Utilization and efforts of Granulated Coal Ash for carbon dioxide fixation

2025.9.4

GCA

CEPCO

The Chugoku Electric Power Co., INC.

Technology of GCA (Granulated Coal Ash)

Features

Mixing and granulating with small amount of cement and water

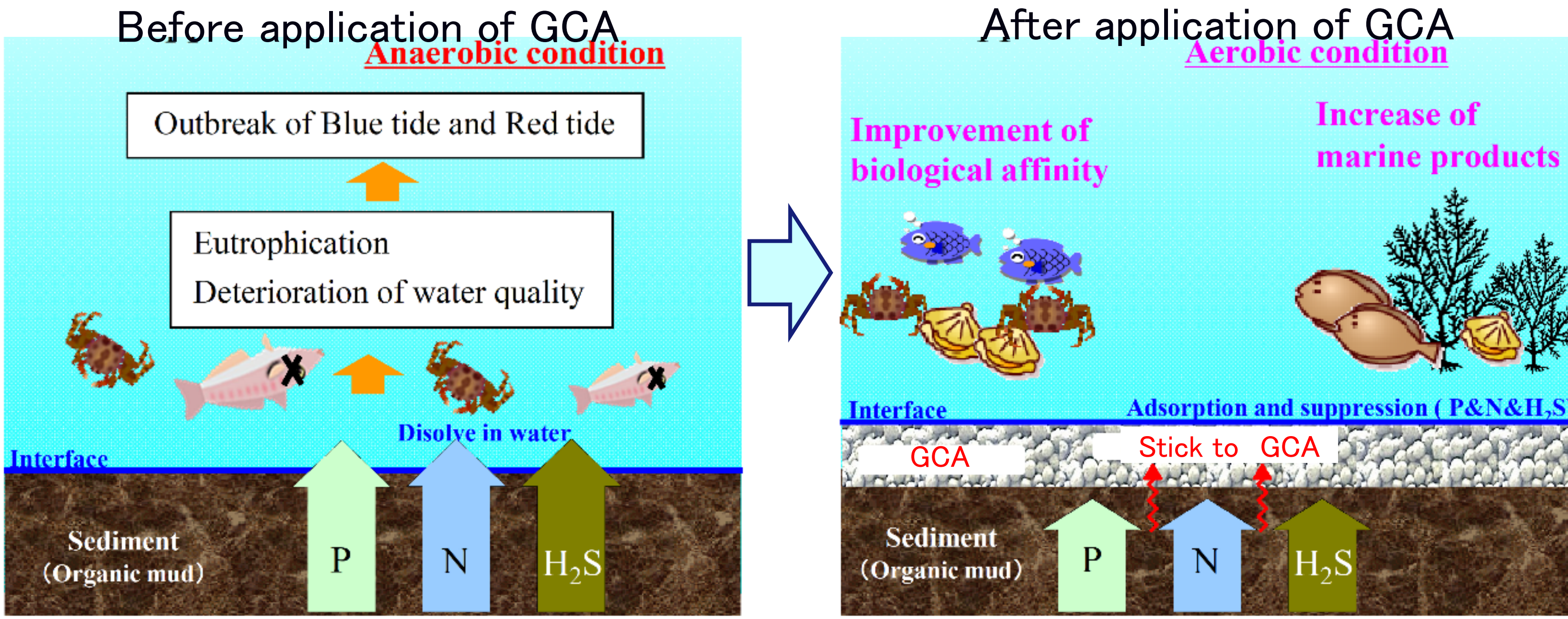
Coal Fly Ash

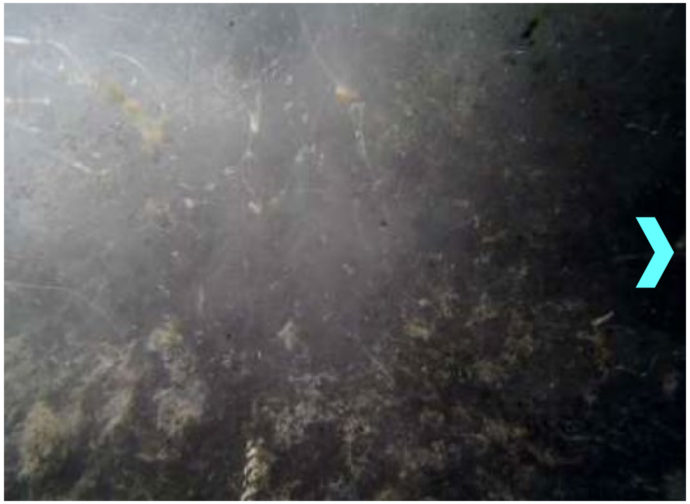
GCA

- **Diameter** : 10～20mm
- **Strength** : around 10N/mm^2
- **Density(dry)** : 0.8～1.1g/cm^3
  (for ref.) Sand: 1.2～1.8g/cm^3
- **Water absorption rate** : 15～25%

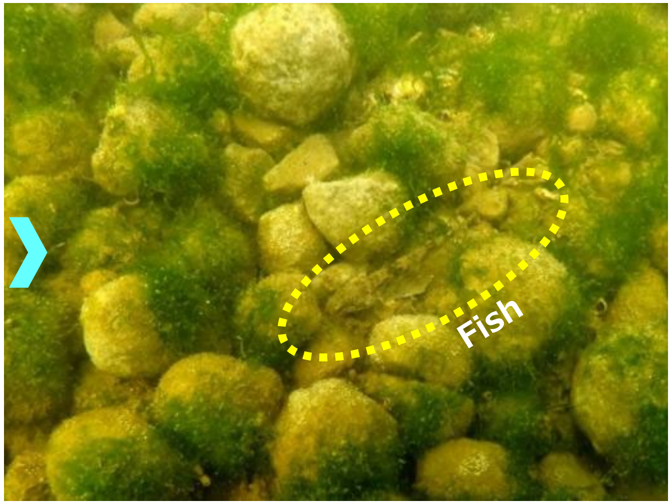
For what the GCA is used?

- The answer is for "Water Purification".
- GCA has remarkable effects on water environment restoration.



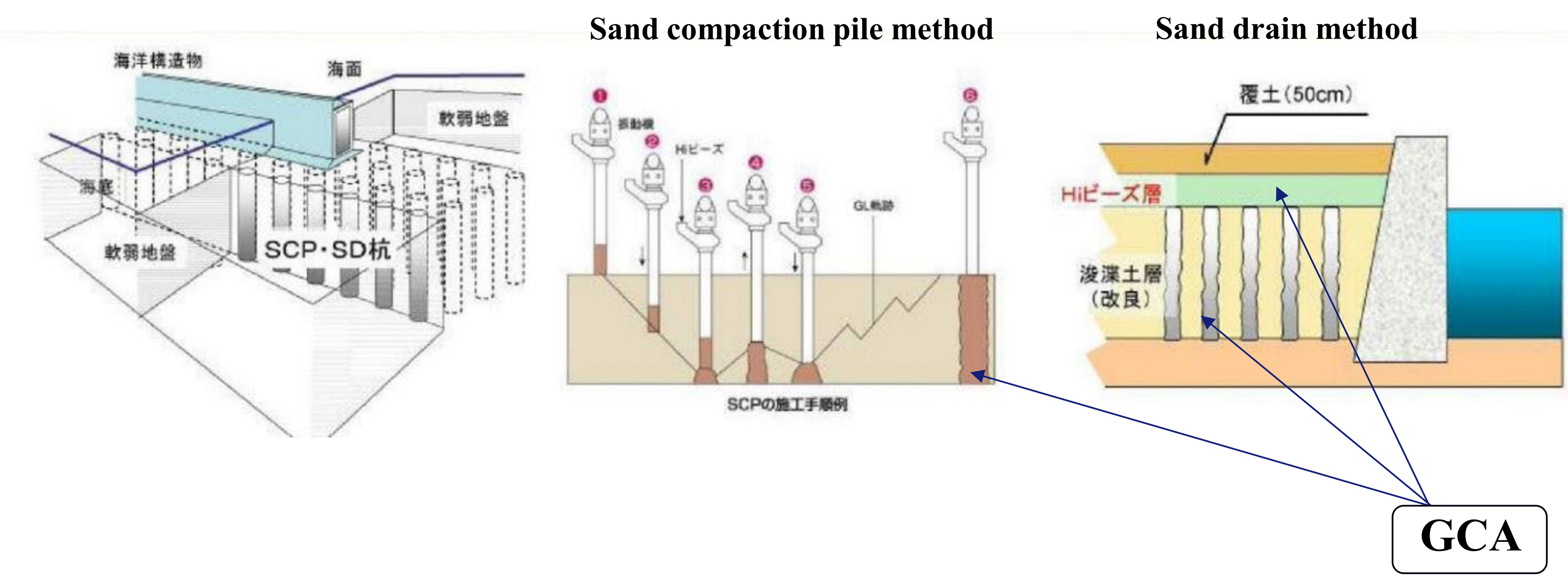


After Applying GCA in river



Any other Use of the GCA?

