

Jan. 15, 2025

Blue carbon and Living Shorelines in Korea

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Lab. (MARBEL Lab.)*


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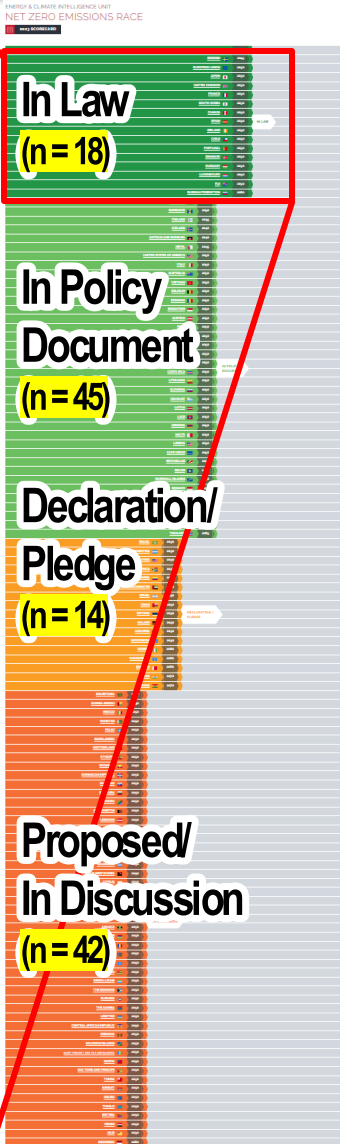
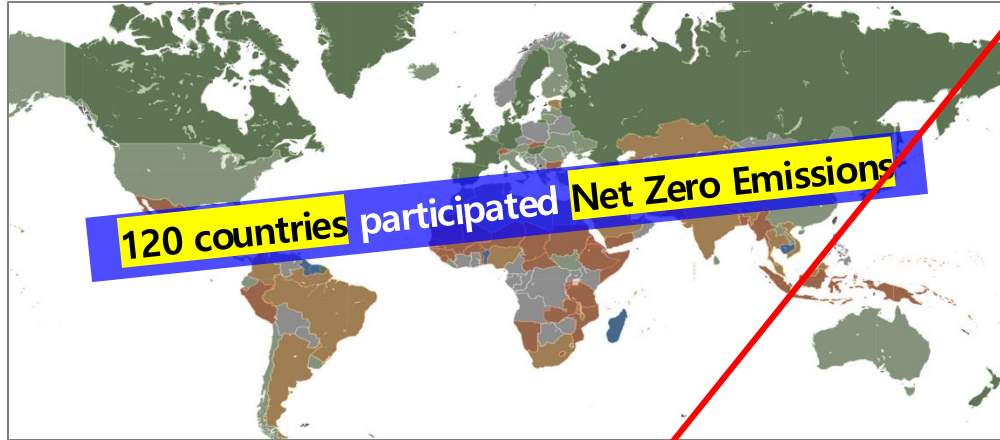


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- 1. Backgrounds**
 - 2. Korean Blue Carbon Science**
 - 3. Key Findings & Discussion**
 - 4. Remarks**
- 

1. Backgrounds

Net Zero Emissions Race(NDC & Net-Zero): K-MOF challenged Negative Emissions



우리는 세계 14번째 탄소중립을 법제화한 국가

3/8

스웨덴
2017년 최초 탄소중립 법제화국

대한민국
세계 14번째 탄소중립 법제화국

우리나라는
탄소중립 기본법 제7조에 따라 2050년까지 탄소중립을 달성하는 것을 국가비전으로 명시하여 세계 14번째로 탄소중립을 법제화한 국가가 되었습니다.

1999.04.2000
탄소중립 녹색성장 위원회

GERMANY	2045
SWEDEN	2045
EUROPEAN UNION	2050
JAPAN	2050
UNITED KINGDOM	2050
FRANCE	2050
ITALY	2050
SOUTH KOREA	2050
CANADA	2050
SPAIN	2050
IRELAND	2050
CHILE	2050
PORTUGAL	2050
DENMARK	2050
HUNGARY	2050
NEW ZEALAND	2050
LUXEMBOURG	2050
FIJI	2050

