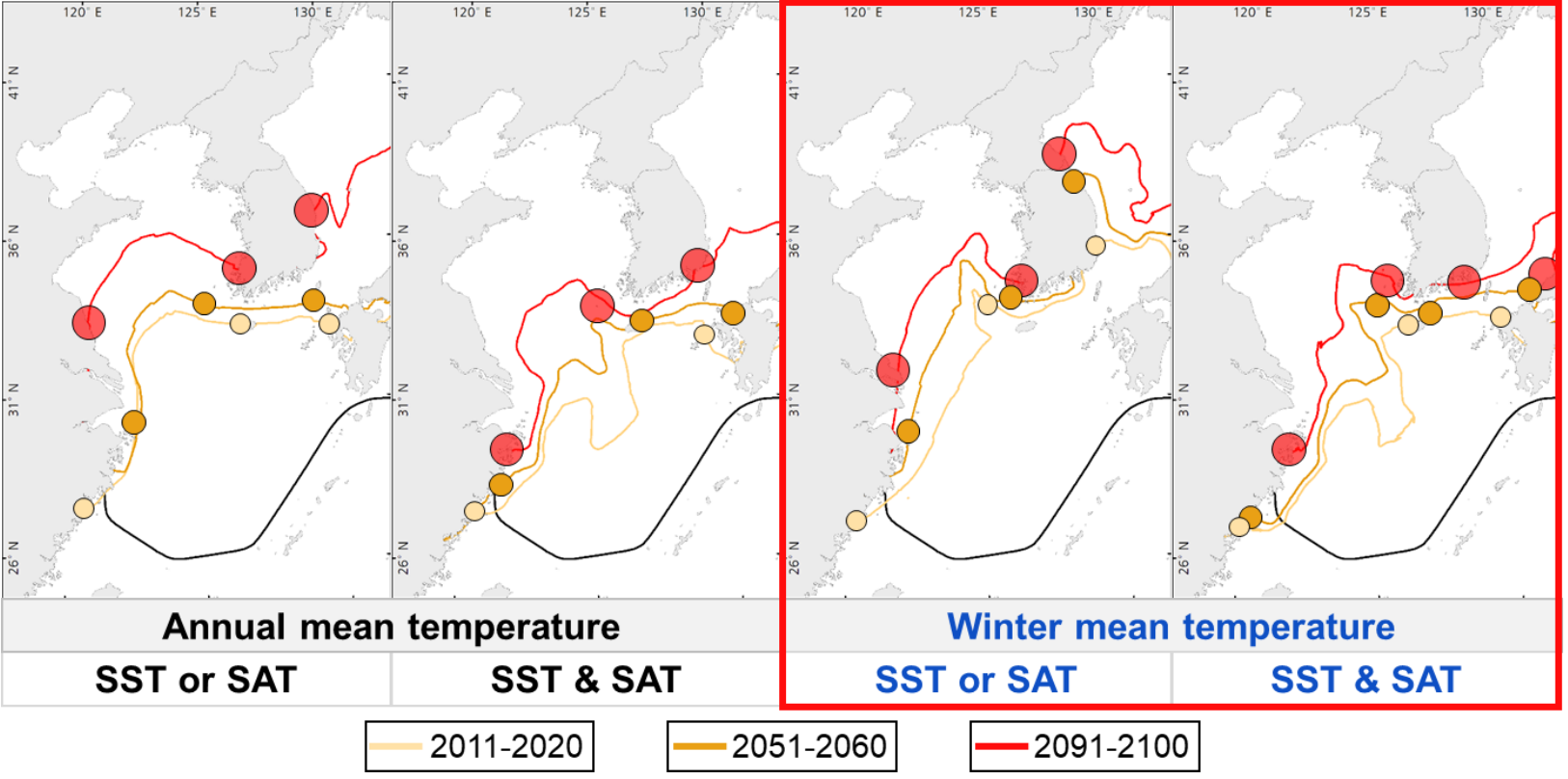
Avicennia marina



Rhizophora stylosa



Northern habitat margins of *Kandelia obovata*



SST or SAT			
Coast	'10s – '50s	'50s – '90s	10yr mean
C. East	413.6 km	192.8 km	75.8 km
K. West	20.3 km	84.7 km	13.1 km
K. S-East	264.1 km	121.3 km	48.2 km