- *The answer is for "Civil Engineering Work".*
- *GCA was originally developed as a alternative material for sea sand, which has been in shortage in Japan for the past few decades.*
- *GCA has been widely applied as the material for sand compaction pile and sand drain method in Japan.*



Where GCA manufacturing plant can be located?

Overview of GCA factory in Misumi Coal PS with total capacity of 2GW

Summary of Manufacturing Plant

➢ ***The factory can be launched only with reasonable CAPEX and appropriate space in PS. The required area for the facility* area to be built is approx. 5,000m².***

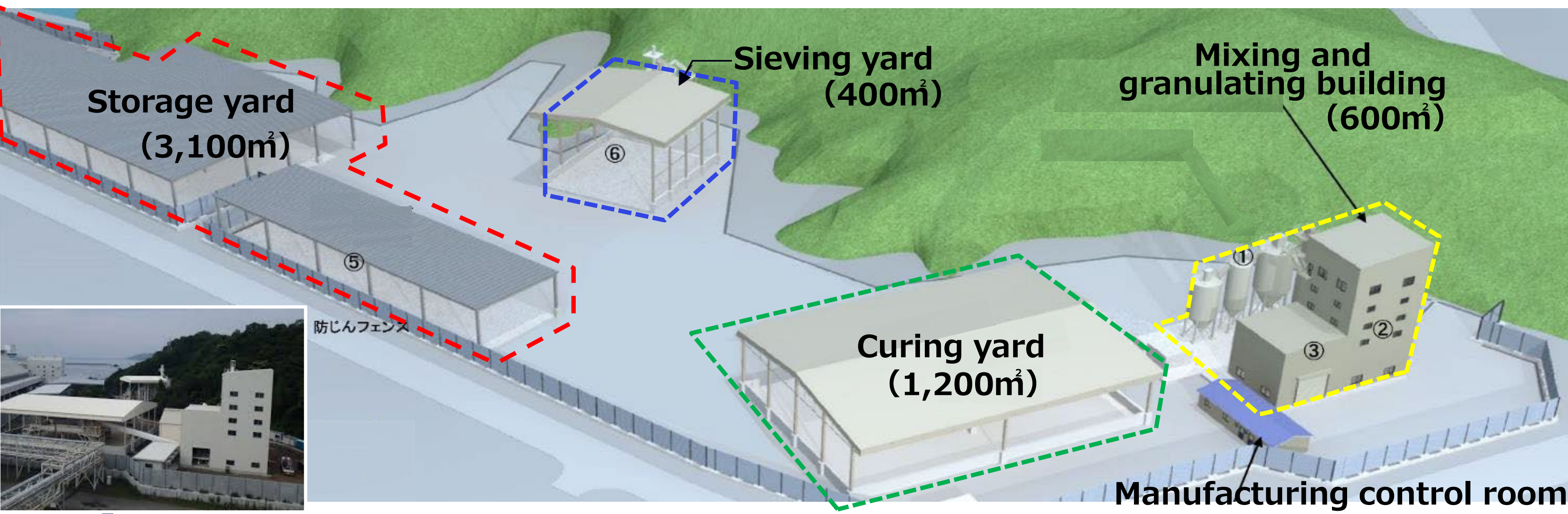
*** Capacity of the GCA Manufacturing plant in Misumi PS**

✓ **Manufacturing capacity**

60,000 m³/year, ***200 m³/day*** (***50,000t/year***,***170t/day*** for fly ash)

✓ **Storage capacity**

40,000 m³(including off-site temporary stock yard)



Summary of each facility in manufacturing process

Manufacturing facility

Curing yard

Mixing and granulation building

Manufacturing control room

Specification and Quality Control of GCA

GCA's quality is strictly controlled as per its quality standard, which enhances its reliability as its **easy-handling** for civil work and **eco-friendly** material in Japan.

Quality item	Unit	Test method	Standard value	Remarks
Soil particles density	g/cm^3	JIS-A-1202	2.1～2.4	Cohesive soil 2.5～2.75, Sandy Soil 2.6～2.8, Blast furnace slag 2.6～2.9
Dry density	g/cm^3	JIS-A-1225	0.8～1.1	Cohesive soil 0.5～1.4, Sandy Soil 1.2～1.8, Blast furnace slag 0.8～1.1
Wet density	g/cm^3	JIS-A-1225	1.0～1.4	Cohesive soil 1.2～1.6, Sandy Soil 1.6～2.0, Blast furnace slag 0.9～1.3
Moisture content	%	JIS-A-1203	15～35	
Particle size distribution	%	JIS-A-1204	Refer to Fig.1	Particle size additive curve by sieve
Permeability test (Triaxial compression test)	m/s	JIS-A-1218	1.04×10^{-2}m/s (0Ec) 4.99×10^{-7}m/s(6Ec)	
Optimum Moisture content	%	JIS-A-1210	40～50 (less than 5mm) 20～30 (less than 40mm)	
Water absorption rate	%	JIS-A-1110 JIS-A-1109	15～25	Blast furnace slag 0.5～3.0
Internal friction angle (Triaxial compression test)	angle	JGS 0524	≧35 (0Eco) ≧45 (6Eco)	Cohesive Soil 35°, Sandy Soil 30°
Crushing Strength	MPa	JIS-Z-8841	More than 1.2	
Elution test of heavy metal	—	Marine pollution regulation in Japan	Less than regulation value	Do not use inland condition in Japan

Value of Dry and Wet density is in 90% of the maximum dry density with optimal moisture content.

Business development in Japan (2013～2022) (1/2)

