Carbon budget and heavy metal flux in the river system on the silicate and carbonate rock area in the Okinawa Island Japan

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Introduction

Coral reef ecosystem is known to act as a CO$_2$ source for atmospheric CO$_2$ because of its release effect of calcification. On the other hand, weathering of lime stone absorbs CO$_2$ from atmosphere. If we try to estimate CO$_2$ budget as a whole island system including weathering of inland rocks of the island as well as production of carbonate in surrounding coral reefs, we will obtain a different aspects about sink or source of CO$_2$ in coral reef ecosystem.

Fig. 1 Schematics of carbon cycles between weathering and calcification
Purpose
In this study we investigate quantity of Ca$^{2+}$ supplied from river system and deposition of CaCO$_3$ in coral reef to re-evaluate a role of coral reef ecosystem on global warming and also investigate the effect of heavy metals on coral reef water.

Methods We selected two typical rivers of “Genka” and “Mukue”. We also selected two reef sites ”Bise” and “Sesoko”.
Ca$^{2+}$ concentration was measured in the samples from the rivers for the estimations of weathering effect. Calcification was measured at the Bise site and trace metal concentrations were measured in the samples from the Sesoko site.

![Fig.2 Sampling sites]
Fig3. Sampling points of Genka and Mukue river. Ca distribution was used for estimation of a flux of carbon from land to coral reef
Amount of CO$_2$ absorbed by weathering

Absorbed CO$_2$ = C $\times$ R $\times$ A$_{\text{land}}$ ....... (eq. 1)

C: Ca$^{2+}$ concentration (mol/m$^3$)
R: Runoff (m/yr) (= rain fall – evaporation)
A$_{\text{land}}$: Land Area (m$^2$)

=1.03x10$^9$ Non lime stone

Amount of CO$_2$ released from coral reef

Released CO$_2$ = 0.6G $\times$ A$_{\text{reef}}$ $\times$ P ....... (eq. 2)

G: Calcification rate at 100% of coral (mol/m$^2$/yr)
A$_{\text{reef}}$: Coral reef area around Okinawa I.(m$^2$)
P: Percent cover of coral (= up to 24%)

CO$_2$ budget of whole coral reef island system

From eq. 1 and 2,

CO$_2$ budget = Absorbed CO$_2$ – Released CO$_2$

Fig4. Procedure of a calculation of CO$_2$ budget for the island system
The maximum amount of CO$_2$ absorption and release as a whole Island system were $132.4 \times 10^7$ CO$_2$ mol/year in 1998 and $18.6 \times 10^7$ CO$_2$ mol/year in 1993, respectively. The maximum absorption was 7 times higher than that release amount. Frequency of the absorption year was overwhelming the release year.

Fig5. CO$_2$ budget as a whole island system in Okinawa
Conclusions

• CO$_2$ budgets during 27 years from 1982 to 2008 indicated that the coral island system had been significantly absorbing CO$_2$ as a whole in Okinawa I.

• Our estimated values were largely influenced by the annual precipitation because CO$_2$ flux by weathering were based on rain fall, evaporation and river Ca$^{2+}$ concentration.

• When global warming increases a rain fall and hence the weathering, the absorption effect would be accelerated and could lead to a negative feedback of increasing atmospheric CO$_2$ in the future.