SST and SAT			
Coast	'10s – '50s	'50s – '90s	10yr mean
C. East	55.4 km	348.6 km	50.5 km
K. West	NA	83.2 km	10.4 km
K. S-East	66.8 km	84.9 km	19.0 km

Results

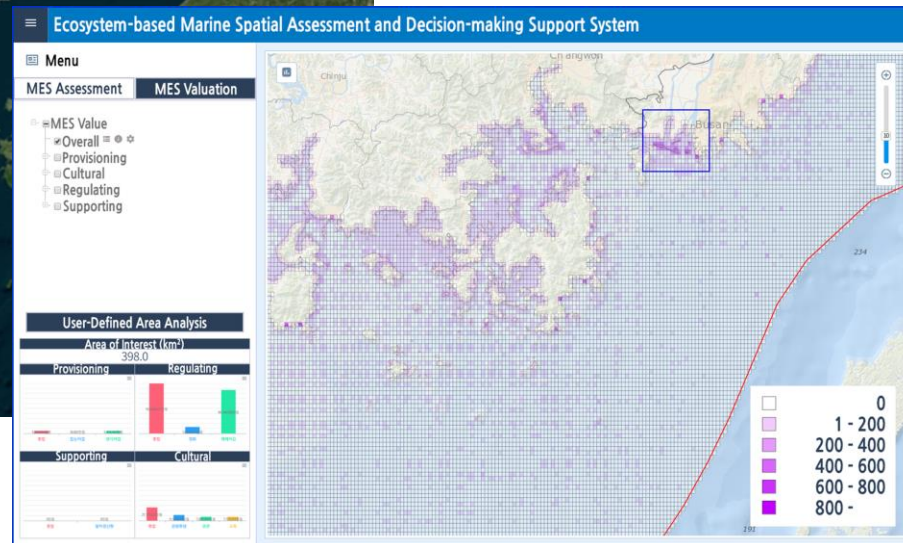
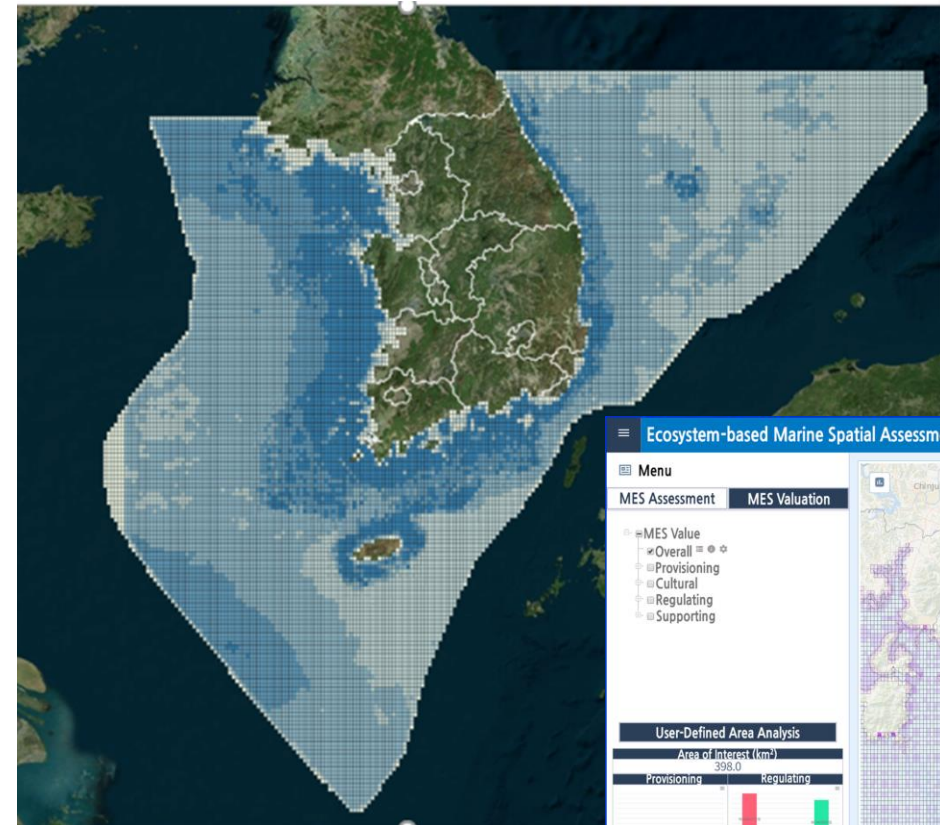
MES value mapping (1x1 km) in 2021