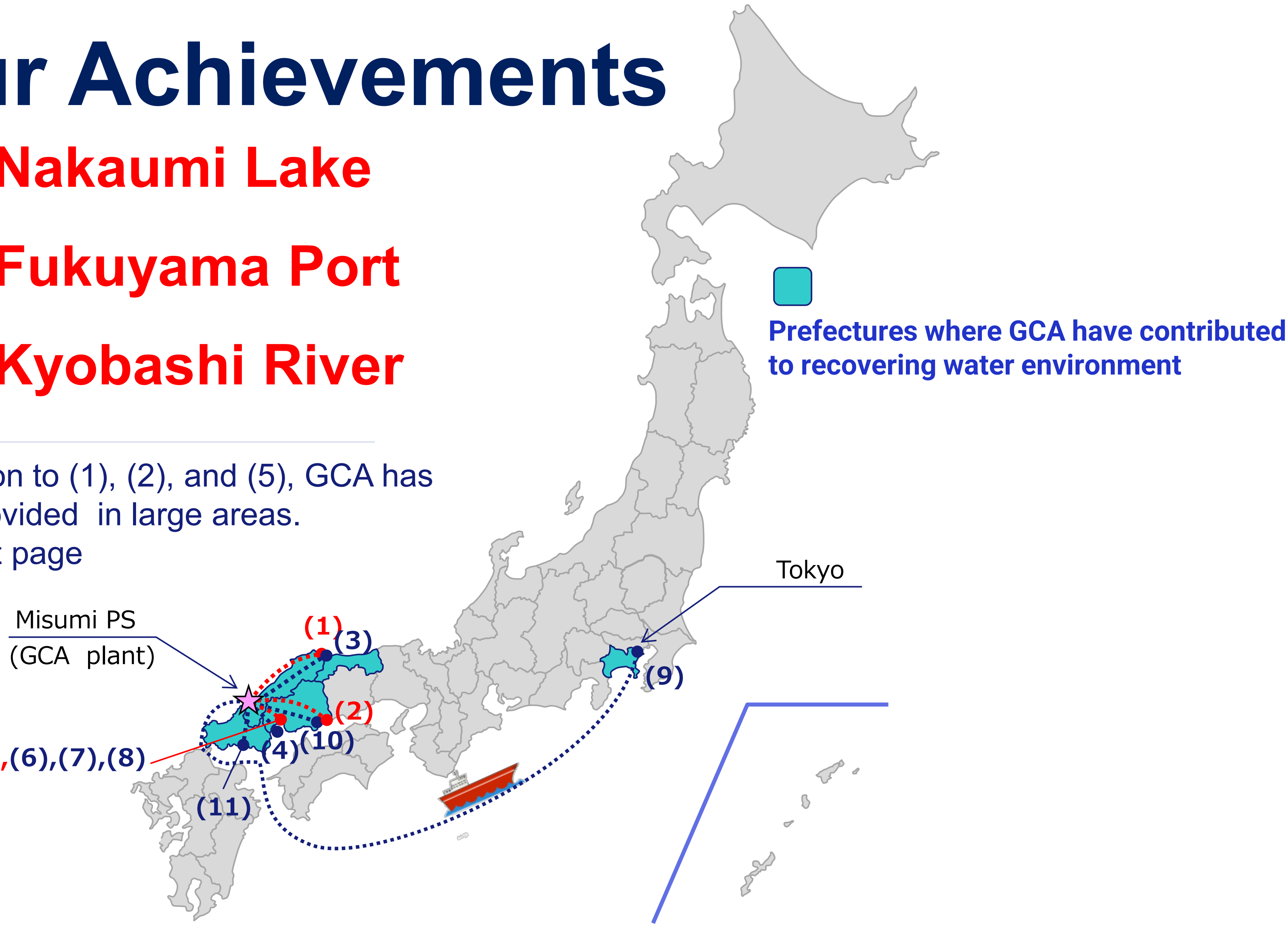
Our Achievements

(1) Nakaumi Lake

(2) Fukuyama Port

(5) Kyobashi River

In addition to (1), (2), and (5), GCA has been provided in large areas.
See next page



Business development in Japan (2013～2022)(2/2)

GCA has contributed to recovering water environment all over Japan

No.	Site Area	Site Area Condition	Targeted Environmental Improvement	Applicaiton Vol. (m^3)
1	**Nakaumi Lake**	Closed Lagoon Zone	*Restoring Natural Purification Function*	307,000
2	**Fukuyama Port**	Inner Harbor Zone	*Reducing Sludge*	17,200
3	Yasugi Port		*Recovering Biodiversity*	14,000
4	Hiroshima Bay			9,400
5	**Kyobashi River**	Tidal River Zone	*Creating Attractive Scenery for Tourism*	2,700
6	Hon River			590
7	Tenma River			435
8	Ota River			100
9	Tsurumi River		*Reducing Sludge*	30
10	Onomichi Port	Inner Harbor Zone		300
11	Tokuyama Port			800

No. 1: Nakaumi-Lake (1/3)

Project Overview

Back Ground

Nakaumi-Lake had been in danger of water pollution due to eutrophication.

As seaweed beds have decreased due to reclamation in the lakeshore area, natural purification function has seriously weakened.

CEPCO's Contribution

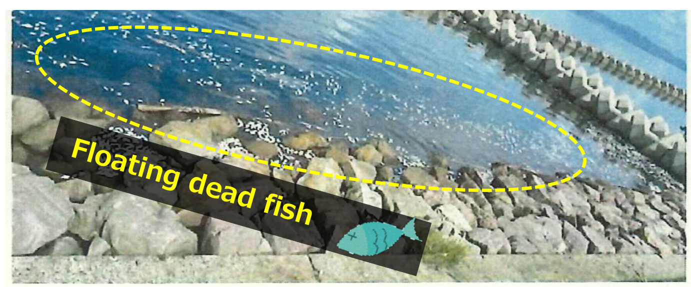
Since 2003, GCA sand-capping has been implemented to restore the lake's natural purification function.

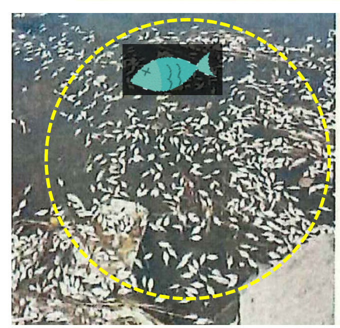
After application of GCA, water quality had been dramatically improved

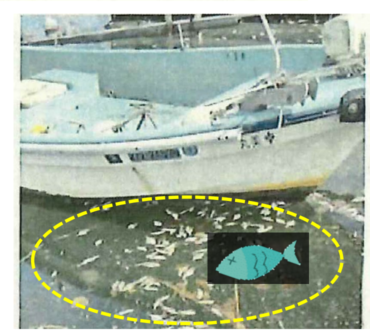
Mechanism of Water Quality Deterioration

1. Nutrient salts flow into rivers
2. **Eutrophication**
3. Outbreak of plankton
4. Outbreak of red tide and blue-green algae
5. Fish and shellfish die due to lack of oxygen in water
6. Landscape deterioration and offensive odor generation is caused

