2023 IPBC, Paris, France

Feb. 23, 2023

Blue Carbon Research and contribution to Policy of the Republic of Korea

Jongmin Lee, Ph. D

Administrative Secretary
Blue Carbon Research Center
Seoul National University

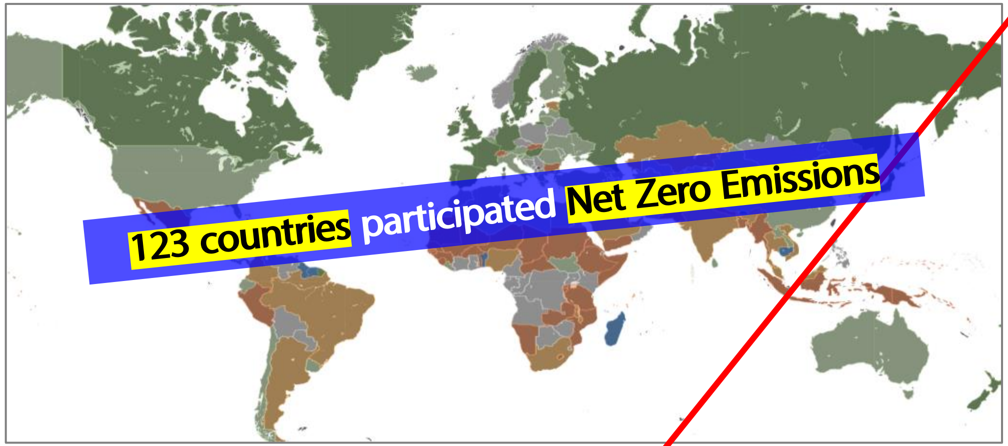
Ministry of Oceans And Fisheries

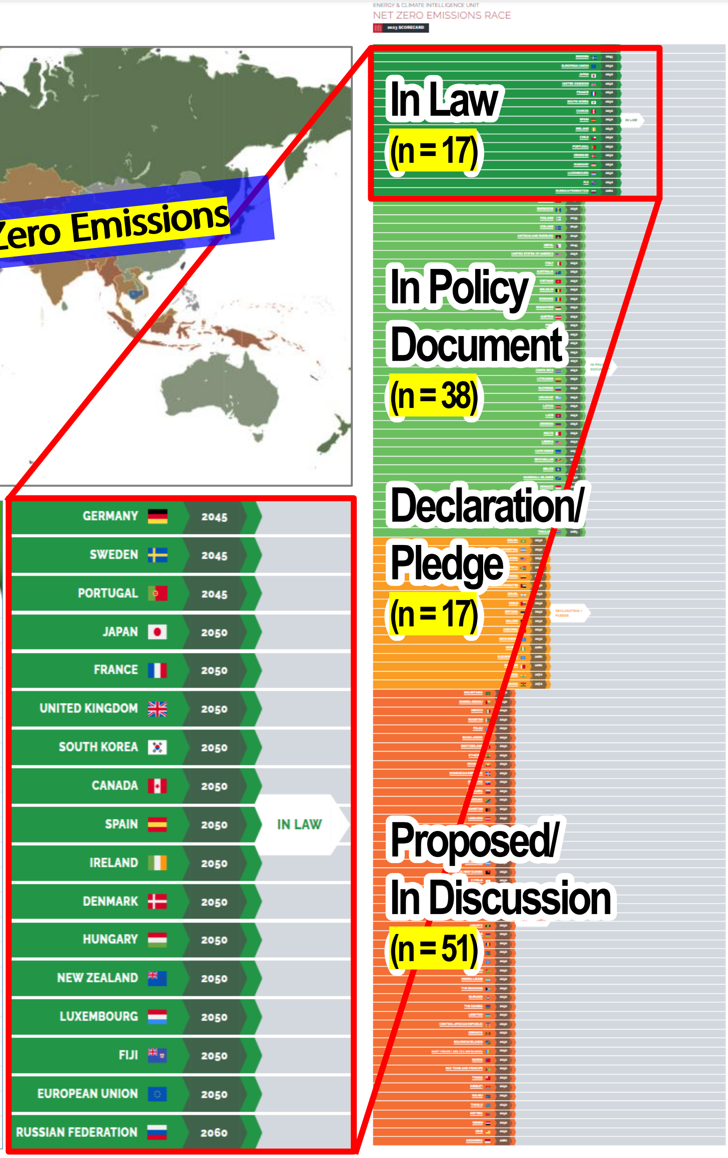
Blue Carbon Research Center

CONTENTS

1. Backgrounds

Net Zero Emissions Race: K-MOF challenged Negative Emissions



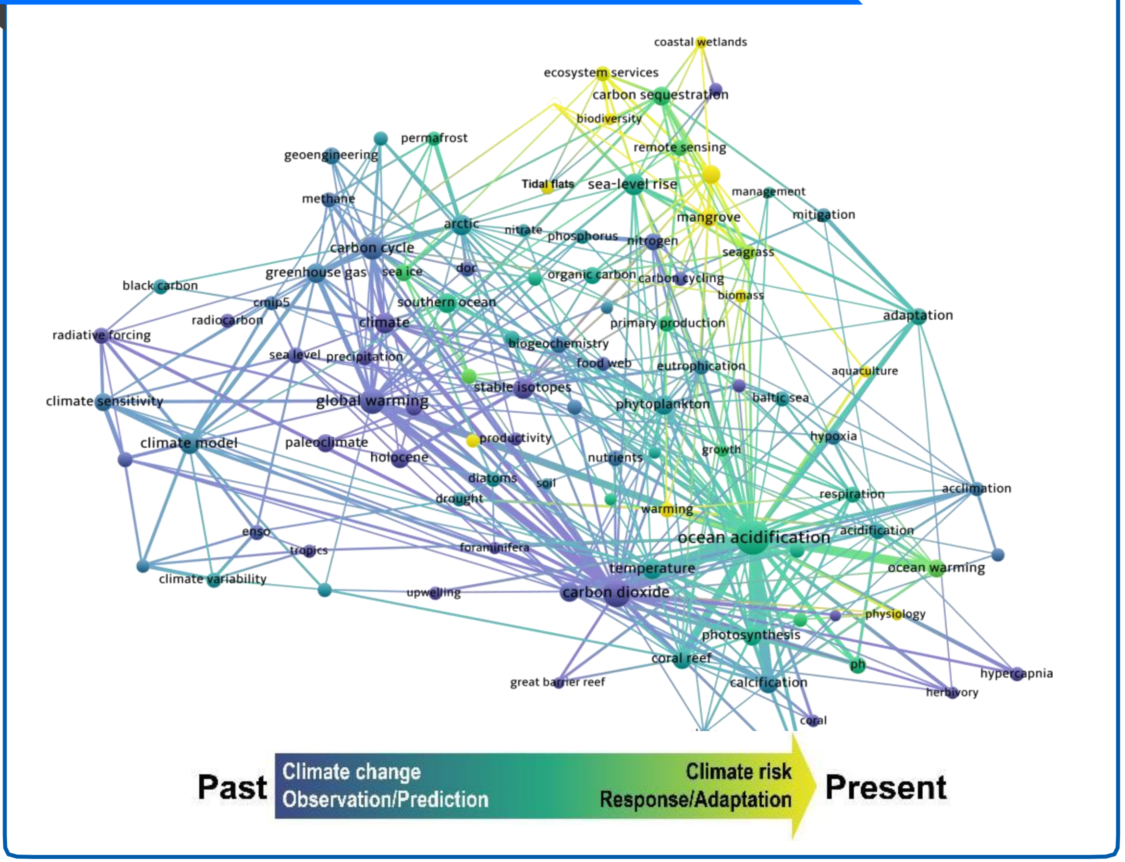


1. Backgrounds

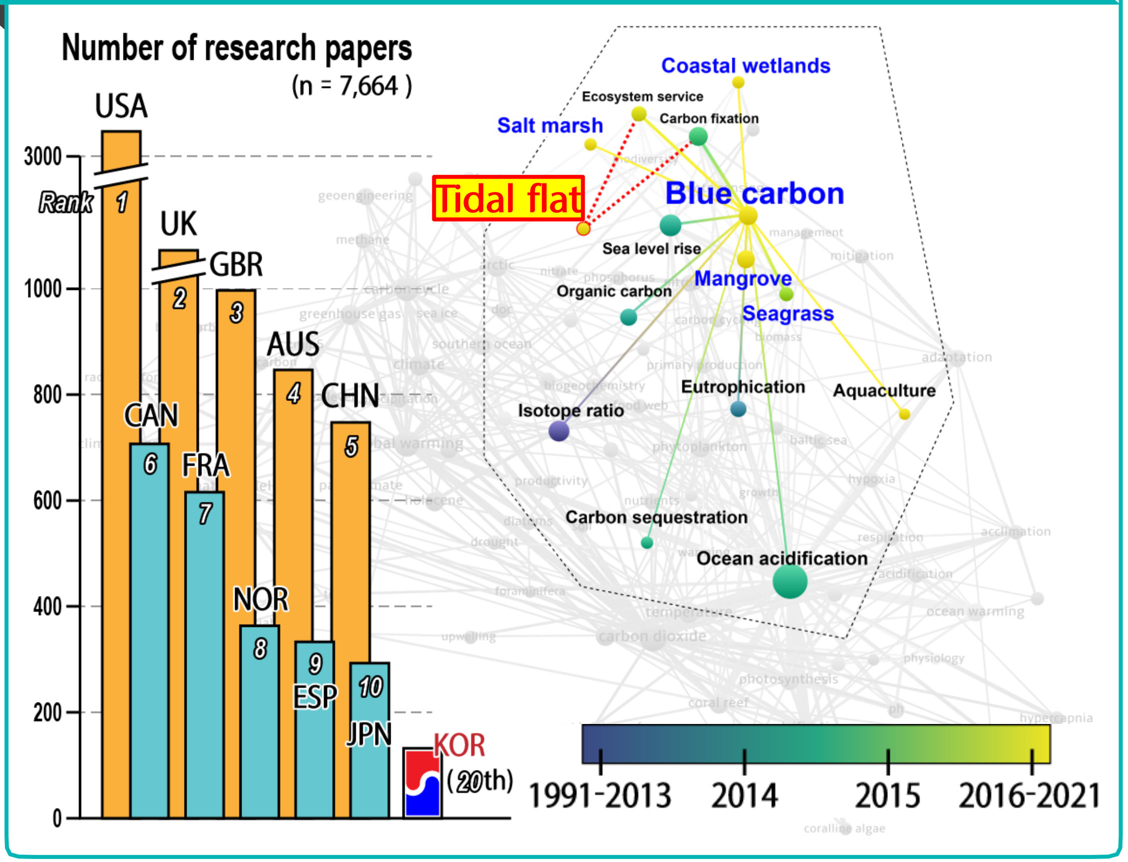