- Provisioning, regulating and cultural
- **The first national scale valuation map**



Tidal wetlands ES values

Services	Total Values (mil. USD)	X 10 ⁴ USD km ⁻² yr ⁻¹
Total	12,761.8	510.5
Provisioning	38.9	1.55
Regulating	11,699.0	467.96
Nitrogen removal	1,997.6	79.90
Phosphate removal	7,920.6	316.83
Organic material removal	99.8	3.99
Disaster prevention	1,529.6	61.18
Carbon sequestration	8.6	0.34
Cultural	1,023.9	40.96
Tourism	462.0	18.48
Aesthetic value	316.3	12.65
Education	162.5	6.50
Heritage	53.9	2.16
Inspiration	29.2	1.17



Meta-analysis of ecosystem services values

Mangrove forests (294×10^4 USD $\text{Km}^{-2}\text{yr}^{-1}$), **1.5 times higher** than bare-soil tidal wetlands

Bare-soil	Total ESV	Provisioning					Regulating Services										Supporting		Cultural Services		
		FP	WP	RM	HR	CS	GR	CR	EP	WR	WT	SF	FC	WR	NT	MD	HS	BD	RE	AE	SP
Liaoning	386.8	NA	NA	NA	NA	111.7	35	41.5	NA	NA	NA	62.9	47	NA	NA	NA	NA	NA	16.9	NA	NA
Liaoning	120.1	0.8	NA	0.5	NA	NA	5.3	29.7	NA	29.5	31.6	4.4	NA	NA	NA	NA	NA	NA	NA	NA	
Liaoning	1.7	NA	0.3	NA	NA	NA	0.2	0.1	NA	NA	0.2	0.4	NA	NA	NA	NA	NA	NA	NA	NA	
Hangzhou	160.1	1.6	8	1.5	74.6	NA	NA	NA	NA	NA	NA	7.1	NA	0.6	NA	NA	24.2	NA	NA	NA	
Hangzhou	400.2	NA	NA	NA	NA	NA	NA	NA	NA	17	NA	NA	NA	NA	NA	NA	1.8	NA	NA	NA	
Jiangsu	147.4	1	NA	0.6	NA	NA	6.5	36.5	NA	36.2	38.7	5.4	NA	NA	NA	NA	9.9	12.6	NA	NA	
Jiangsu	148.6	0.7	NA	0.2	NA	NA	4.3	40.5	NA	48.3	43.1	4.1	NA	NA	NA	NA	5.9	13.2	NA	NA	
Jiangsu	139.9	0.9	NA	0.6	NA	NA	6.2	34.6	NA	34.2	36.8	5.1	NA	NA	NA	NA	9.4	12	NA	NA	
Laizhou	257.5	6.7	4.4	4.6	NA	NA	NA	5.3	NA	61	32.8	NA	NA	18.6	32.5	14	12.7	24	21.7	NA	
East China Sea	212.6	1	NA	0.2	52.6	NA	6.1	58	NA	NA	61.6	5.8	NA	NA	NA	NA	8.5	NA	18.8	NA	
Mean value	197.5	1.8	4.2	1.2	63.6	111.7	11	60.9	11.1	41.8	32.7	4.6	62.9	47	9.6	32.5	13.3	7.8	14.8	18.4	NA