Floating dead fish due to eutrophication



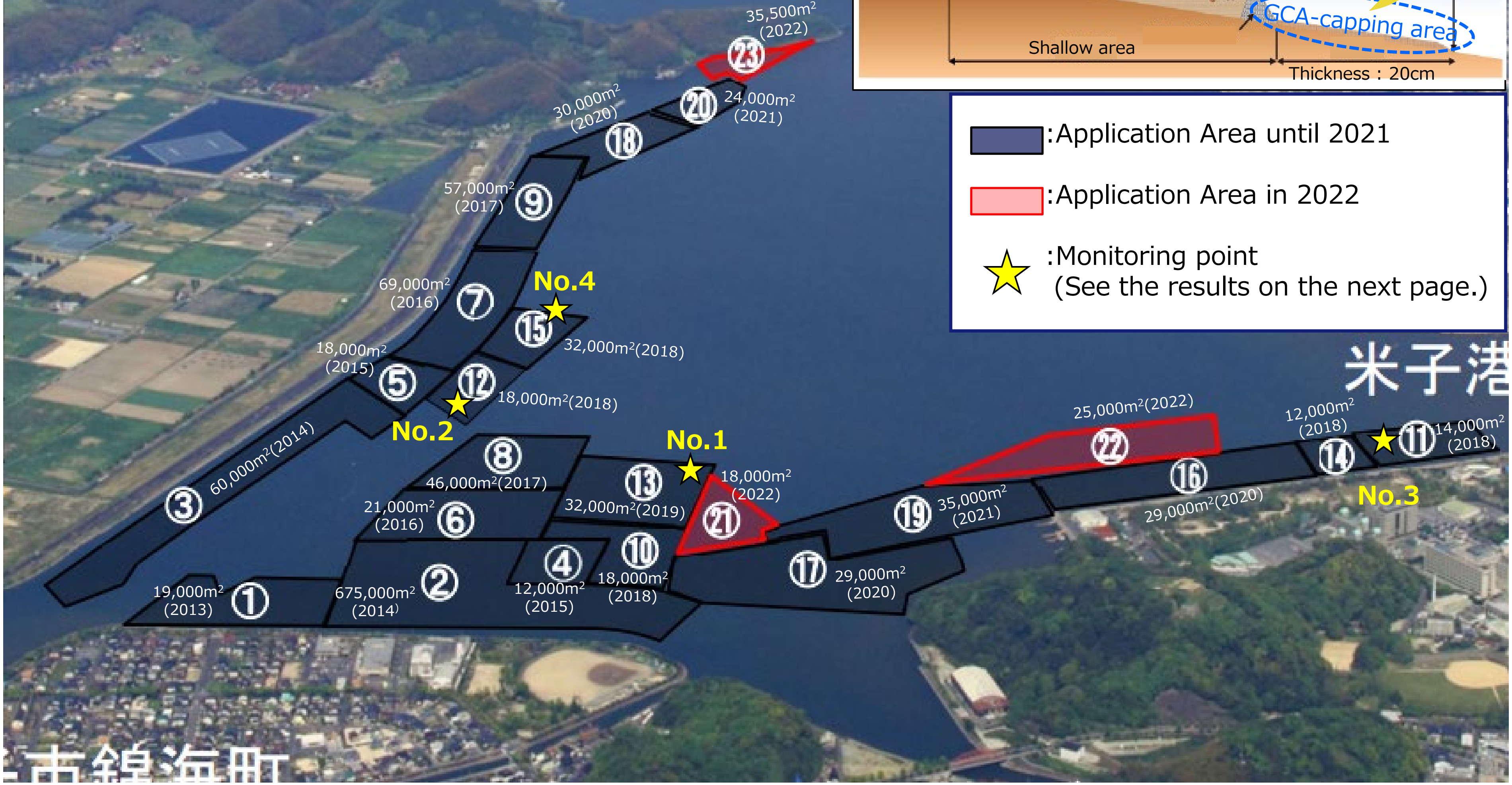


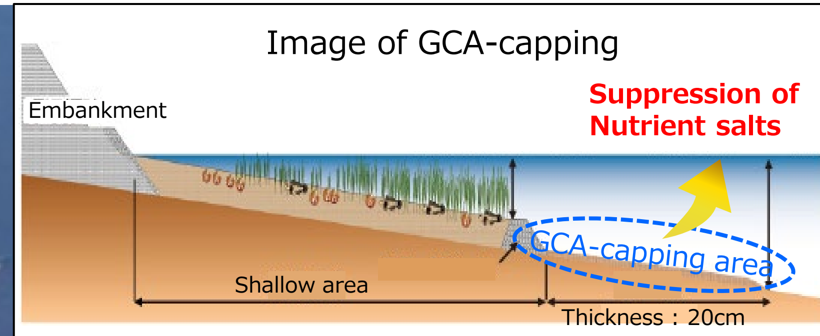


No. 1: Nakaumi-Lake (2/3)

Applicaiton Area

In total, approx.400,000m² of GCA has been provided for the past 10 years.



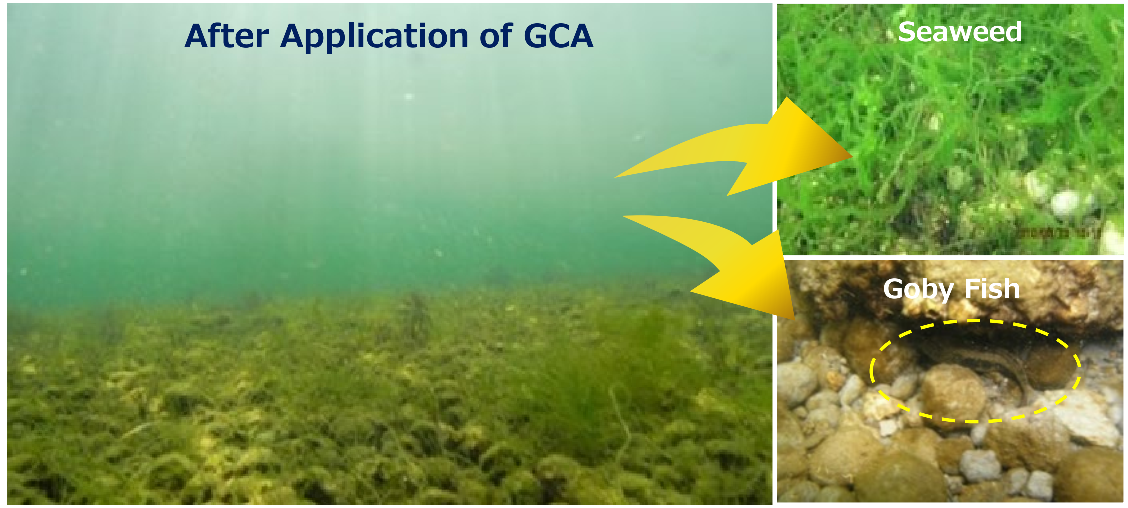


No. 1: Nakaumi-Lake (3/3)

Achievements

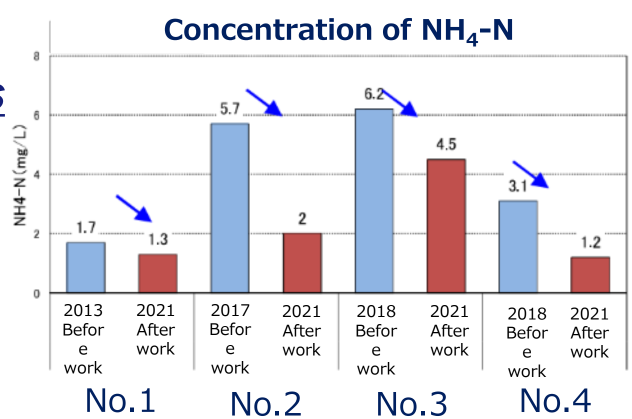
01

Habitat Restoration

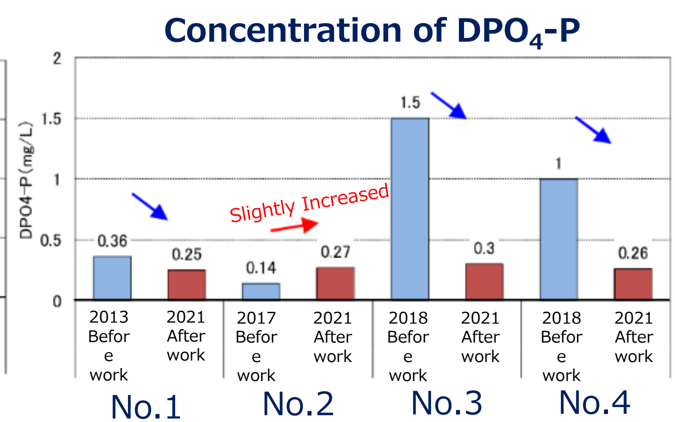


02

Suppression of nutrients



NH_4-N: Ammonia Nitrogen



DPO_4-P: Soluble Phosphate

No. 2: Fukuyama Port (1/3)

Project Overview

Back Ground

In Fukuyama Port, floating scum caused by polluted water had occurred since late 2000s.