2050 Negative 해양수산 탄소 네거티브

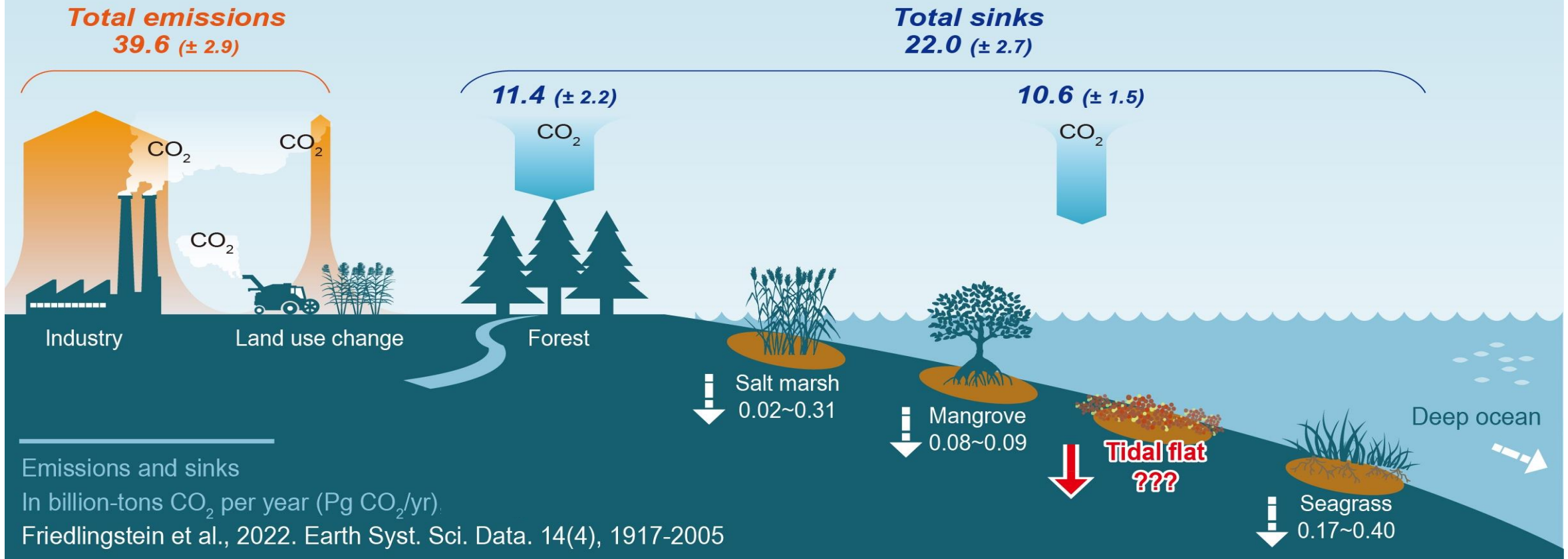
<p>해운 '18년 102만톤 '50년 31만톤</p> <p>선박 탄소 배출 최소화</p>	<p>수산-어촌 '18년 304만톤 '50년 12만톤</p> <p>친환경 수산-어촌 터전 마련</p>
<p>해양에너지 '50년 230만톤 감축</p> <p>해양 재생에너지 확대</p>	<p>흡수원 '50년 136만톤 흡수</p> <p>CCS '50년 최대 6,000만톤 저장</p> <p>바다의 탄소 흡수-저장 확대</p>
<p>항만 '50년 탄소중립</p> <p>탄소중립 항만 구축</p>	<p>해양폐기물 '50년 해양플라스틱 ZERO</p> <p>해양폐기물 재활용 극대화</p>

1. Backgrounds

The Importance of **the Ocean** in Response to **Climate Change**

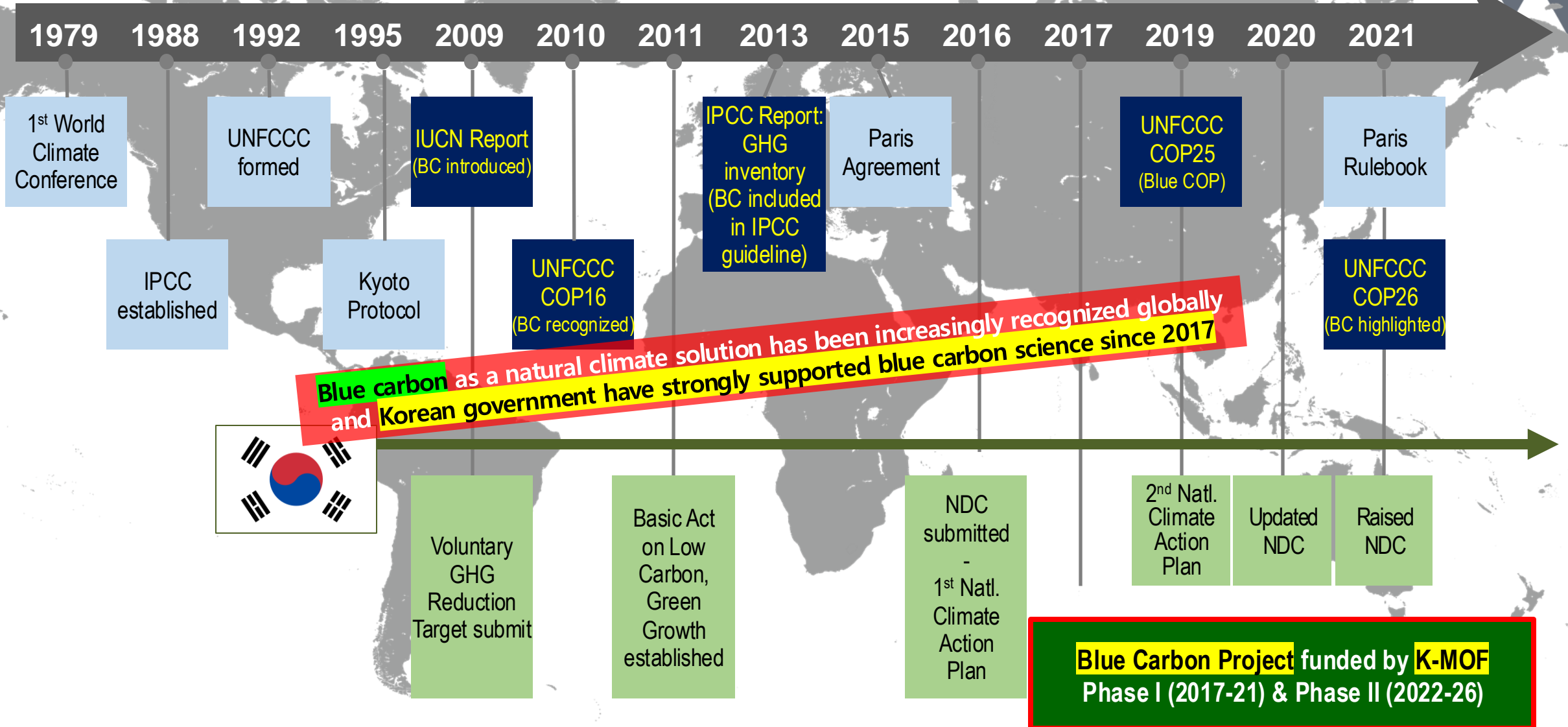
- ✓ Global carbon budget (2012-2021, 10yr average): CO₂ emissions vs. CO₂ Sinks
- ✓ CO₂ **emissions**: ~39.6 Pg yr⁻¹, **Sinks**: ~22.0 Pg yr⁻¹ (**Green C** 11.4 Pg yr⁻¹ ≈ **Blue C** 10.6 Pg yr⁻¹)