197.5×10^4 USD/ $\text{km}^2 \cdot \text{yr}$

Multidisciplinary MES values of 2021, **ca. 2.5 times** than meta-analysis

Mangroves	Total ESV	Provisioning					Regulating										Supporting		Cultural		
		FP	WP	RM	HR	CS	GR	CR	AR	WR	WT	SF	FC	WR	NT	MD	HS	BD	RE	AE	SP
Shenzhen/China	93.9	0.4	23.2	0.1	NA	NA	NA	NA	NA	NA	NA	2.6	NA	NA	NA	NA	3.7	8.3	NA	NA	
Ximen/China	1029.6	NA	NA	48.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	126.4	376.6	NA	31.4	NA	231.8	
Can Gio/Vietnam	126.3	24.1	NA	3.2	NA	17.3	NA	NA	NA	NA	NA	37.5	NA	NA	NA	NA	NA	44.2	NA	NA	
Sinaloa, Mexico	195.6	43.3	NA	4.7	NA	NA	NA	37.8	NA	NA	NA	NA	NA	NA	NA	NA	104.2	NA	5.5	NA	
Global value	133.5	6.2	NA	2.2	NA	NA	NA	24.6	NA	NA	89.5	NA	NA	NA	NA	2.3	NA	8.8	NA	NA	
China	322.6	NA	NA	4	NA	NA	NA	NA	NA	NA	49.9	NA	NA	NA	35.7	225.5	NA	7.5	NA	NA	
Global value	583.1	220.4	NA	2.9	NA	2.3	NA	99.5	NA	NA	92.5	NA	NA	NA	NA	NA	NA	165.6	NA	NA	
Ca Mau/Vietnam	233.5	59.1	NA	60.9	NA	6.6	NA	NA	NA	NA	106.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	
East China Sea	212.6	1	NA	0.2	52.6	NA	6.1	58	NA	NA	61.6	5.8	NA	NA	NA	NA	8.5	NA	18.8	NA	
Liaoning/China	8.8	0.1	1.6	1.1	NA	NA	0.2	0.6	NA	NA	0.4	2.2	NA	NA	NA	NA	2	0.6	NA	NA	
Mean value	294.0	44.3	12.4	12.8	52.6	8.7	3	43.7	58.3	96.4	53.5	31	NA	NA	81.1	201.5	29.6	38.1	12.2	231.8	

294.0×10^4 USD/ $\text{km}^2 \cdot \text{yr}$

- ✓ Tidal wetlands in 2021 vs. mangrove forests in 2050 : **bare-tidal wetlands are more valuable?**
 - Border price issue
 - Trans- and multi-disciplinary approach to MES measurement and valuation → more scientifically concrete approach and applicable to ecosystem management

- ✓ **Down scale modelling** of marine parameters variation, based on SSP scenarios
 - Global scale → national/local levels (higher resolution)
 - Comprehensive approach to climate change : risks + opportunities

- ✓ **Projects/actions-focused International cooperation** on biodiversity re-distribution
 - Region-wide collaboration for MES valuation, considering effect of border price
 - Joint survey on climate change impact on marine ecosystem in Asian region: re-distribution

- ✓ Incorporation of '**alien species** introduction'-related arrangements into long-term **climate change adaptation strategy and marine policy**
 - Socio-economic impact assessments on coastal area
 - Alien species-related issue and impact assessment to be put into marine spatial policy and coastal management

Thank you for attention