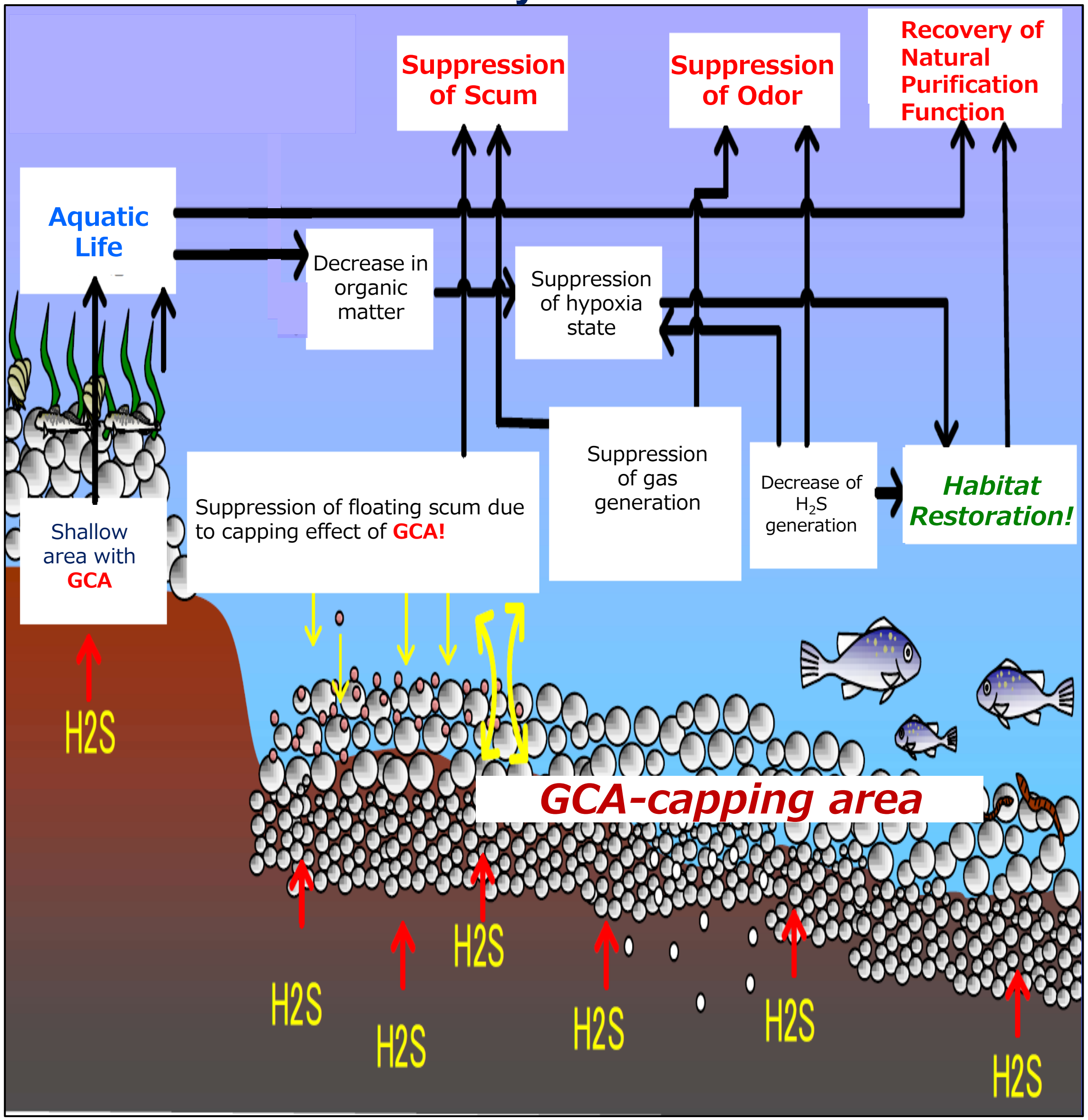
CEPCO's Contribution

To solve the environmental problem, the project of improving water quality with applying GCA had been launched in 2011.

(Results)

✓ **GCA reduced construction costs by approx.20% ,compared to conventional method (dredging, sand covering)**

Mechanism of In-water Habitat Restoration by GCA



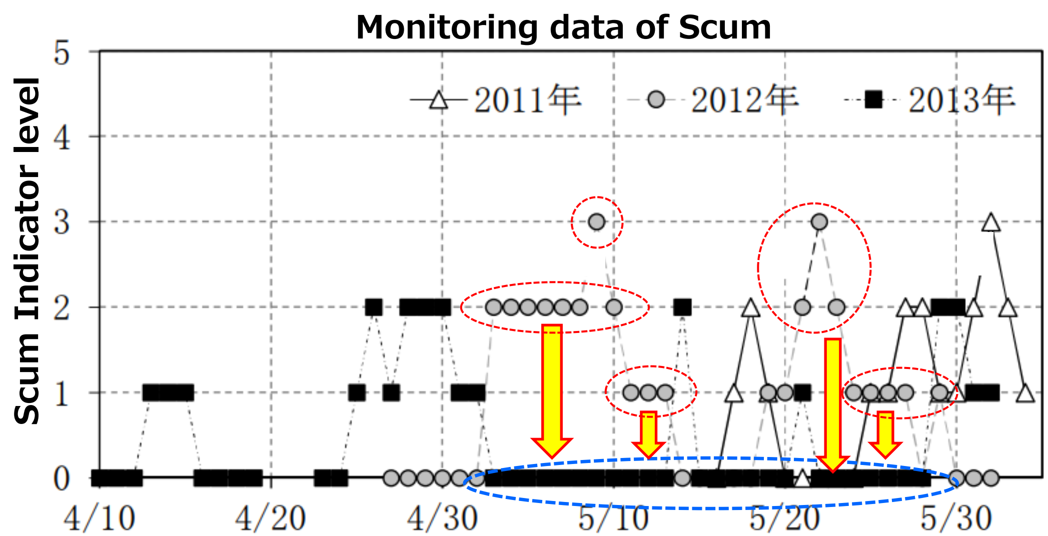
No. 2: Fukuyama Port (2/3)

Achievements

01

Suppression of Scum

- ✓ After the application of GCA, the scum on the sea surface completely disappeared!
- ✓ Bird came back to flock to the restored low tide areas for catching fish. As scum tend to be observed at spring, therefore monitoring the scum was carried out between Apr. to May.



Definition
Level 0
Nothing floats
Level 1
Slightly covered
Level 2
Locally covered
Level 3
Partially covered
Level 4
Widely covered
Level 5
Fully covered

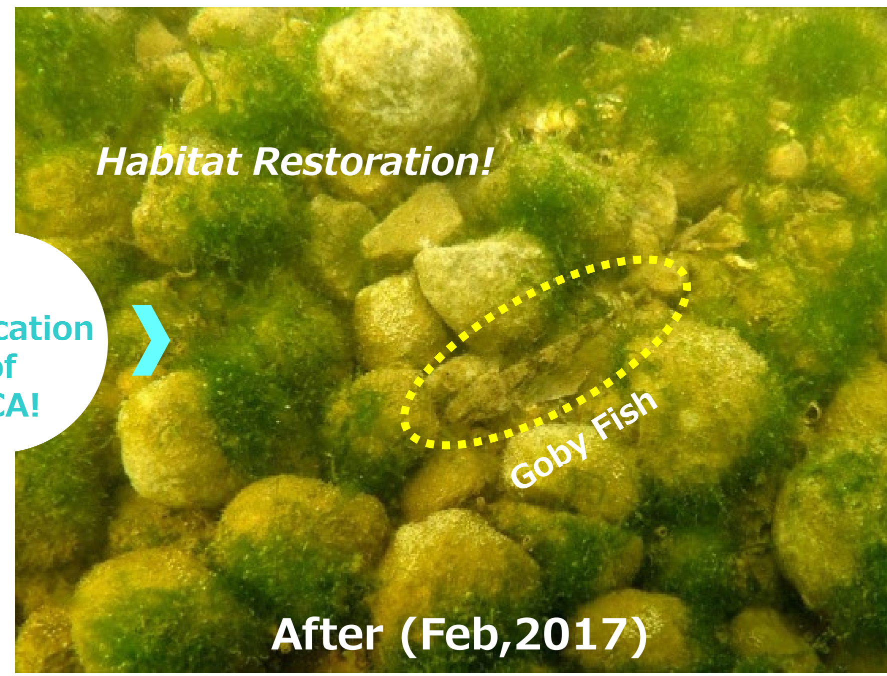
Achievements

02

Habitat Restoration

After application of GCA, the water clarity has improved significantly and seaweed is growing on the seabed!

Application of GCA!



No. 3 : Kyobashi River, Hiroshima (1/5)

Project Overview

Back Ground

Hiroshima-City has many rivers in its urban area. The riverside scenery had been worsened with sedimentation sludge at early 2000s.

To renew the area with more attractive spot for tourists, GCA was used to recover the riverside environment.