Global carbon budget 2012 - 2021



1. Backgrounds

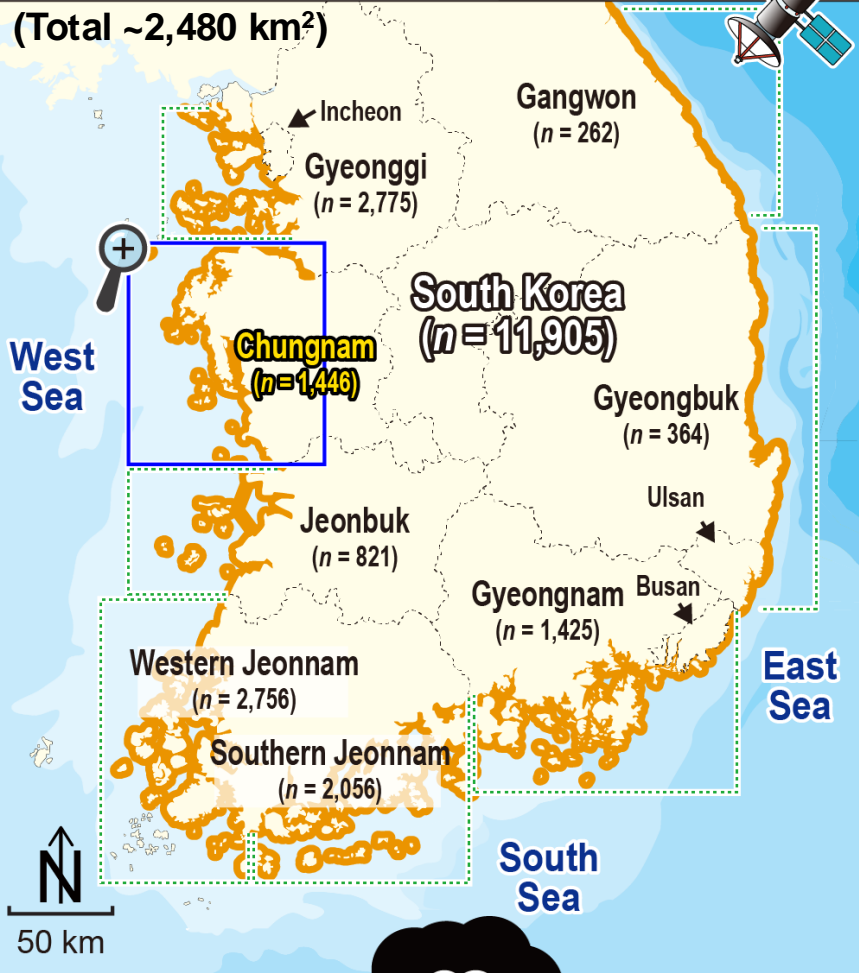
Blue Carbon Science in a Global Window of Climate Change



2. Korean Blue Carbon Science

Phase-I (2017-2021)

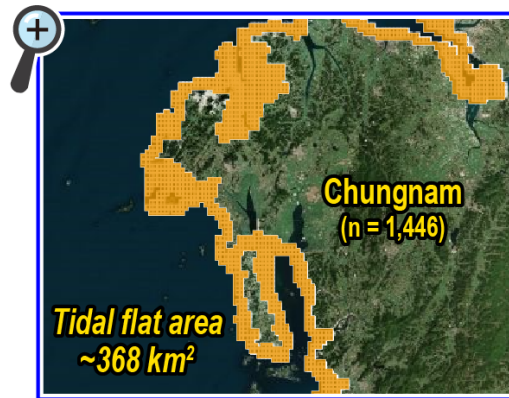
Intertidal area of South Korea



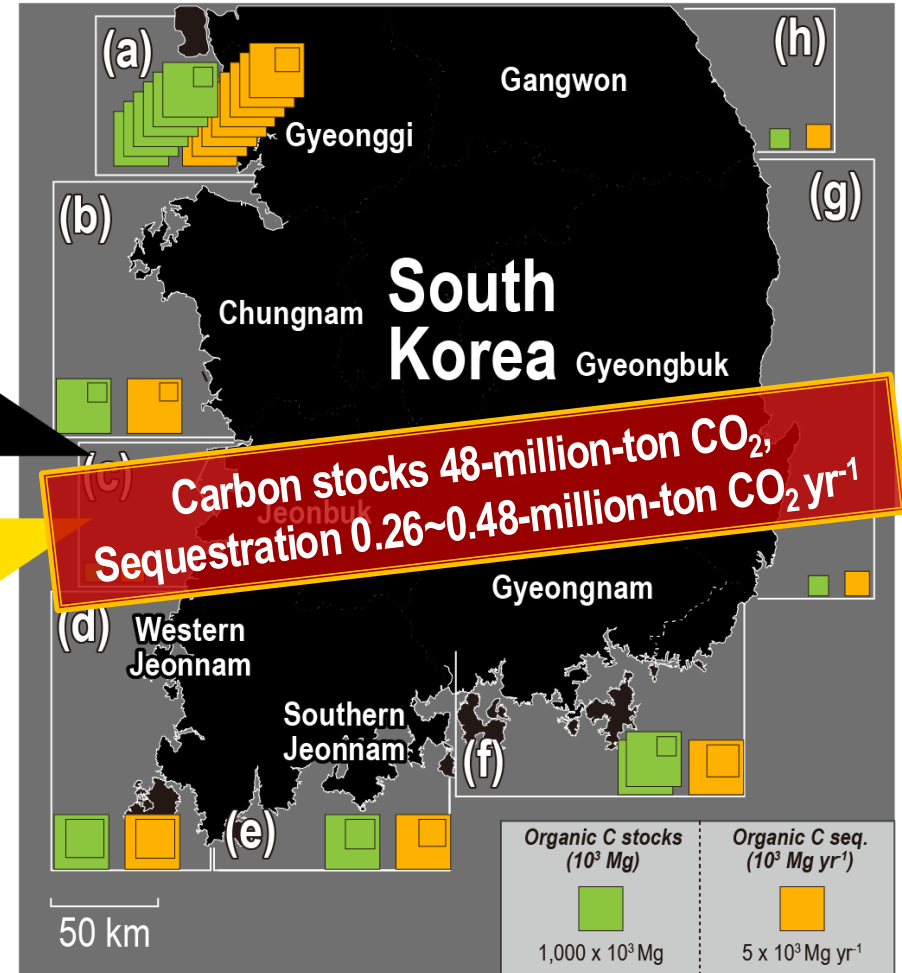
Field study (n = 303)

