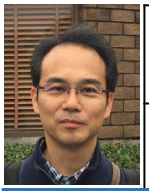
【Grant-in-Aid for Scientific Research (S)】

# Establishment of evaluation methods for carbon dioxide storage by Freshwater Carbon

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| Project Information | Project Number : 25H00408　Project Period (FY) : 2025-2029<br>Keywords : Submerged Aquatic Plant, Phytoplankton, Organic Carbon, Robot Measurement, Photosynthesis Experiment |


## Purpose and Background of the Research

**●Outline of the Research**

The annual sequestration of $CO_2$ in shallow coastal areas totals approximately 1 billion tons, accounting for about one-third of the total $CO_2$ absorption in the ocean, which is around 3 billion tons. To achieve further $CO_2$ sequestration, the enhancement of blue carbon, which stores $CO_2$ through aquatic organisms in shallow coastal areas, needs to be promoted globally. On the other hand, it has been discovered that freshwater lakes and reservoirs can also act as long-term $CO_2$ sinks, called "Freshwater Carbon." The total area of shallow coastal areas and freshwater lakes worldwide is 180 million $km^2$ and 500 million $km^2$, respectively. Although the $CO_2$ storage potential of freshwater carbon is significant, there is no evaluation method for it. Therefore, this study aims to develop an evaluation method for $CO_2$ storage by phytoplankton and aquatic plants in lakes and reservoirs within the climate zones to which Japan belongs, using field observations, numerical model simulations including machine learning, and satellite analysis. Additionally, to aim for global expansion, the study will collaborate with international organizations and include diverse lakes in subtropical and Mediterranean climates as research subjects, with the goal of contributing to carbon neutrality as a global frontrunner in freshwater carbon research.

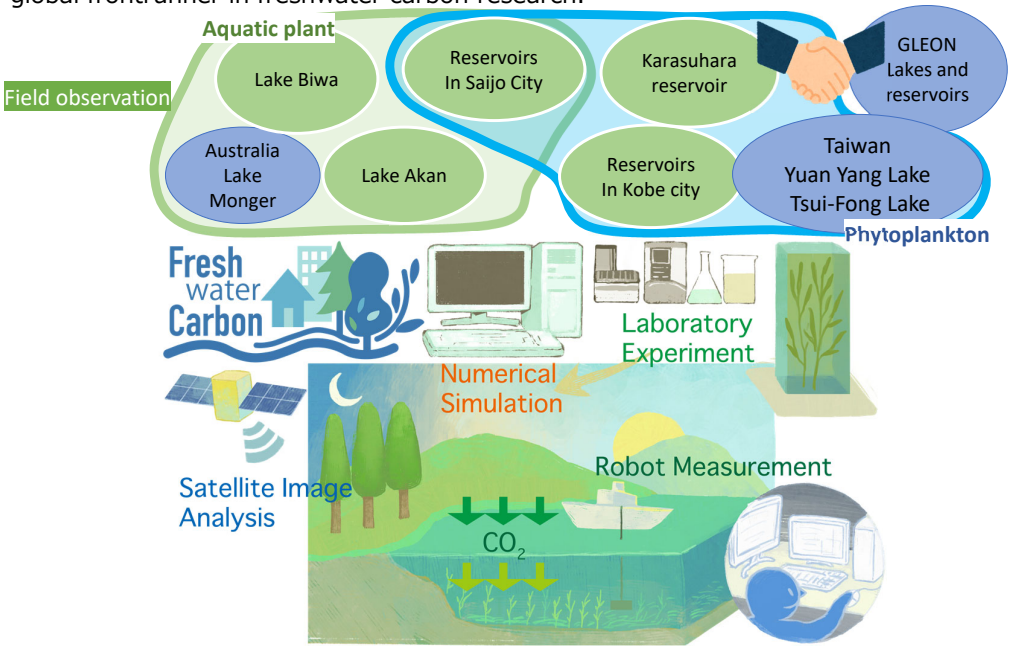


Figure 1.　Conceptual diagram of field observations, laboratory experiments, and numerical simulations of $CO_2$ sequestration by Freshwater Carbon.