CEPCO's Contribution

CEPCO had tackled the challenging environmental-improving project with GCA, which resulted in great success with remarkable effect as follows;

- **Easy access to the waterfront**
- **Decrease sludge and odor.**
- **Diversification of aquatic species**

The Goal

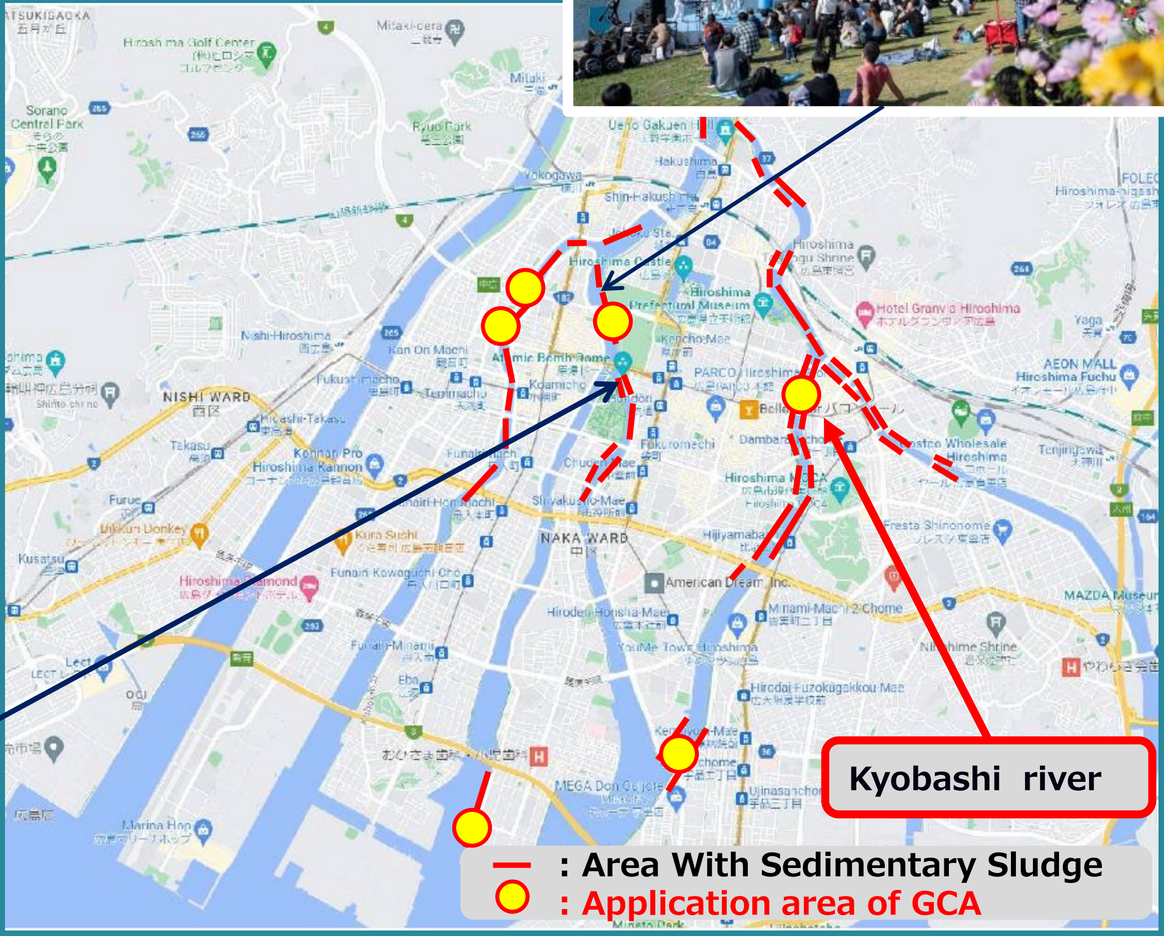
Before project

Scenery with Sedimentary Sludge
(before the start of the project in 2012)

Application Area

Sightseeing-spots had become more attractive with GCA use!
Please see the next page for detailed results !

Riverside Park near Hiroshima Castle



Peace Memorial Park

Achievements

01

Easy access to the waterfront

As the GCA has moderate strength, it enhances bearing capacity of surface soil.
The river tidal flat was used to be hard to walk due to soft sludge sediment, however it became **walkable** with ease after **GCA use** !


Before (Nov,2012)

Application of GCA!


After (Jul,2014)

Hard to walk..

Dirty scenery..

Walkable!

Beautiful scenery!

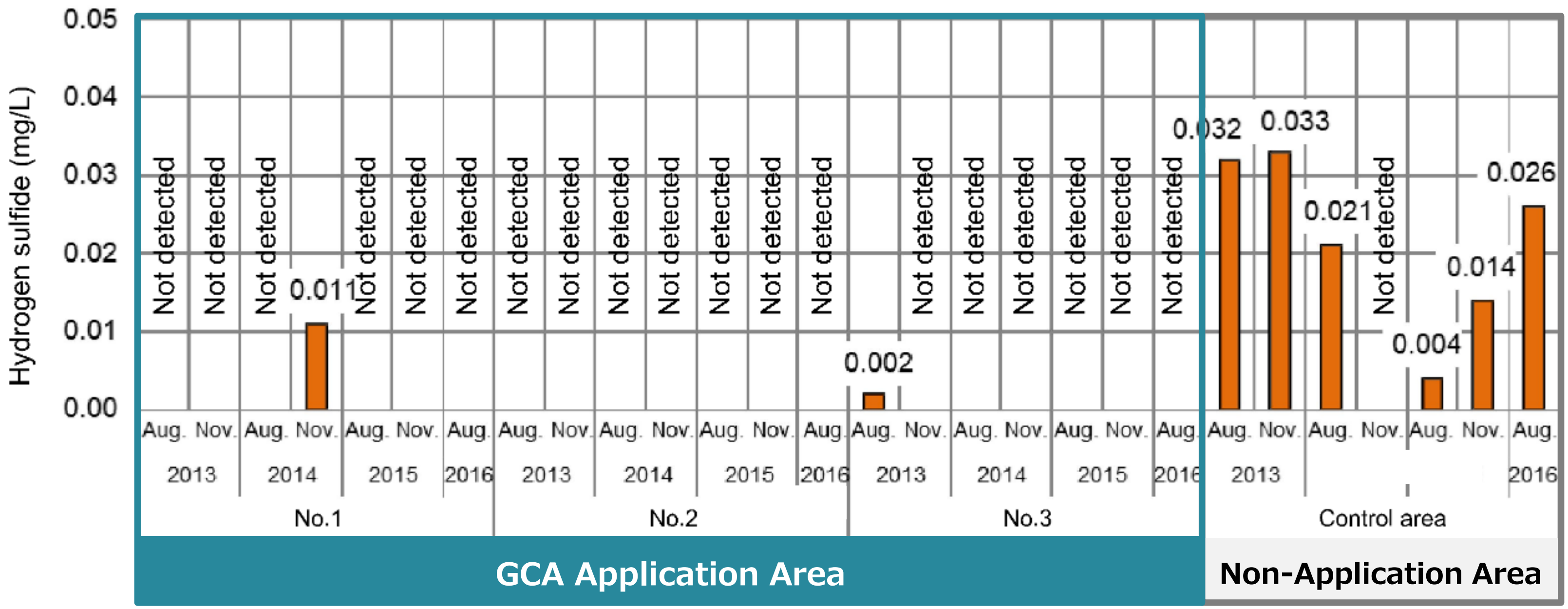
Achievements

02

Decrease sludge and odor.

H_2S causes bad smell and deterioration of water quality. Minerals eluted from GCA activate microorganisms and it helps decrease of sludge.