Sand Mixed Mud

Remote sensing (n = 11,905)



Lee et al., 2021



Tidal flats can absorb CO₂, which generates 110,000~200,000 cars a year!!

2. Korean Blue Carbon Science

Phase-II (2022-2026): \$40 million dollars

Blue Carbon Project: Phase-II

2021

R&D strategies for climate change
Research planning (SNU)

Living shoreline
Research planning (SNU)

블루카본 기반 기후변화 적응형
 해안조성기술개발 사업 기획연구
 - 본 보고서 -

2021. 9. 9.

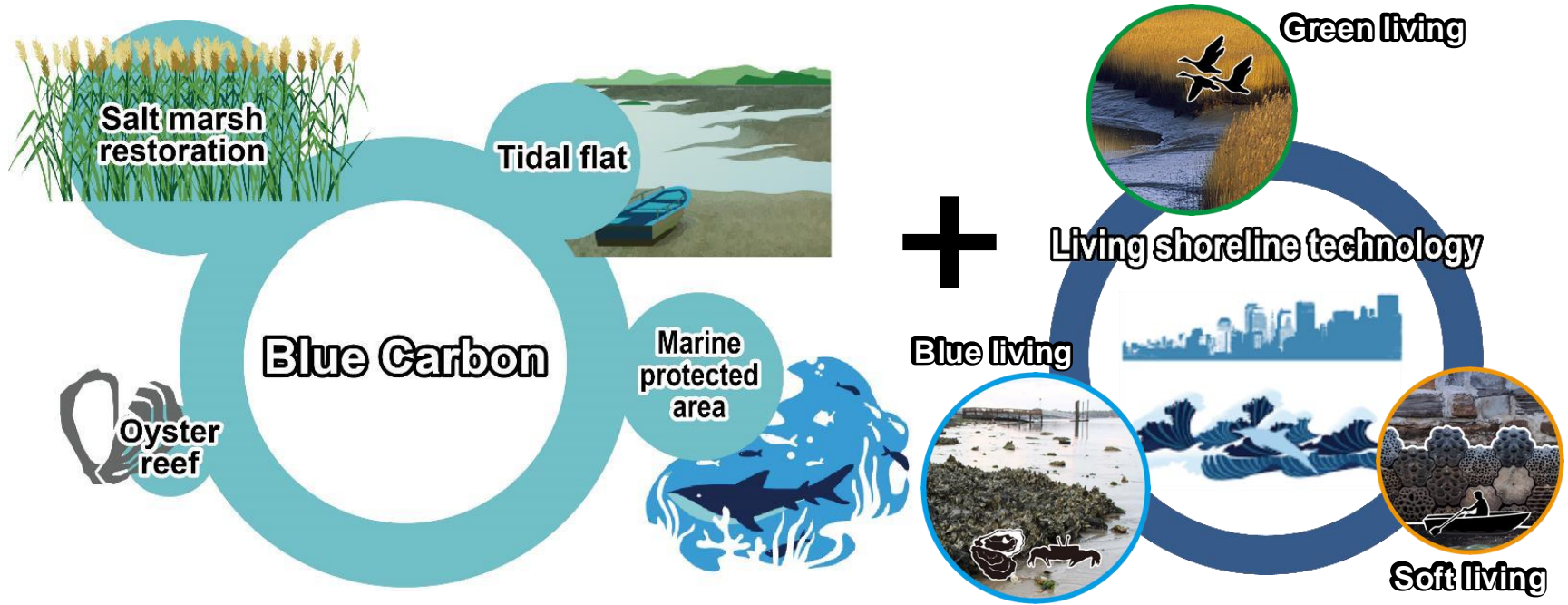
서울대학교
 산학협력단

2022-26

Blue Carbon Project (phase-II)
→ On going('22~26) (SNU)



[Title] Development of living shoreline technology based on blue carbon science toward climate change adaptation



The project aims to support **net-zero by 2050** through
 1) Enhancement & Excavation of **blue carbon**
 2) Construction & management of **living shoreline** technology

2. Korean Blue Carbon Science

Phase-II (2022-2026): Objectives, contents, and expected outcomes

Research objectives

Aimed to develop techniques on enhancement of “**blue carbon resources**” and apply in situ along the coasts of Korea using the “**living shoreline techniques**” towards “**carbon neutrality**”