Mini-review for Climate Change and Blue Carbon

- 7,700 research papers about Climate change & Blue Carbon, **Korea: 130 papers (ranked 20th)**
- (Past) Observation/Prediction of CC → (Present) Response/Adaptation of Climate risk

Keyword network analysis: ~7700 papers

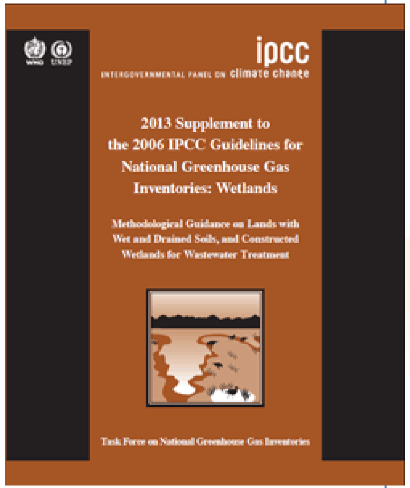


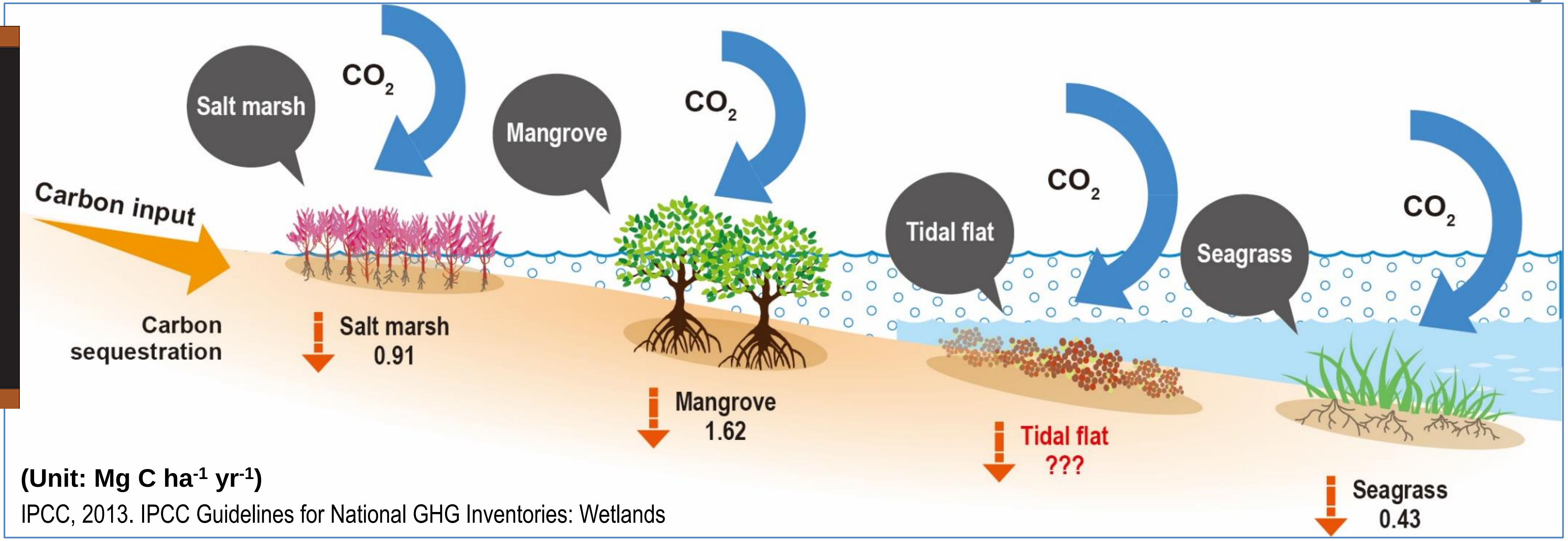
Blue Carbon network: Mangrove, Salt marsh, Seagrass



1. Backgrounds

We focused on the "Tidal flat", as an Emerging Blue Carbon





(Unit: Mg C ha^{-1} yr^{-1})