H_2S generation was **dramatically suppressed after application of GCA!**



Comparison of H_2S generation between application and non-application area

No. 3 : Kyobashi River, (5/5)

Achievements

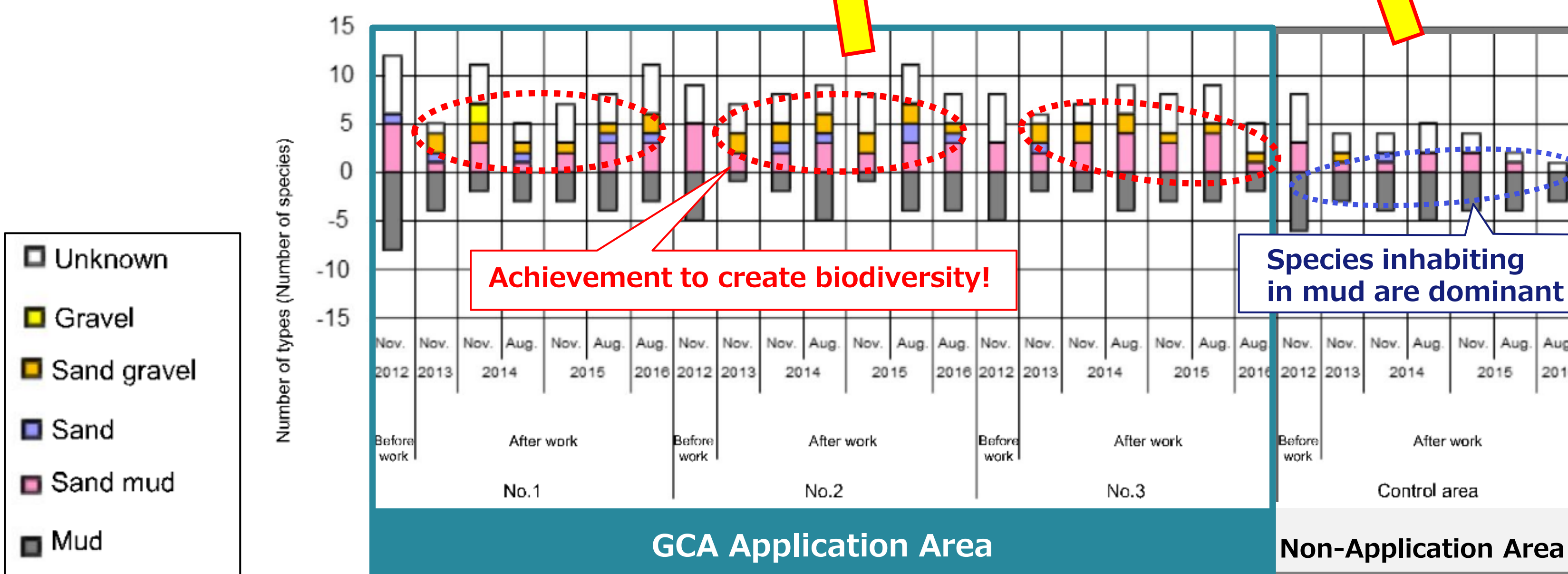
03

Diversification of aquatic species

After application of GCA,
biodiversity has dramatically improved!

Sampled in Application Area

Sampled in Non-Application Area



Comparison of biodiversity between application and non-application area

Certifications of GCA

In Japan, materials certified and registered by government agencies bring great benefits when used in public buildings.
GCA has received prestigious certifications and registrations including:

01

Registered material of New Technology Information System(NETIS) by Ministry of Land, Infrastructure, Transport and Tourism

02

Certification as “Shimane Green Products” (eco friendly recycled material) by Shimane local government

03

Environmental Verification Technology (ETV) by Ministry of the Environment

Record of Awards in Coal Ash Industry in Japan

Record of Awards

CEPCO has been committed to clarifying the fundamental features of coal fly ash and GCA, such as applicability to civil work material or effect of environmental remediation collaborating with university and governmental laboratory. CEPCO's challenge was highly evaluated with some awards from Japan Society of Civil Engineering etc..

01 **Japan Society of Civil Engineers Environmental in 2021**
(Title of thesis:Coastal Marine Environmental Improvement Project with utilizing of GCA)

02 **The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology in 2018**
Prizes for Science and Technology
(Title of thesis: Development of aquatic sediment improvement material with granulated coal ash)

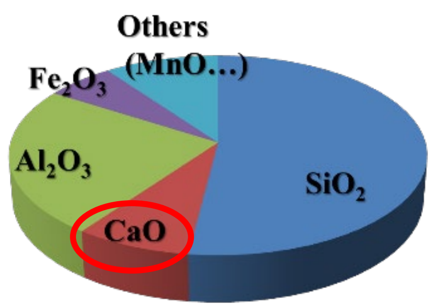
03 **Japanese Geotechnical Society, Chugoku branch Technology Award in 2021**
(Title of thesis : Application and demonstration of aquatic sediment improvement technology with recycling material

Japan Society of Civil Engineering Web site (https://www.jsce-int.org/node/780)

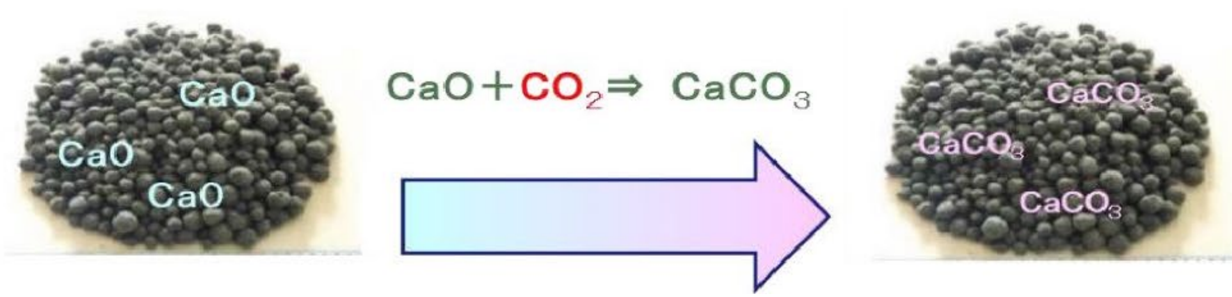
The new initiatives to CO_2 fixing technology

