Effect of cycle of carbon and nitrogen in a city park on global warming

Kentaro Okura[1], Yosuke Morimitsu[1], Kazuhiro Yamada[2], Ryusuke Hatano[1]

[1]Graduate School of Agriculture, Hokkaido University, Sapporo, Japan
[2]Public Interest Incorporated Foundation Sapporo Parks and Greenery Association

Introduction: Global warming has been progressed rapidly, so it is concerned that global warming affects ecosystems and human life (IPCC, 2007). It is also said that settlements accumulate a lot of carbon and nitrogen as well as cropland and grassland, but few researches have been conducted yet. Settlements are all developed land excluding five land categories (forestland, farmland, grassland, wetland and cropland) that are defined by IPCC. So, it is needed that ecosystem carbon fixation and soil greenhouse gases (GHGs) emissions in the settlements affecting global warming are evaluated (Bramryd, 1980; Churkina, 2008). Composting of green residues and applying composts to soil is well conducted in parks and gardens. Compost application increases soil carbon (Shimizu et al., 2009), but composting releases GHGs. Therefore, in order to evaluate the effect of settlements on global warming, it is necessary to know the carbon and nitrogen cycling and flows related to GHGs in the areas covered by vegetation and composting and compost use. Yurigahara park is a urban park located at the northern Sapporo and making manure from green residues. Therefore the objective of this study is to evaluate the carbon and nitrogen cycling and the effects on global warming.

Materials and methods: This study was conducted in Yurigahara park with area of 25.4 ha from May 2012 until January 2015. There were three major land uses in this park, flower(lily) garden (10.3%), lawn (20.6%) and forest (27.9%). Litter and residues in forests and flower garden also from other parks were used to make manure. In lawn residue was not collected. Manure was applied to mainly flower garden. We modeled carbon and nitrogen stock and flow shown in Fig 1. In each land use, GHGs emissions, plant carbon fixation and soil physico-chemical properties were measured in the each land use. In manure barn, GHGs emissions and manure properties were also measured. GHGs emissions were measured by closed chamber method. At the same time, atmospheric temperature, soil temperature and soil moisture were measured. Plant growths were measured by collecting plant residues. Carbon and nitrogen densities of the residues were analyzed in the laboratory. Global warming potential (GWP) was calculated by Eq.1.

$$GWP = CO_2\ \text{emission} \times 1 + CH_4\ \text{emission} \times 25 + N_2O\ \text{emission} \times 298 \quad \ldots \text{(Eq.1)}$$

Results: Carbon and nitrogen cycling is shown in Fig 2. Carbon budget was +32.5 Mg C including import and export in 2014. Carbon import was 87.1 Mg C, 90% of which was contributed by carbon fixation in forest. Carbon export was +119.5 Mg C, 97% of which was heterotrophic respiration in three land uses. Besides, nitrogen import in 2014 was 242.1 kg N and nitrogen export was 11.4. GWP of this park in 2014 was 8.39 $MgCO_2eq$ and the contributions of CO_2, CH_4 and N_2O were 94.4, 1.39 and 4.23 %, respectively. It means that this park enhanced global warming and main contributor was soil heterotrophic respiration.

Conclusion: Though it was expected that urban park has the role to accumulate carbon in urban area, Yurigahara park released carbon by heterotrophic respiration and enhanced global warming.

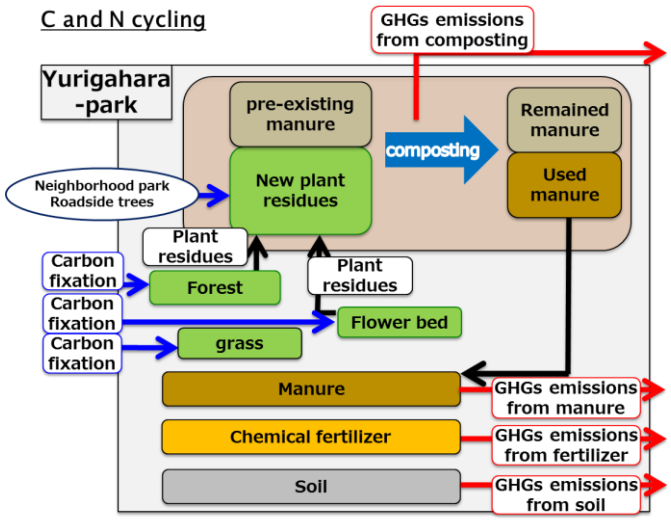

Fig 1. Carbon and nitrogen cycling in Yurigahara-park

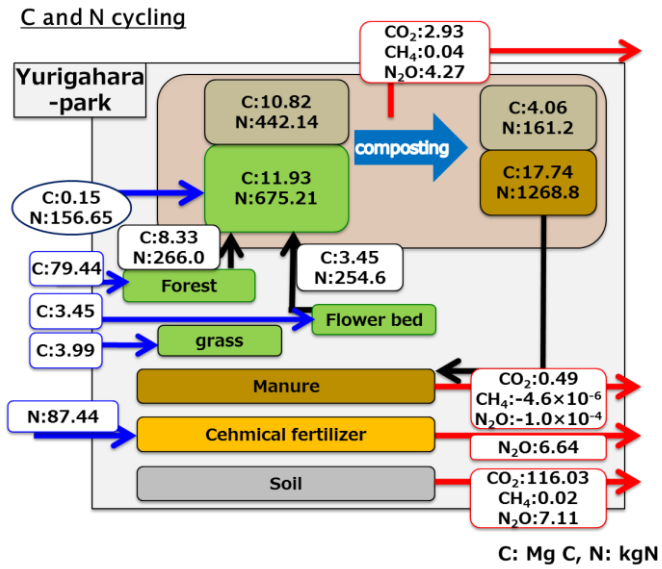

Fig 2. The results of carbon and nitrogen cycling in 2014

E-mail: kuraken@chem.agr.hokudai.ac.jp