IPCC, 2013. IPCC Guidelines for National GHG Inventories: Wetlands

32 km^2

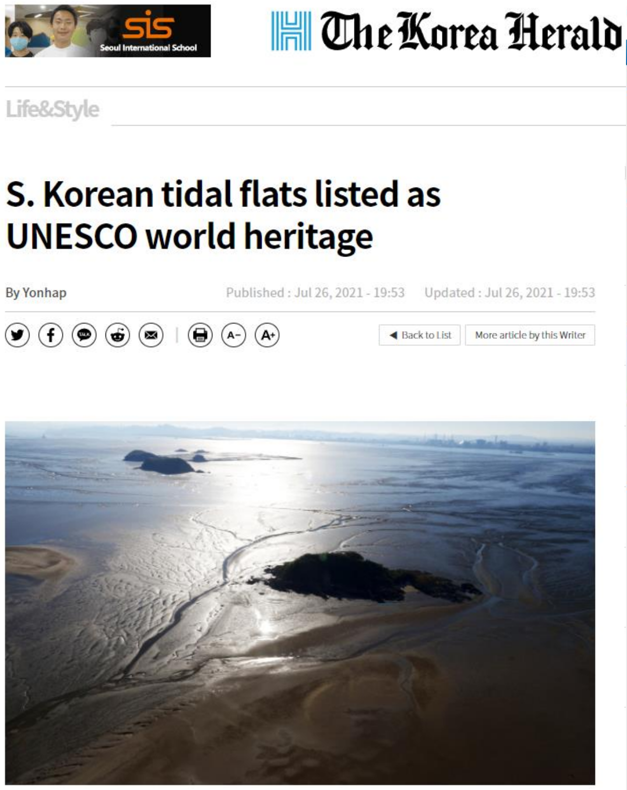
0(?) km^2

2,450 km^2

45 km^2

1. Backgrounds

Getbol, the Korean Tidal Flats inscribed as UNESCO world heritage in 2021



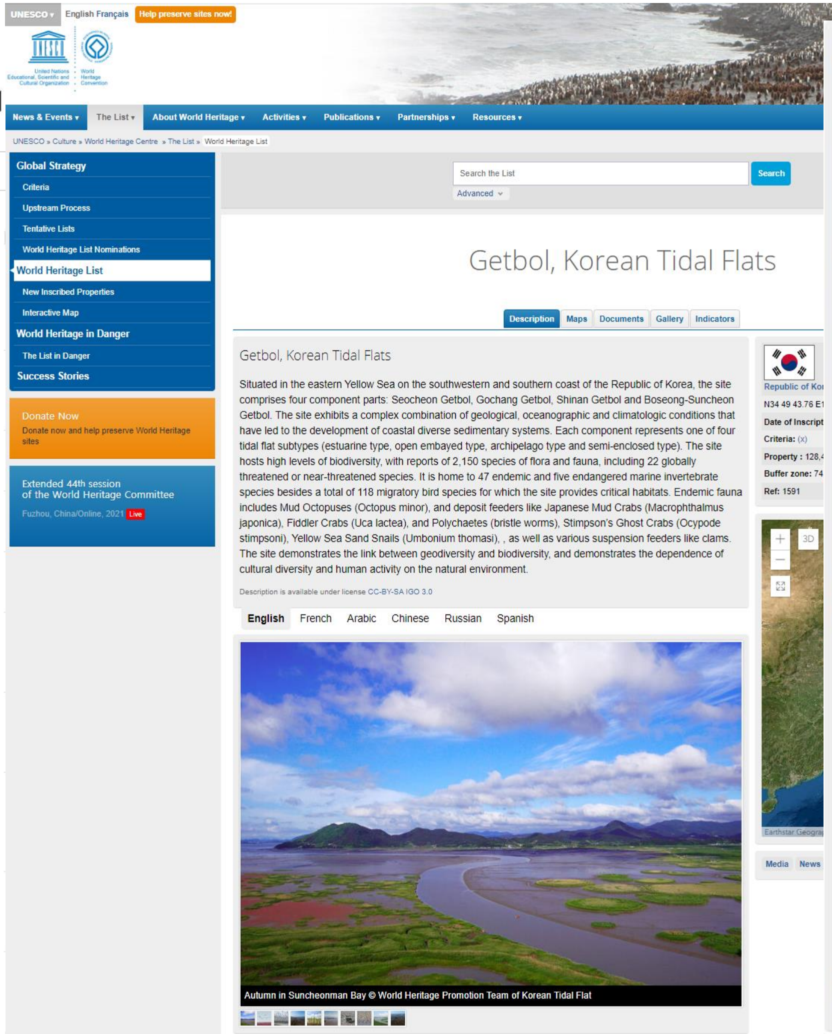
Life&Style

S. Korean tidal flats listed as UNESCO world heritage

By Yonhap Published : Jul 26, 2021 - 19:53 Updated : Jul 26, 2021 - 19:53

View of a tidal flat in Seocheon, South Chungcheong Province (Cultural Heritage Administration/Yonhap)

South Korea's tidal flats have been officially inscribed as a UNESCO world natural heritage despite receiving a deferral in a preliminary review, cultural heritage authorities said Monday.



Global Strategy
Criteria
Upstream Process
Tentative Lists
World Heritage List Nominations
World Heritage List
New Inscribed Properties
Interactive Map
World Heritage in Danger
The List in Danger
Success Stories

Getbol, Korean Tidal Flats

Description | Maps | Documents | Gallery | Indicators

Getbol, Korean Tidal Flats

Situated in the eastern Yellow Sea on the southwestern and southern coast of the Republic of Korea, the site comprises four component parts: Seocheon Getbol, Gochang Getbol, Shinan Getbol and Boseong-Suncheon Getbol. The site exhibits a complex combination of geological, oceanographic and climatologic conditions that have led to the development of coastal diverse sedimentary systems. Each component represents one of four tidal flat subtypes (estuarine type, open embayed type, archipelago type and semi-enclosed type). The site hosts high levels of biodiversity, with reports of 2,150 species of flora and fauna, including 22 globally threatened or near-threatened species. It is home to 47 endemic and five endangered marine invertebrate species besides a total of 118 migratory bird species for which the site provides critical habitats. Endemic fauna includes Mud Octopuses (Octopus minor), and deposit feeders like Japanese Mud Crabs (Macrophthalmus japonica), Fiddler Crabs (Uca lactea), and Polychaetes (bristle worms), Stimpson's Ghost Crabs (Ocypode stimpsoni), Yellow Sea Sand Snails (Umbonium thomasi), , as well as various suspension feeders like clams. The site demonstrates the link between geodiversity and biodiversity, and demonstrates the dependence of cultural diversity and human activity on the natural environment.

English French Arabic Chinese Russian Spanish

Autumn in Suncheonman Bay © World Heritage Promotion Team of Korean Tidal Flat

Multiple Locations (4)

Name & Location	State Party	Coordinates	Property	Buffer Zone
Seocheon Getbol	Republic of Korea	N36 2 42.99 E126 36 49.69	6,809 ha	3,657 ha
Gochang Getbol	Republic of Korea	N35 32 56.54 E126 32 59.75	5,531 ha	1,880 ha
Shinan Getbol	Republic of Korea	N34 49 43.76 E126 6 15.99	110,086 ha	67,254 ha
Boseong-Suncheon Getbol	Republic of Korea	N34 49 11.25 E127 27 32.19	5,985 ha	1,801 ha

View World Heritage Properties into different formats (RSS/XML/KML)

1. Backgrounds

Blue Carbon Science in a Global Window of Climate Change

- **1979**: 1st World Climate Conference
- **1988**: IPCC established
- **1992**: UNFCCC formed
- **1995**: Kyoto Protocol
- **2009**: IUCN Report (BC introduced)
- **2010**: UNFCCC COP16 (BC recognized)
- **2011**
- **2013**: IPCC Report: GHG inventory (BC included in IPCC guideline)
- **2015**: Paris Agreement
- **2016**
- **2017**
- **2019**: UNFCCC COP25 (Blue COP)
- **2020**
- **2021**: Paris Rulebook; UNFCCC COP26 (BC highlighted)

Blue carbon as a natural climate solution has been increasingly recognized globally and Korean government have strongly supported blue carbon science since 2017

Korea:

- **2009**: Voluntary GHG Reduction Target submit
- **2011**: Basic Act on Low Carbon, Green Growth established
- **2016**: NDC submitted - 1st Natl. Climate Action Plan
- **2019**: 2nd Natl. Climate Action Plan
- **2020**: Updated NDC
- **2021**: Raised NDC

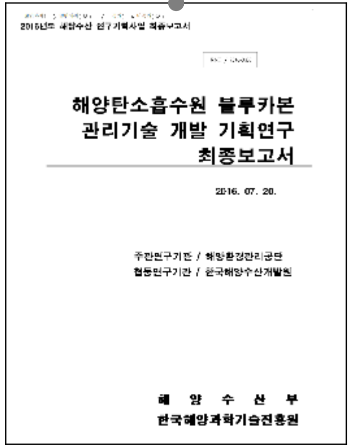
Blue Carbon Project funded by K-MOF
Phase I (2017-21) & Phase II (2022-26)

2. Korean Blue Carbon Science

Phase-I (2017-2021): $8 million dollar

Blue Carbon Project: Phase-I

2016	2017-21
Development of Blue Carbon Management Research planning (KOEM)	Blue Carbon Project (phase-I) → Completed (2017-21) (KOEM)