Major expected outcomes

- **Blue Carbon Map of Tidal flats**
 - Excavation of new carbon reduction resources
 - New Blue Carbon absorption/emission factors
 - Inclusion of information about tidal flat area (>80%)
- **International network operation (IPCC, COP, etc.)**
- **Development of Living shoreline technology**
 - Test-bed demonstration & Guidelines suggestion
 - Technical guidelines for Living shoreline
 - Announcement of coastal management

Three major subjects & research contents

1. Enhancement & Excavation of Blue Carbon

Subject 1

- 1.1. Identification of carbon cycle in tidal flats
- 1.2. Excavation of new carbon reduction resources
- 1.3. Development of remote sensing technology
- 1.4. Construction of **Blue Carbon database**
- 1.5. Reinforcement of international network

2. Construction of Living Shoreline

Subject 2

- 2.1. Development of Living shoreline technology
- 2.2. Analysis of Living shoreline effects
- 2.3. **Test-bed operation** & Technology demonstration

3. Management of Blue Carbon & Living Shoreline

Subject 3

- 3.1. Enactment of Law & System
- 3.2. Reinforcement of business in local government

3. Key Findings & Discussion

Criteria for Inclusion as Actionable Blue Carbon Ecosystems

		Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Category	Habitat type	Large scale of GHG removals or emissions	Long-term storage of fixed CO ₂	Carbon loss by anthropogenic impacts	Practical management to reduce emission	Included in IPCC GHG accounting guidelines	Alignment with other policies
Actionable Blue Carbon Ecosystems for Mitigation	Mangrove	YES	YES	YES	YES	YES	YES
	Salt marsh	YES	YES	YES	YES	YES	YES
	Seagrass	YES	YES	YES	YES	YES	YES
Emerging Blue Carbon Ecosystems	Tidal flat	?	?	YES	?	NO	YES
	Benthic sediment	?	YES	YES	?	NO	?
	Macroalgae	YES	YES	YES	YES	NO	YES
Other Ocean Ecosystems (Not actionable)	Coral reef	NO	NO	NO	NO	NO	YES
	Oyster reef	NO	?	NO	NO	NO	YES
	Phytoplankton	YES	?	?	NO	NO	NO
	Fish	NO	NO	NO	NO	NO	YES

3. Key Findings & Discussion

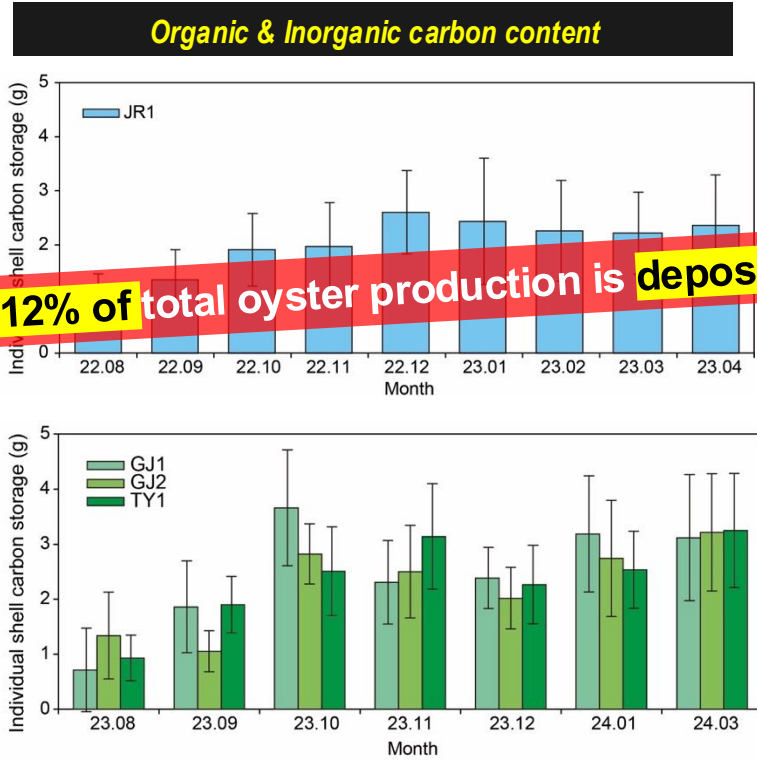
Criteria for Inclusion as Actionable Blue Carbon Ecosystems

Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Large scale of GHG removals or emissions	Long-term storage of fixed CO ₂	Carbon loss by anthropogenic impacts	Practical management to reduce emission	Included in IPCC GHG accounting guidelines	Alignment with other policies
NO	?	NO	NO	NO	YES

Category	Habitat type
Emerging Blue Carbon Ecosystems	Oyster reef



about 12% of total oyster production is deposited as carbon



Jansen & Bogaart et al., 2020_Wageningen

3. Key Findings & Discussion

Enhancement of Tidal flat BC: Practical management to carbon reduction

Living Shoreline (Green, Blue, Soft) Test-beds Construction & Monitoring Schedule

① Green Living Test-bed 1	
Construction	Oct. 2022
Monitoring	Oct. 2022 ~ Jul. 2023 (10 month)
Location	Daebu, Gyeonggi, South Korea
② Green Living Test-bed 1	
Construction	Jun. 2023
Monitoring	Jun. 2023 ~ Dec. 2026 (43 month)
Location	Seocheon, Chungnam, South Korea
③ Blue Living Test-bed	
Construction	Oct. 2023
Monitoring	Oct. 2023 ~ Dec. 2026 (39 month)
Location	Gangjin, Jeonnam, South Korea
④ Soft Living Test-bed 1	
Construction	Nov. 2022
Monitoring	Nov. 2022 ~ Nov. 2024 (24 month)
Location	Busan, South Korea
⑤ Soft Living Test-bed 2	
Construction	Nov. 2023
Monitoring	Nov. 2023 ~ Dec. 2026 (38 month)
Location	Pohang, Gyeongbuk, South Korea