## Expected Research Achievements

On-site observations will be conducted in targeted regions, including small lakes in subarctic and temperate zones. The observation results will be used to verify the 3D numerical model for $CO_2$ sequestration developed in this study to quantify the contributions of phytoplankton, aquatic plants, and dissolved organic carbon to the partial pressure of $CO_2$ in water. Ultimately, using models of phytoplankton and aquatic plants based on laboratory experiments, the study aims to establish evaluation methods for $CO_2$ capture and storage ratios in freshwater areas.

**● The Difficulties in Solving The Topics**

① In lakes where aquatic plant photosynthesis is active, there is no method to estimate the partial pressure of $CO_2$ in the water.
② The impact of fluid flow and the mineralization of dissolved organic carbon on $CO_2$ sequestration cannot be evaluated.
③ There is no method to estimate the burial rate of $CO_2$.
④ There is no simulation model for $CO_2$ for future predictions.

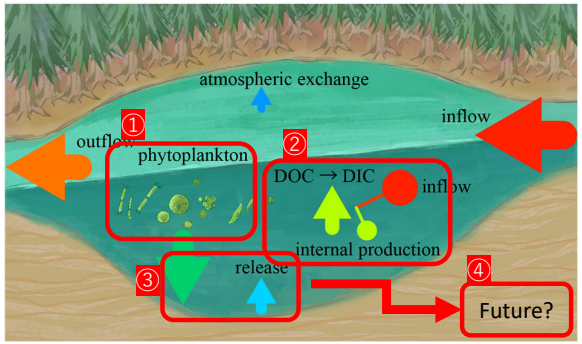


Figure 2. Conceptual diagram of the research topics.

**●Plan 1) Development of Evaluation Methods for $CO_2$ Capture and Storage in Diverse Lakes and Reservoirs**

A 3D numerical model will be incorporated with aquatic plants, and their reproducibility will be verified based on n-site observations and laboratory experiments in multi-scale lakes and reservoirs in subarctic and temperate zones.

**●Plan 2) Evaluation of $CO_2$ Sequestration in Lakes and Reservoirs through On-site Observations and Development of a Robotic Observation System**

On-site observations will be conducted in lakes such as Lake Akan, Lake Suwa, Lake Biwa, the Kawahara Reservoir, and various reservoirs with differing phytoplankton and aquatic plant conditions. $CO_2$ capture and storage ratios will be measured.

**●Plan 3) Evaluation of $CO_2$ Storage by Aquatic Plants and Phytoplankton through On-site Observations**

Laboratory experiments using actual aquatic plants will be conducted to determine $CO_2$ sequestration and release due to aquatic plants' respiration and photosynthesis.

**●Plan 4) Evaluation of Freshwater Carbon Potential Using Satellites and Development of $CO_2$ Sequestration Evaluation Methods**

A numerical model that can evaluate $CO_2$ storage from the past to the present will be developed. Satellite analysis targeting freshwater areas nationwide will be conducted to clarify the potential for enhancing Freshwater Carbon.

**● Social Ripple Effect 1**

It contributes to the "Green Growth Strategy for Carbon Neutrality by 2050" and provides essential methods for re-evaluating the ecosystem services of freshwater areas.

**● Social Ripple Effect 2**

Carbon crediting accelerates carbon neutrality for municipalities and companies that are not located in coastal areas. → Even inland municipalities and companies can use it as a new source of $CO_2$ sequestration, contributing to the regional economy and strengthening climate change countermeasures.

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| Homepage Address, etc. | Freshwater CarbonのHP : https://www2.kobe-u.ac.jp/~aquanak/index.html<br>ko-do（Freshwater Carbon in Kobe City） : https://www.asahi.com/ads/ko-do/ |