2016년도 해양수산 연구개발사업 최종보고서

해양탄소흡수원 블루카본 관리기술 개발 기획연구 최종보고서

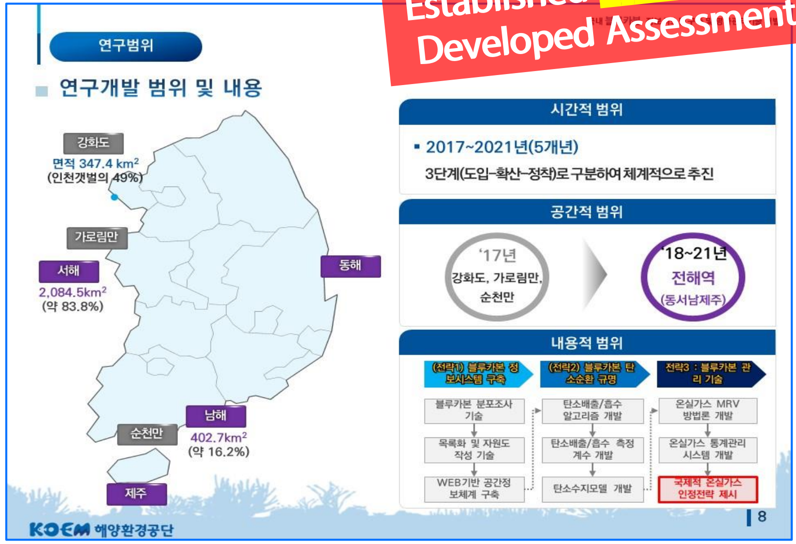
2016. 07. 20.

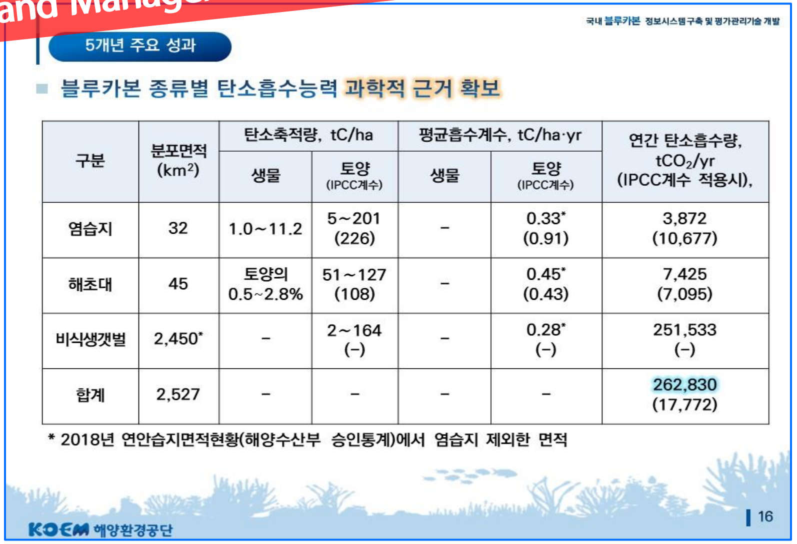
주관연구기관 / 해양환경관리공단
협동연구기관 / 한국해양수산개발원

해 양 수 산 부
한국해양과학기술진흥원

최종보고서

Established K-Blue Carbon Information System & Developed Assessment and Management Tools





국내 블루카본 정보시스템 구축 및 평가관리기술 개발

5개년 주요 성과

블루카본 종류별 탄소흡수능력 과학적 근거 확보

구분	분포면적 (km²)	탄소축적량, tC/ha		평균흡수계수, tC/ha·yr		연간 탄소흡수량, tCO_2/yr (IPCC계수 적용시),
		생물	토양 (IPCC계수)	생물	토양 (IPCC계수)	
염습지	32	1.0~11.2	5~201 (226)	–	0.33* (0.91)	3,872 (10,677)
해초대	45	토양의 0.5~2.8%	51~127 (108)	–	0.45* (0.43)	7,425 (7,095)
비식생갯벌	2,450*	–	2~164 (–)	–	0.28* (–)	251,533 (–)
합계	2,527	–	–	–	–	262,830 (17,772)

* 2018년 연안습지면적현황(해양수산부 승인통계)에서 염습지 제외한 면적

16

KOEM 해양환경공단

2. Korean Blue Carbon Science

Phase-I (2017-2021)

West Sea (14 region)


1. Ganghwa


2. Youngjong


3. Siheung


4. Daebu


5. Hwaseong


6. Garolim Bay


7. Geunheung


8. Ocheon


9. Biin

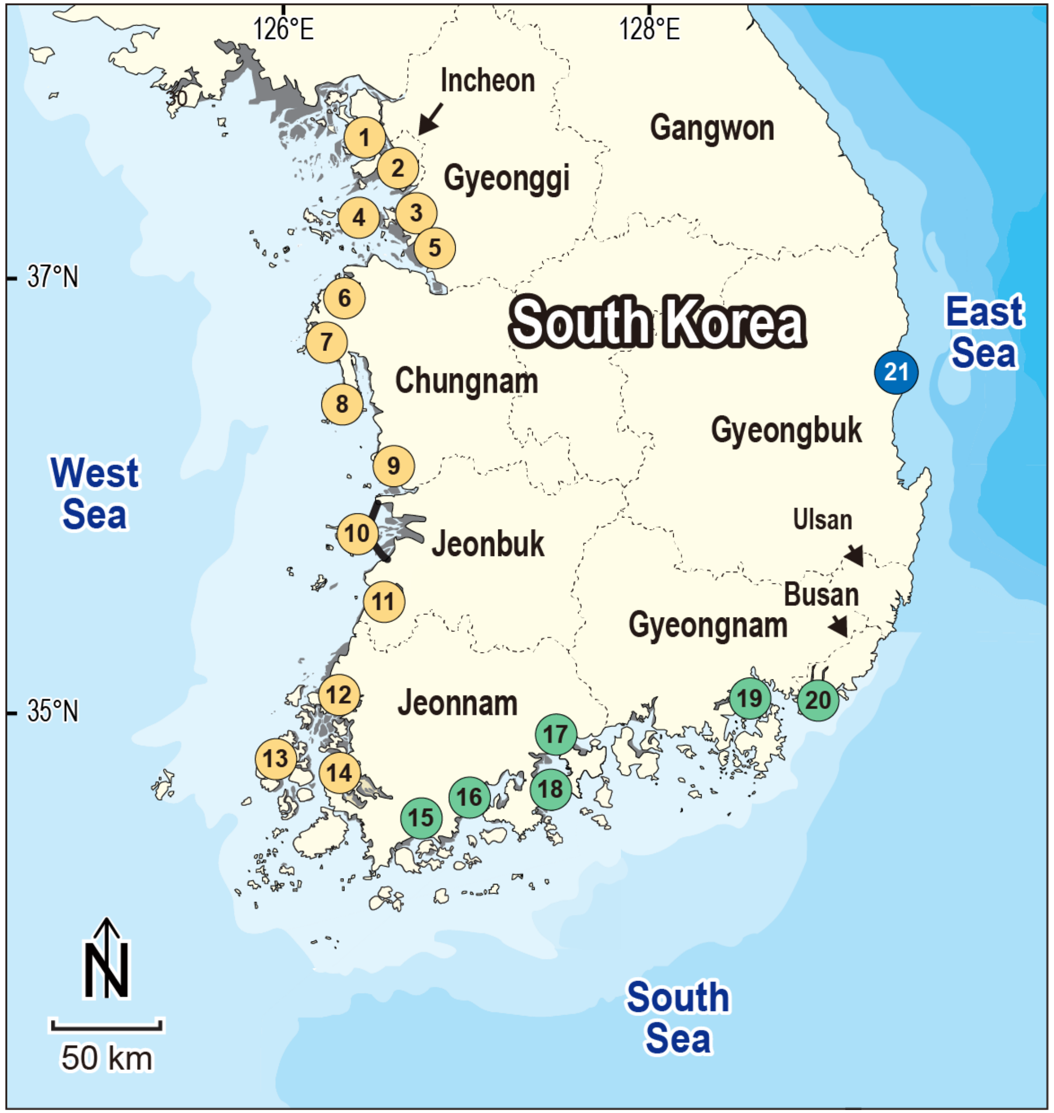

10. Seonyudo


11. Gomso Bay


12. Hampyeong


13. sinan


14. Aphaedo




Multi-Sampler (manpower)