Green Living Pilot Test-bed



Green Living Test-bed



Blue Living Test-bed



Soft Living Test-bed

3. Key Findings & Discussion

Enhancement of Tidal flat BC: Practical management to carbon reduction

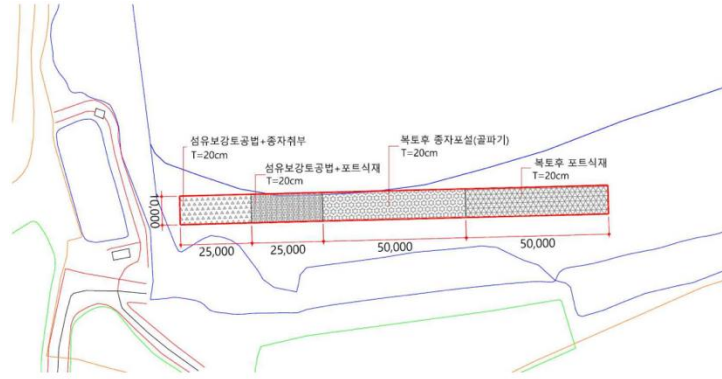
① Green Living Test-bed 1

(Location: Daebu; Monitoring: Oct. 2022 ~ Jul. 2023, 10 month)



② Green Living Test-bed 2

(Location: Seocheon; Monitoring: Jun. 2023 ~ Dec. 2026, 43 month)



Before

After

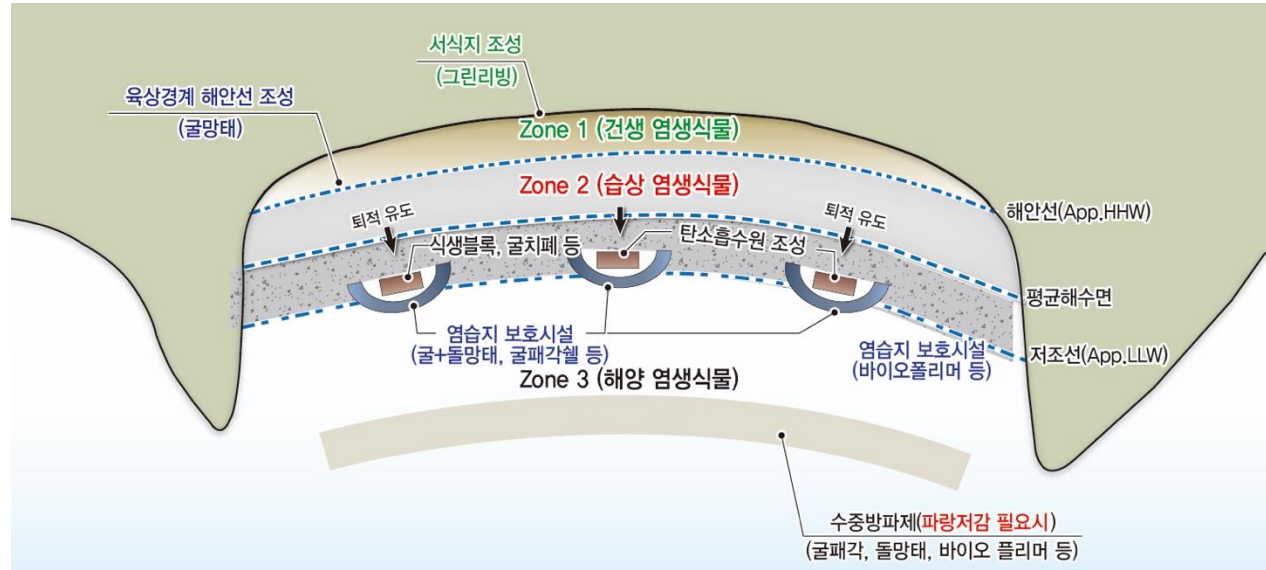


3. Key Findings & Discussion

Enhancement of Tidal flat BC: Practical management to carbon reduction

③ Blue Living Test-bed

(Location: Gangjin; Monitoring: Oct. 2023 ~ Dec. 2026, 39 month)

