Title: The Study of Molecular Composition of Dissolved Organic Matter in Two Different Ecosystems: Inle Lake and Bago Mountains in Myanmar

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Abstract

**Introduction:** Freshwater ecosystems play vital roles in providing ecosystem services to humans. Dissolved organic matter (DOM) in the environment acts as the source and sink of carbon and contributes to the global carbon cycle. DOM refers to the total mass of dissolved organic matter and contains numerous elements. Dissolved organic carbon (DOC) is a mass of carbon and the main component of DOM. Inle Lake is the second largest lake in Myanmar, and it is important for the livelihoods of local people and biodiversity. Dissolved black carbon (DBC), one of the molecular species of DOM, is mainly produced by the combustion of organic matter and it plays an essential role due to its refractory nature. In Myanmar, shifting cultivation is traditionally practiced by the residents for their livelihoods and food security, and Bago Mountains is a famous area for shifting cultivation. Thus, I studied DBC in shifting cultivation in Bago Mountains. The main objective of this study is to explore the dynamics of DOM including DBC, in two different environments by examining the DOC concentration and the DOM molecular compounds of water samples from Inle Lake and soil samples from Bago Mountains. The water quality assessment in the lake was conducted to provide the appropriate times and locations to continue monitoring. Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR-MS) was used for examining the DOM and its biomolecular classes in water samples of Inle Lake and the soil samples of Bago Mountains.

**Spatial and seasonal variations of water quality assessment in Inle Lake:** This study aims to select the appropriate times and locations for the future monitoring of the lake water quality. I found that the agricultural and tourism activities in and around the lake influence the degradation of the water quality. There were two clusters according to cluster analysis (CA): cluster 1 including St.1 and St.2 and cluster 2 including St.3 to St.8. The values were firstly divided into wet and dry seasons. Then, the agricultural and non-agricultural locations during the wet season and the tourism and non-tourism locations during the dry season were compared. There was only a significant difference in total suspended solids (TSS) in agricultural and non-agricultural stations. Moreover, the mean values of electrical conductivity (EC), $Ca^{2+}$, $Na^{+}$, TSS, total dissolved solids (TDS), and

total hardness (TH) in tourism stations were significantly higher than in non-tourism stations. Regarding the results of the Tukey post hoc test of two-way ANOVA, St.1 and St.2 were significantly higher than the other stations in mainly TSS, TDS, and TH. St. 1 and 2 were in the main inlet of the lake and assuming that the sources of those elements, such as sediments and organic matter from the watershed areas, might be carried through the inlet. The proper sampling locations should be St.1 and/or St.2 in cluster 1 and St.8 in cluster 2, and the changes in water quality should be observed twice a year: in September for the wet season and in February for the dry season to monitor in the future.

**Molecular characterization of dissolved organic matter in surface water of Inle Lake:** This study aims to evaluate the sources and diversities of DOM by investigating the molecular composition of DOM in surface lake water using the FT-ICR-MS technique. DOC concentrations and the number of DOM molecular compounds were higher in stations near the main inlets than in other stations. Lignin-like molecules were dominant at all stations regardless of the number of DOM molecules and were significantly more numerous at inlet stations than at canal stations. These results indicate that lignin is the most abundant DOM biomolecular compound, and its main source is terrestrial DOM from the surrounding watershed. The composition of DOM in Inle Lake is mainly regulated through dilution.

**Effect of fire on the molecular composition of dissolved organic matter in shifting cultivation and fallow areas in Bago Mountains:** This study discusses the effect of fire on the molecular composition of DOM in shifting cultivation (SC) and 6 different years of fallows (FP). The DOC concentrations were stable after the fire and there was no significant difference in the number of DOM molecular compounds among SCs and FPs plots. In terms of DOM biomolecular classes, the lipids, proteins, and carbohydrates were getting decreased along with the fallow years after SC and it is probably due to those being easily decomposed DOM compounds and could have been consumed by the soil microbes. No significant difference was found in lignin-like molecules among the SC and fallows indicating that the decomposition of accumulated plant materials such as litter, shrub vegetation, and shed leaves on the soil surface released lignin along with the fallow years. The number of DBC and the non-metric multidimensional scaling (NMDS) results showed that there was no significant difference between the SCs and FPs plots. It is likely that the organic materials can be burned and induced a greater variety of BC due to the fire in SCs plots. It was also assumed that DBC is highly resistant to chemical and

microbial degradation than other biomolecules, which resulted in no differences along with the different fallow years.

**Conclusion:** Inle lake is vital for the local communities in terms of supplying water, livelihood activities, and food security. Thus, the conservation of Inle lake is needed for the sustainability of the ecosystem. The water quality in the lake has degraded mainly due to anthropogenic activities such as agricultural practices and tourism, and this study provides the information for the proper times and locations for future monitoring. Additionally, dissolved organic matter and carbon sources play crucial roles in the lake water quality and the aquatic microorganisms. Lignin is a dominant DOM biomolecular species, and it originated from the woody plants around the watershed areas of the lake. Although there were no longer shifting cultivation practices in the watershed areas, the presence of DBC in the lake water has been found and it is probably due to its recalcitrance. Furthermore, the DBC in Bago Mountains also showed that it did not change along with the time chrono-sequences because DBC is resistant to decomposition. The relative percentages of the overlapped chemical structures of DBC in two different ecosystems were evaluated and 95% of those were not overlapped between Inle Lake and Bago Mountains' samples. It was assumed that the DBC species vary widely between the two different sites and that the chemical structure of DBC might change during the transportation process from the soil to the water ecosystem. The presence of DBC in the streams and the soil on the lake watershed should be checked for further studies to provide the sources and dynamics of carbon in different ecosystems.