Gas-Power Core (gas pressure)

East Sea (1 region)


21. Uljin

South Sea (6 region)


15. Gangjin Bay


16. Deukryang Bay


17. Suncheon Bay


18. Yeoza Bay


19. Jinhae Bay


20. Nakdong River estuary

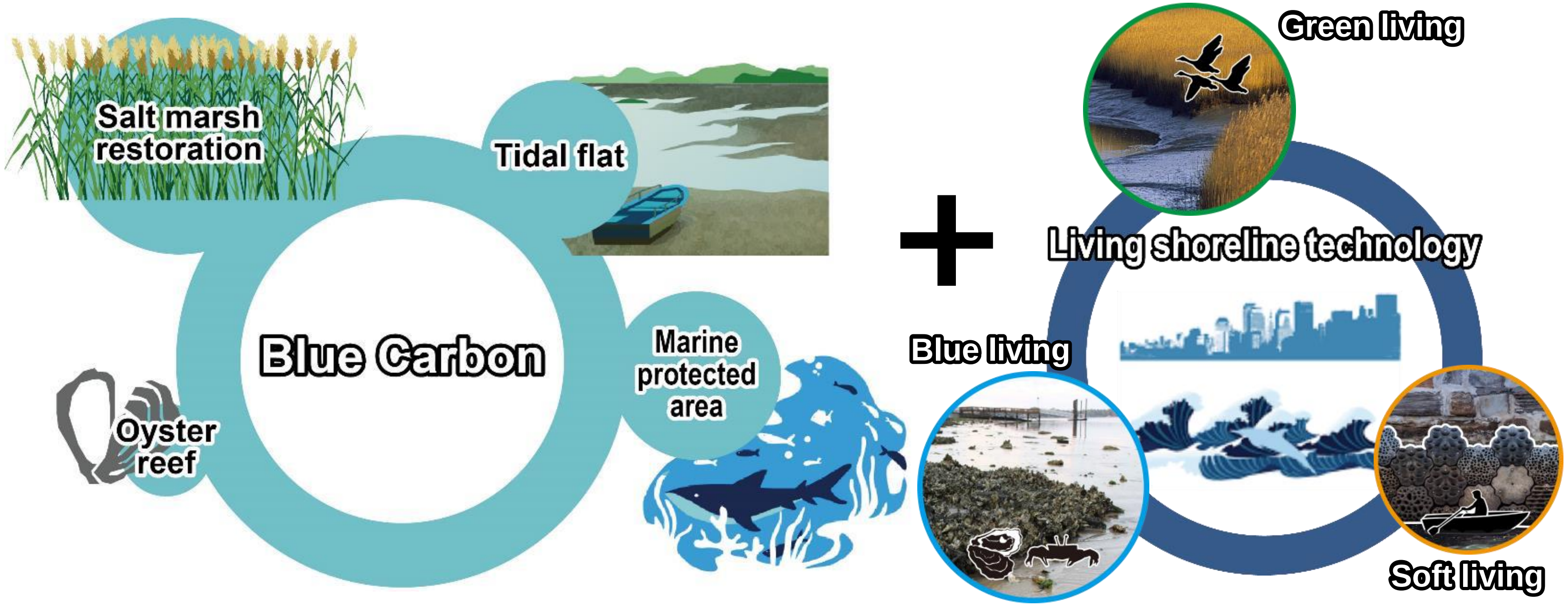
2. Korean Blue Carbon Science

Phase-II (2022-2026): $40 million dollar

Blue Carbon Project: Phase-II

2021	2022-26
R&D strategies for climate change Research planning (SNU)	Blue Carbon Project (phase-II) → On going('22~26) (SNU)
Living shoreline Research planning (SNU)	
블루카본 기반 기후변화 적응형 해안조성기술개발 사업 기획연구 - 본 보고서 - 2021. 9. 9. 서울대학교 산학협력단	Blue Carbon Research Center

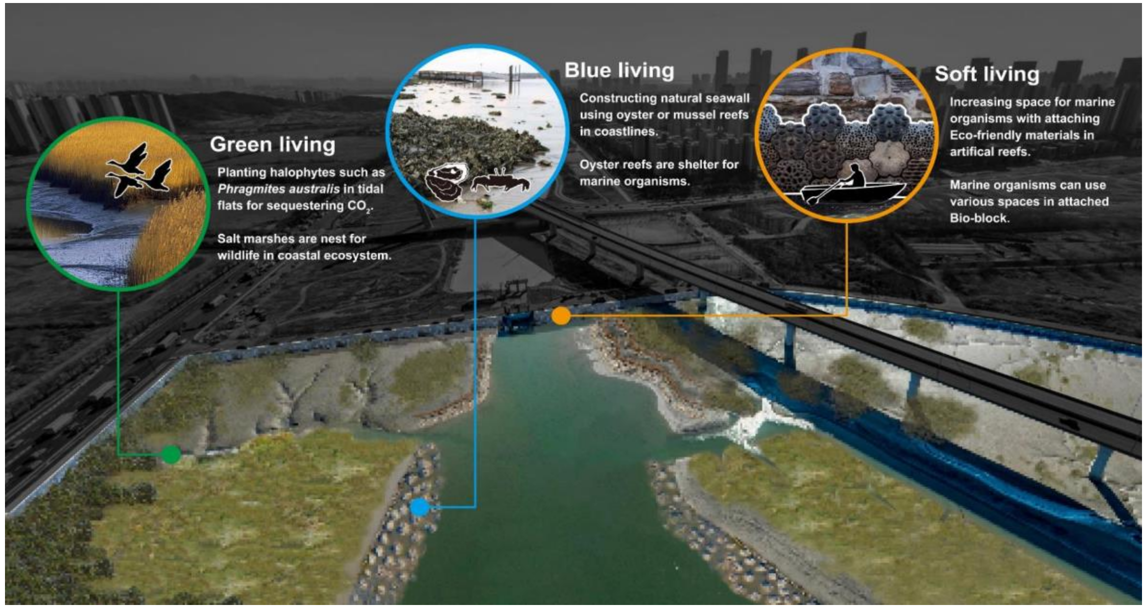
[Title] Development of living shoreline technology based on blue carbon science toward climate change adaptation



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): Approach



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

Subject 1 — **1. Enhancement & Excavation of Blue Carbon**

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

Subject 2 — **2. Construction of Living Shoreline**

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

Subject 3 — **3. Management of Blue Carbon & Living Shoreline**

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

2. Korean Blue Carbon Science

Phase-II (2022-2026): 29 Institutions

- Principle: 1 Institution
- Cooperative: 26 Institution
- Entrusted: 2 Institution

Seoul National University
Blue Carbon Research Center

Advisory Group

Team	Target
Team 1	Blue Carbon
Team 2	Living shoreline
Team 3	Management

(Team 1-1) SNU
- Assessment carbon sequestration
- Identification of carbon cycle in tidal flat

SNU	Process (Sedimentation)
SNU	Process (Model)
SNU	Process (Food Web)
SNU	Process (Resuspension)
KMOU	Process (Production)
SU	Process (Carbon cycle)
BETO	Mass media
ESDI	Business model

(Team 1-2) KSNU
- Excavation of new carbon reduction
- International network operation

KSNU	Absorption (Salt marsh)
KIOST	Absorption (Salt marsh)
BRC	Absorption (Salt marsh)
KSNU	Emission (Salt marsh)
CNU	Absorption (Oyster reef)
WEB	Absorption (Benthic sediment)
FIRA	Absorption (Seagrass)
KSNU	Absorption (Benthic sediment)
MABIK	Absorption (Coral reef)
KSNU	Absorption /Emission (Model)

(Team 2) Oceanic
- Development of Living Shoreline tech.
- Standard guidelines of technologies

GEO SR	Ecological investigation
Sekwangeng	Physical investigation
Aracnt	Selection assessment
NeoEnBiz	Green living
Econgeo	Green living
Billion21	Green living
DY	Blue living
MEI	Soft living
KU	Resilience system
Enctec	Ecosystem assessment