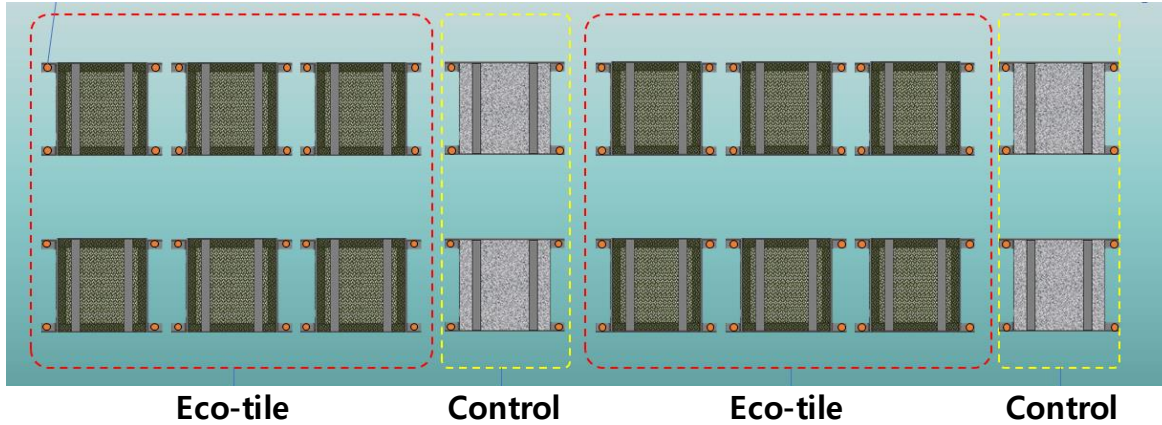


3. Key Findings & Discussion

Enhancement of Tidal flat BC: Practical management to carbon reduction

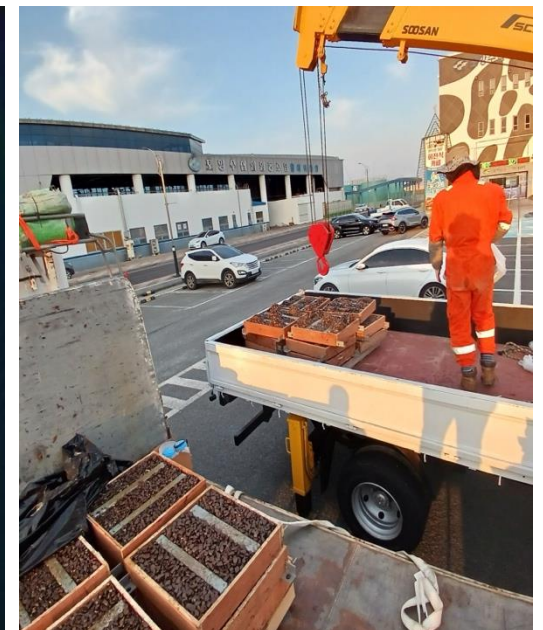
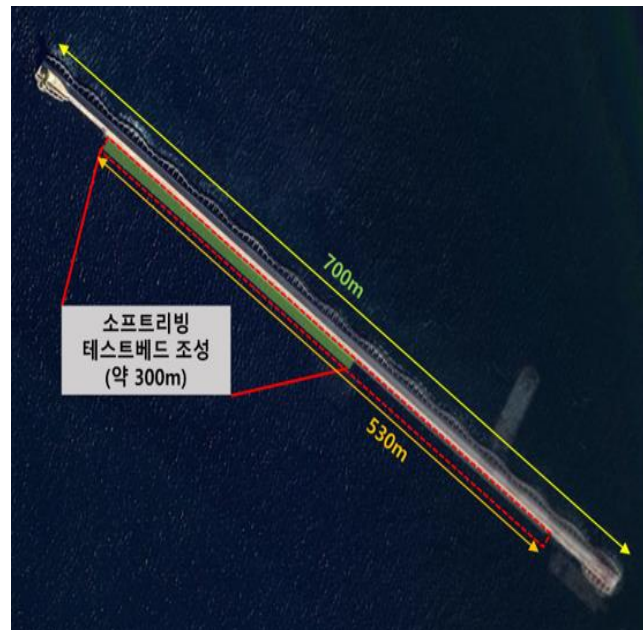
④ Soft Living Test-bed 1

(Location: Busan; Monitoring: Nov. 2022 ~ Nov. 2024 24 month)



⑤ Soft Living Test-bed 2

(Location: Pohang; Monitoring: Nov. 2023 ~ Dec. 2026, 38 month)



4. Remarks

Published Works since 2000s

Our efforts on reporting the ecological significance of the Korean Tidal Flats during the past decades