➢ *The remarkable effect of CO_2 absorption in GCA have been proven.*

Mechanism of CO2 adsorption in GCA

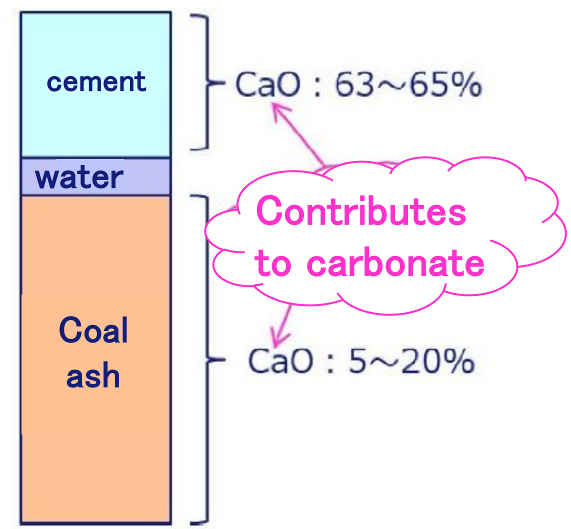


Composition of GCA



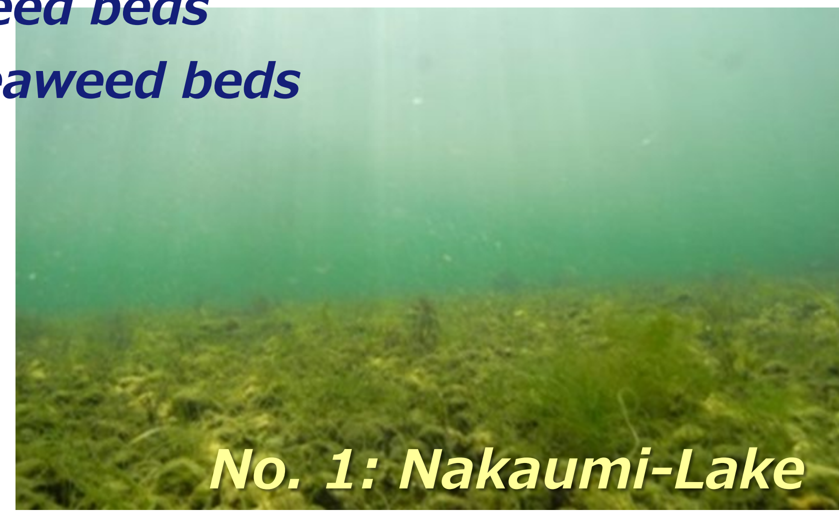
CO_2 absorption by carbonation

Material composition of GCA

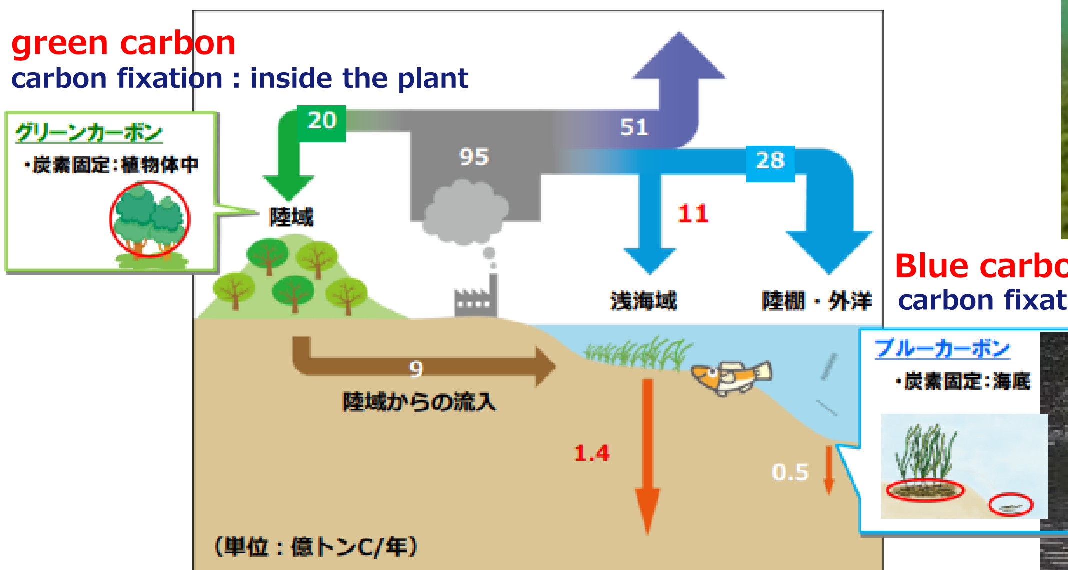


Blue Carbon

- ***Blue carbon is the carbon that is absorbed by coastal and marine ecosystems through photosynthesis and then accumulated on the seafloor and in the deep ocean.***
- ***The main sink for blue carbon is seaweed beds***
- ***GCA contributes to the formation of seaweed beds***

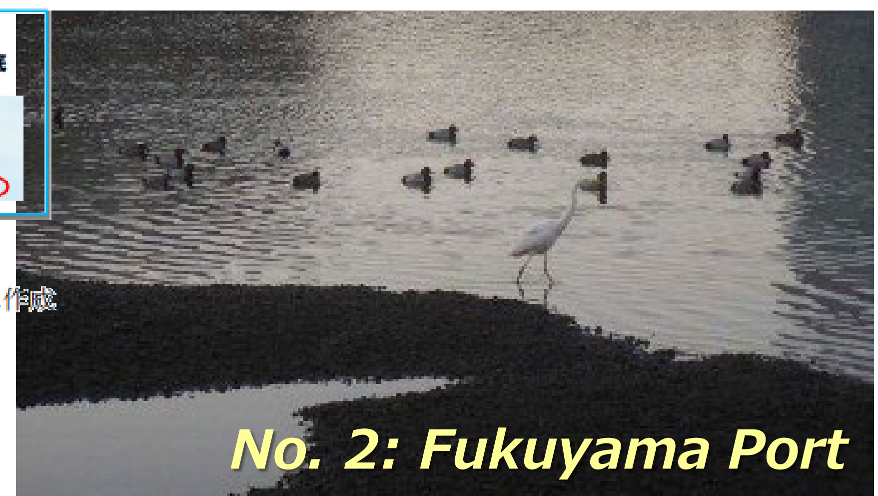


green carbon
carbon fixation : inside the plant



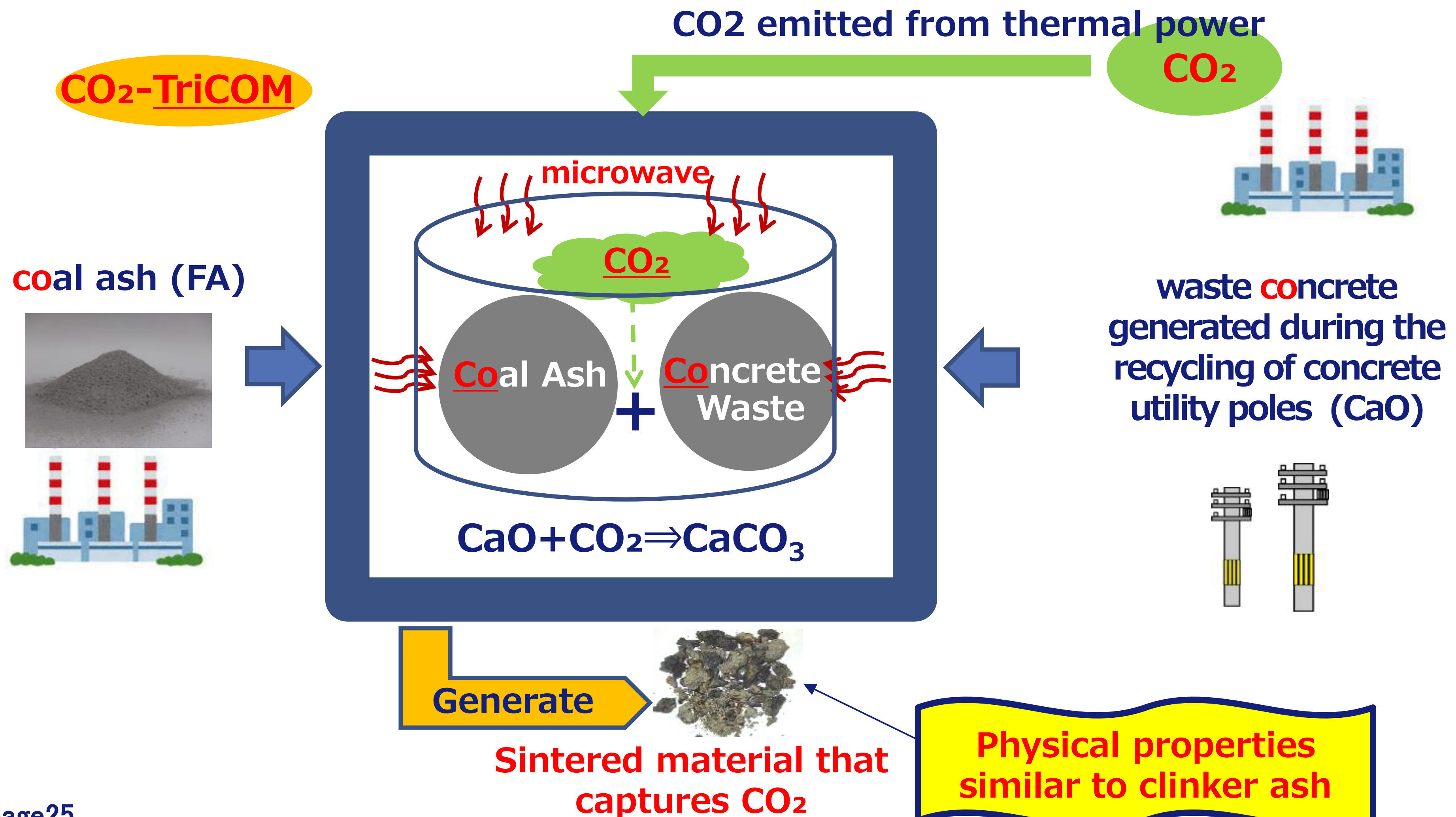
出典：Kuwae and Crooks (2021)を参考に作成

Blue carbon
carbon fixation : seafloor



Other initiatives（CO2-TRICOM）

➢ ***This technology combines coal ash (fly ash) with waste concrete generated during the recycling of concrete utility poles, sinters it using microwaves, and absorbs the CO2 emitted from thermal power plants to produce a Sintered material.***



CEPCO are developing products such as civil engineering and construction materials that utilize the properties of coal ash generated from coal-fired power plants, as well as developing application technologies for such materials, and are actively developing coal ash products.

一日も。百年も。

Thank you for your attention

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