(Team 3) KOEM
- Verification of vegetation
- Blue Carbon Management

AU	Remote sensing
KMI	Law & System
Sundo soft.	Database
GEOLABS	Remote sensing
Ocean Citech	Remote sensing

3. Key Findings & Discussion

Criteria for Inclusion as Actionable Blue Caron Ecosystems

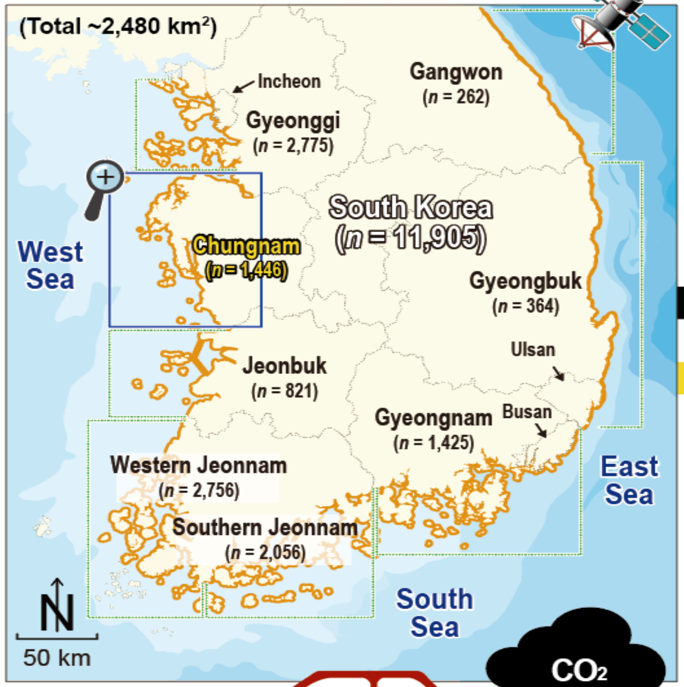
Category	Habitat type	Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Conservation International, 2021)					
		Large scale of GHG removals or emissions	Long-term storage of fixed CO_2	Carbon loss by anthropogenic impacts	Practical management to reduce emission	Included in IPCC GHG accounting guidelines	Alignment with other policies
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

BC criteria for Tidal flats: Large scale of GHG removals/emissions

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
		Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Emerging Blue Carbon Ecosystems	Tidal flat	? → YES	?	YES	?	NO	YES

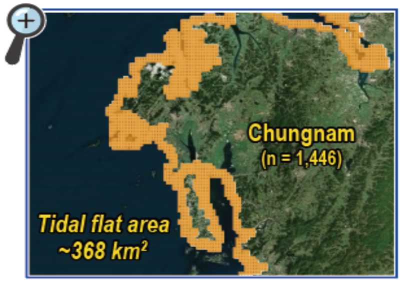
Intertidal area of South Korea



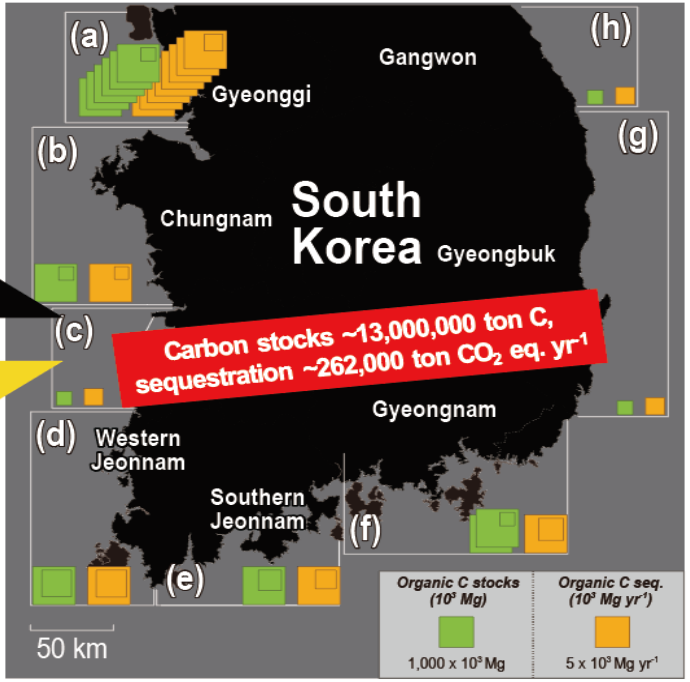
Field study (n = 303)

Sand Mixed Mud

Remote sensing (n = 11,905)



Lee et al., 2021



연안습지 탄소흡수량 '블루카본' 국가 온실가스 통계 첫 반영 | 연합뉴스

(서울=연합뉴스) 차민지 기자 = 해양수산부는 염생식물이 서식하는 연안습지의 탄소 흡수량(블루카본)을 산정해 올해부터 국가 온실가스 통계에 반영...

https://www.yna.co.kr

분야										
연안습지	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	-6	-10	-13	-14	-14	-7	-8	-8	-6	-3
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	-5	-5	-7	-10	-12	-5	-5	-6	-7	-7
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	-7	-7	-9	-8	-8	-11	-9	-9	-11	-11
	2020	2019년 대비								
	-11	2.2%								

The tidal flats can absorb CO_2, which generates ~110,000 cars a year!!

3. Key Findings & Discussion

BC criteria for Tidal flats: Long-term storage of fixed CO_2

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
		Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Emerging Blue Carbon Ecosystems	Tidal flat	? → YES	? → YES	YES	?	NO	YES

Method (Sedimentation rate)	Depth & Time scale	Strength	Weakness
Surface marker horizons (e.g., Feldspar, brick dust)	• **Depth: 0–10 cm** • **Time: 0–10 yr**	• Capable of quantifying erosion • Time-series analysis with fine scale resolution	• Limited timescale along durability of marker • Confusion of time scale using wrong marker
Surface elevation tables (e.g., Vertical pipe)	• **Depth: 0–10 cm** • **Time: 0–10 yr**	• Capable of quantifying surface elevation change • Time-series analysis with regular sampling	• Limited comparison between sites for some of stations with inconsistent reference depths
^{137}Cs (e.g., Chernobyl (1986) and Fukushima (2011) explosion)	• **Depth: 0–100 cm** • **Time: 0–40 yr**	• Capable of quantifying multi-decadal resolution • Straightforward age dating calculations	• Limitation of peak detection in Southern Hemisphere due to atmospheric fallout/washout • ^{137}Cs can be mobilized in saline sediments
^{210}Pb (e.g., Half-life of ^{210}Pb; 22.3 years)	• **Depth: 0–100 cm** • **Time: 0–150 yr**	• Capable of quantifying sub-decadal resolution • Long-term record including onset of sea level rise	• Limitation of peak detection in arid climate sediments due to atmospheric fallout/washout
Historic event horizons (e.g., Volcanic eruption)	• **Depth: 0–150 cm** • **Time: 10–1,000 yr**	• Capable of quantifying from sub-decadal to millennial resolution	• Limited to only opportunistically available
^{14}C (e.g., Half-life of ^{14}C; 5,700 years)	• **Depth: 10–10,000 cm** • **Time: 100–100,000 yr**	• Capable of quantifying from centennial to millennial resolution • Capable for identification of variable rates when multiple macrofossils and depths are dated	• Limitation of age dating of plant roots which grow to various depth • Limitation of age dating of mollusks which capable of mobility