<p>Vol. 212: 85-100, 2006</p> <p>MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser 212 (2006)</p> <p>Tidal resuspension of microphytobenthos in a Nanamura Sea, Japan: flood-ebb and spring-neap cycles</p> <p>Chul-Hwan Koh¹, Jong Seong Khim^{1*}, Hiroyo Hroyuki Mogi¹, Kenji Hroyuki Mogi²</p> <p>¹School of Earth and Environmental Sciences (Oceanography), Seoul National University, Seoul 151-747, Korea</p>	<p>Available online at www.sciencedirect.com</p> <p>ScienceDirect</p> <p>Estuarine, Coastal and Shelf Science 72 (2007) 1-10</p> <p>Within-day and seasonal patterns of microphytobenthos determined by co-measurement of sediment oxygen demand and chlorophylls in the intertidal mudflats of the Nanamura Sea, Japan</p> <p>Chul-Hwan Koh¹, Jong Seong Khim^{1*}, Hiroyo Hroyuki Mogi¹, Kenji Hroyuki Mogi²</p> <p>¹School of Earth and Environmental Sciences (Oceanography), Seoul National University, Seoul 151-747, Korea</p>	<p>Journal of Coastal Research 20 (6) 1188-1198</p> <p>The Relationship between Primary Production of Microphytobenthos and Tidal Cycle on the Mudflat, West Coast of Korea</p> <p>Bong-Oh Kwon¹, Chul-Hwan Koh¹, Jong Seong Khim^{1*}, Jinsoo Park¹, and Jun Hwan Hwang¹</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Ocean & Coastal Management 90 (2014)</p> <p>The Korean tidal flat of the Yellow Sea: Physical and management</p> <p>Chul-Hwan Koh, Jong Seong Khim[*]</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Ocean & Coastal Management 90 (2014)</p> <p>The Saemangeum tidal flat: Long-term environmental changes in marine benthic flora and fauna in embankment</p> <p>Jongseong Ryu¹, Jungho Nam¹, Jinsoo Park¹, Bong-Oh Kwon¹, Sung Joon Song¹, Seongho Hong¹, Won Keun Chang¹, Jo</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Journal of Sea Research 118 (2016) 1-11</p> <p>Temporal dynamics and spatial heterogeneity of microalgal biomass in recently reclaimed intertidal flats of the Saemangeum area, Korea</p> <p>Bong-Oh Kwon¹, Yeonjung Lee¹, Jinsoo Park¹, Jongseong Ryu¹, Seongho Hong¹, Seunghyun Son¹</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	
<p>Chemosphere 168 (2017) 105-112</p> <p>Hard science is essential to restoring soft-sediment in burgeoning East Asia</p> <p>Shing Yip Lee¹, Jong Seong Khim^{2*}</p> <p>¹School of Earth and Environmental Sciences, Southern Cross University, Lismore, QLD 4202, Australia</p> <p>²School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Environmental Pollution 182 (2018)</p> <p>Rainfall effects on the erodibility of sediment in the intertidal flat</p> <p>Hun Jun Ha¹, Hosang Kim¹, Junsung Noh¹, Ho Kyung Ha¹</p> <p>¹School of Earth and Environmental Sciences and Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Environmental Pollution 182 (2018)</p> <p>Development of temperature-based algorithms for microphytobenthic primary production in a tidal mudflat, Korea</p> <p>Bong-Oh Kwon¹, Hae-Cheol Kim¹, Chul-Hwan Koh¹, Jong Seunghyun Son¹, Yong Hoon Kim¹, Jong Seong Khim^{1*}</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Environment International 134 (2018)</p> <p>Influence of tidal forcings on microphytobenthic sediment fluxes in a disturbed coastal environment</p> <p>Hun Jun Ha¹, Hosang Kim¹, Bong-Oh Kwon¹, Jong Seong Khim^{1*}</p> <p>¹Department of Ocean Sciences, Inha University, Incheon 222, Republic of Korea</p>	<p>Environment International 134 (2018)</p> <p>Microbial mechanism for enhanced methane emissions from Phragmites-introduced tidal marsh</p> <p>Jinyun Kim¹, Doong R. Chaudhary¹, Jaehyun Lee¹, Chaebo Bong-Oh Kwon¹, Jong Seong Khim^{1*}, Hojeong Kang¹</p> <p>¹Department of Ocean Sciences, Inha University, Incheon 222, Republic of Korea</p>	<p>Marine Pollution Bulletin 154 (2018)</p> <p>Natural purification capacity of tidal flats for organic matter</p> <p>Taewoon Kim¹, Junsung Noh¹, Bong-Oh Kwon¹, Seongho Hong¹, Jong Seong Khim^{1*}</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Marine Pollution Bulletin 154 (2018)</p> <p>Spatiotemporal variability in microphytobenthic primary production across bare intertidal flats, mangrove forest of Asia and Australia</p> <p>Shing Yip Lee¹, Jong Seong Khim^{2*}, Junjung Noh¹, Seongho Hong¹, Junjung Noh¹, Shing Yip Lee¹, Jungho Nam¹</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>
<p>Marine Pollution Bulletin 171 (2021) 112701</p> <p>Baseline Spatiotemporal Variability of Microphytobenthos Associated with the Microphytobenthos of Tidal Flats</p> <p>Beomgi Kim¹, Jongmin Lee¹, Junsung Noh¹, Hanna Bae¹, Changho Kyuon Hwang¹, Donggi Kim¹, Bong-Oh Kwon¹, Ho Kyung Ha¹, Cedric Delattre¹, Philippe Michaud¹, Jong Seong Khim^{1*}</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Science of the Total Environment 827 (2021) 154300</p> <p>Microbial decomposition of soil organic matter determines characteristics of mangrove forests in East Asia</p> <p>Jinyun Kim¹, Jaehyun Lee¹, Verang Yang¹, Jeongeun Yun¹, Weon-Bong Oh Kwon¹, Hojeong Kang¹*</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Science of the Total Environment 827 (2021) 154300</p> <p>The first national scale evaluation of organic carbon sequestration rates of coastal sediments along the West and East Sea of South Korea</p> <p>Jongmin Lee¹, Beomgi Kim¹, Junsung Noh¹, Changkook Lee¹, Inha Junsoo Park¹, Seongho Hong¹, Sukki Lee¹, Seong-Gil Kim¹, Sujin Jungho Nam¹, Kyungsik Choi¹, Jong Seong Khim^{1*}</p> <p>¹School of Earth and Environmental Sciences & Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>	<p>Science of the Total Environment 827 (2021) 154300</p> <p>Environmental drivers affecting the bacterial community structure in the Yellow Sea</p> <p>Hanbyul Lee¹, Young-Mok Heo¹, Sun-Li Kwon¹, Yeonju Yoo¹, Dong Jong Seong Khim^{1*}, Jae-Jin Kim¹</p> <p>¹Division of Environmental Science & Ecological Engineering, College of Earth Science & Environment, Seoul National University, Seoul, Republic of Korea</p>	<p>Science of the Total Environment 827 (2021) 154300</p> <p>The first national scale evaluation of total nitrogen stocks and burial rates of intertidal sediments along the entire coast of South Korea</p> <p>Inha Kwon¹, Changkook Lee¹, Jongmin Lee¹, Beomgi Kim¹, Shin Young Park¹, Jongsu Kim¹, Junghyun Lee¹, Junjung Noh¹, Bong-Oh Kwon¹, Sujin Son¹, Hoon-Joo Yoon¹, Jungho Nam¹, Kyungsik Choi¹, Jong Seong Khim^{1*}</p> <p>¹School of Earth and Environmental Sciences, Research Institute of Oceanography, Seoul National University, Seoul, Republic of Korea</p>		

Article: 19
(2006-2022)



**Thank you
for listening!**



Ministry of Oceans
And Fisheries



Blue Carbon
Research Center