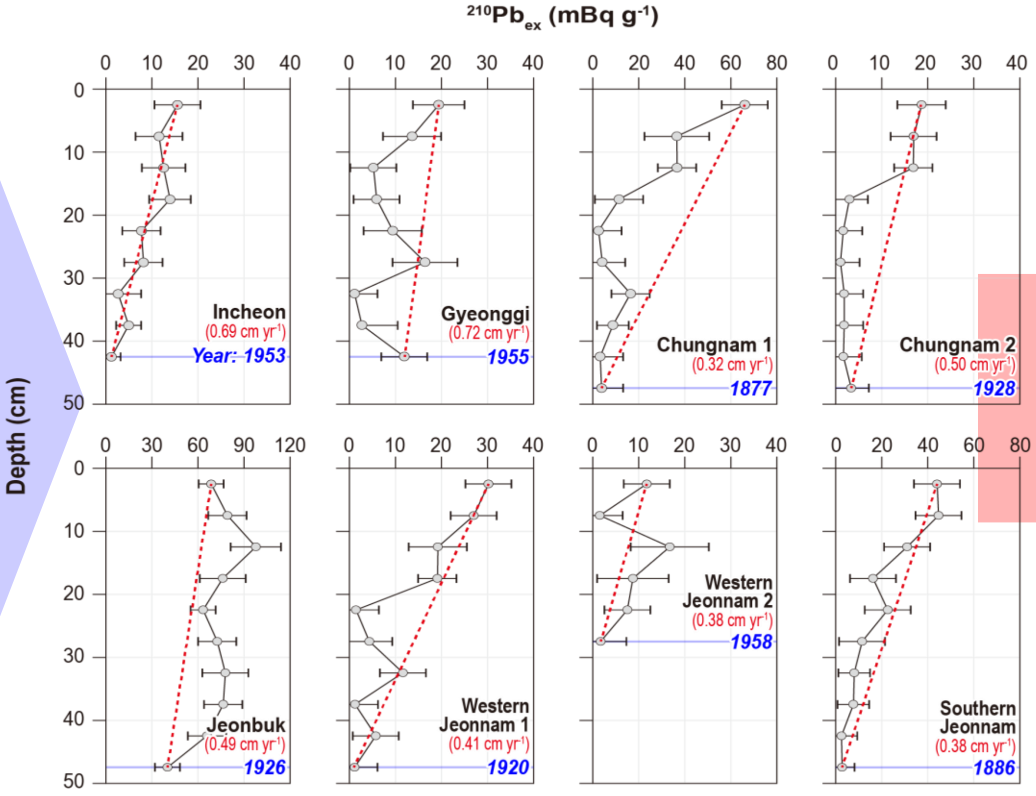
Breithaupt et al., 2018. *Limnology and Oceanography.* 63 (S1), S477-S495

3. Key Findings & Discussion

BC criteria for Tidal flats: Long-term storage of fixed CO_2

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
		Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Emerging Blue Carbon Ecosystems	Tidal flat	? → YES	? → YES	YES	?	NO	YES

Current sediment coring (max depth: ~1 m)



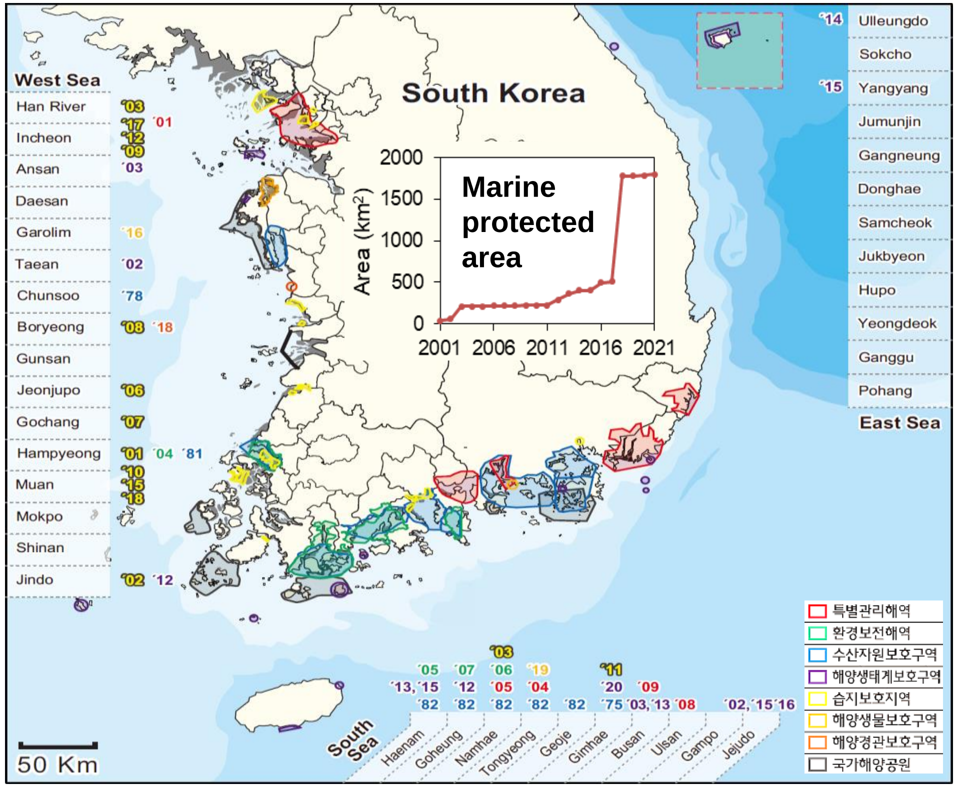
Lee et al, 2021

Upcoming sediment coring (max depth: ~6 m)

3. Key Findings & Discussion

BC criteria for Tidal flats: Practical management to reduce emission

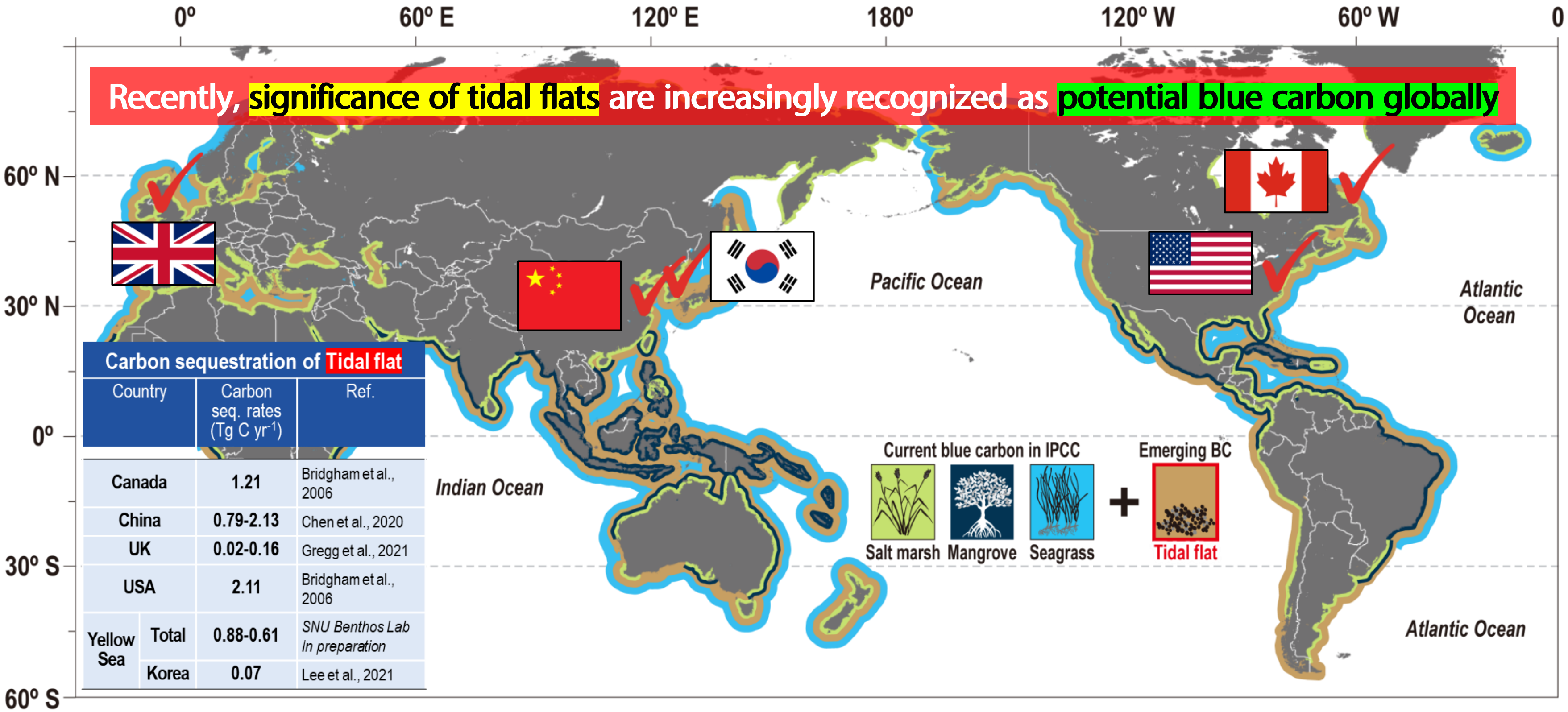
Category	Habitat type	Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
		Large scale of GHG removals or emissions	Long-term storage of fixed CO_2	Carbon loss by anthropogenic impacts	Practical management to reduce emission	Included in IPCC GHG accounting guidelines	Alignment with other policies
Emerging Blue Carbon Ecosystems	Tidal flat	? → YES	? → YES	YES	? → YES	NO	YES



3. Key Findings & Discussion

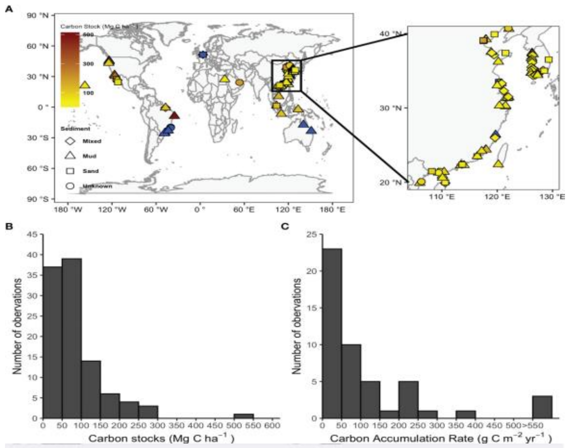
BC criteria for Tidal flats: Included in IPCC GHG accounting guidelines

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
		Blue Carbon Criteria (Adapted from Lovelock & Duarte, 2019; Pidgeon et al., 2021)					
Emerging Blue Carbon Ecosystems	Tidal flat	? → YES	? → YES	YES	? → YES	NO → YES	YES



Carbon sequestration of Tidal flat

Country		Carbon seq. rates ($Tg\ C\ yr^{-1}$)	Ref.
Canada		1.21	Bridgham et al., 2006
China		0.79-2.13	Chen et al., 2020
UK		0.02-0.16	Gregg et al., 2021
USA		2.11	Bridgham et al., 2006
Yellow Sea	Total	0.88-0.61	*SNU Benthos Lab In preparation*
Yellow Sea	Korea	0.07	Lee et al., 2021



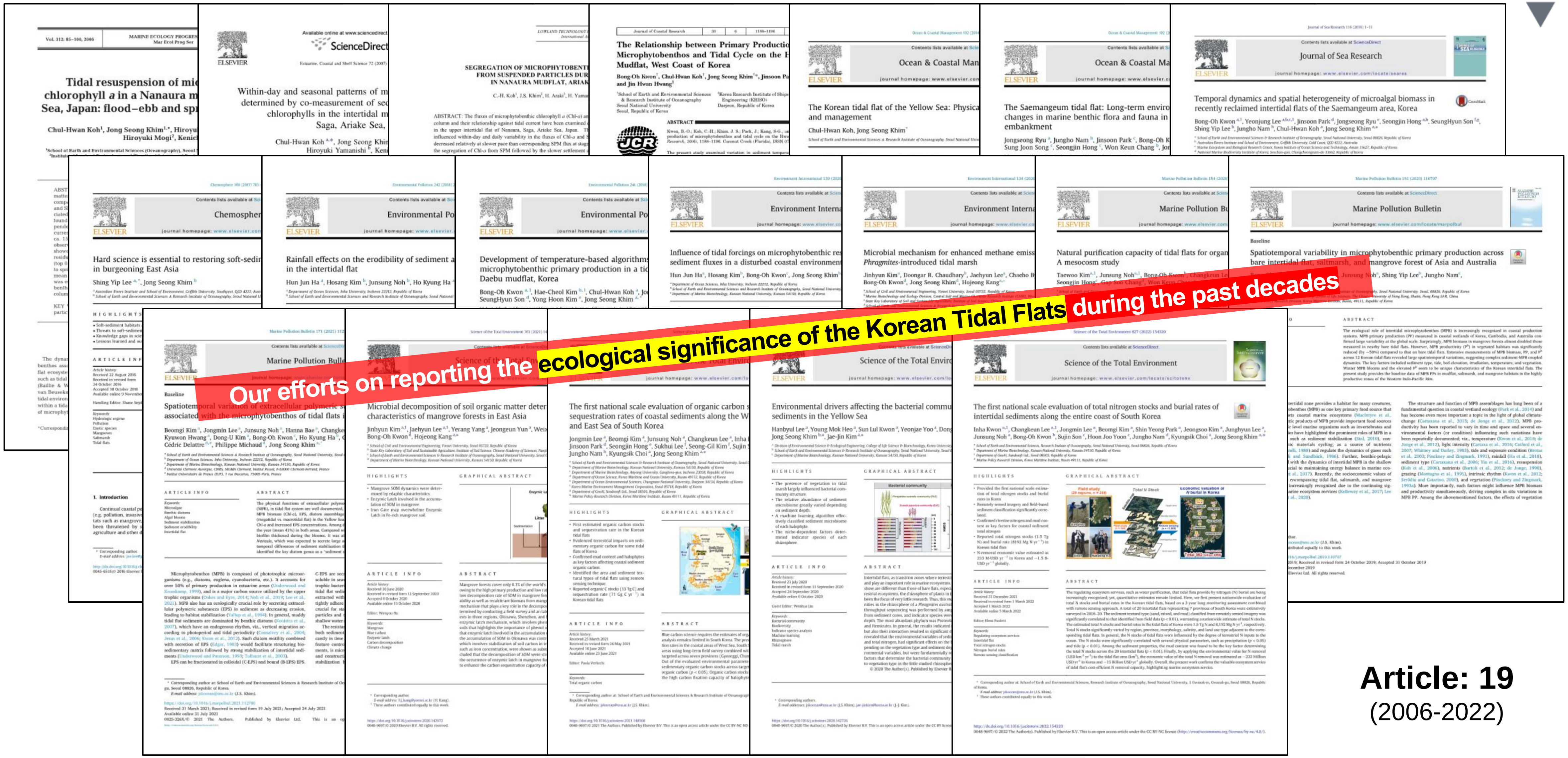
Tidal Flats as a Significant Carbon Reservoir in Global Coastal Ecosystems

Tidal flats are widely distributed and provide a variety of ecosystem services. Nevertheless, the consequences of tidal flat loss and implications for services such as carbon (C) sequestration have...

Front. Mar. Sci., 30 May 2022

4. Remarks

Published Works since 2000s



Article: 19

(2006-2022)

4. Remarks

Collaboration Efforts since 2016

In the World


Mangrove Monitoring (Australia)


BC conference (Nanjing Univ.)


FIO 2018 (Qingdao, China)


UNFCCC COP24 (Katowice, Poland)


BC conference (Qingdao, China)


CKC conference (Canada)


Blue Carbon Workshop (Indonesia)


Mangrove Monitoring (Cambodia)


BioGeo 2018 (Florida, USA)


EAS 2018 (Philippines)


IMBeR 2019 (Brest, France)


Living Shoreline con. (New Jersey, USA)


COP27 (Sharm El-sheikh , Egypt)

2016 2017 2018 2019 2020 2021 2022 2023


BC symposium


Prof. D. M. Paterson (Univ. St. Andrews)


Prof. C. Lovelock (Univ. Queensland)


BC Workshop (Seoul, Korea)


Blue Carbon Forum (Seoul, Korea)


KOR-IDN Blue C sem. (Seoul, South Korea)


Prof. G. L. Chmura (McGill Univ.)


Dr. P. Mcgonigal (SERC's)


Blue Carbon Forum (Jeju, Korea)


Kor.-Ind. BC Seminar


BC Workshop (Seoul, Korea)

In Korea

Thank you for listening!

Ministry of Oceans And Fisheries

Blue Carbon Research Center