ARTICLE IN PRESS

Physics and Chemistry of the Earth xxx (2016) 1–7

Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

journal homepage: www.elsevier.com/locate/pce

Effects of salinity on dynamics of soil carbon in degraded coastal wetlands: Implications on wetland restoration

Qingqing Zhao, Junhong Bai*, Qiongqiong Lu, Guangliang Zhang

State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University, Beijing, 100875, PR China

ARTICLE INFO

Article history:
Received 16 May 2016
Received in revised form
14 August 2016
Accepted 26 August 2016
Available online xxx

Keywords:
Salinity
Soil carbon
Wetland restoration
Coastal wetlands

ABSTRACT

To investigate the effects of salinity on dynamics of soil carbon contents and stocks, soil samples were collected at a depth of 30 cm at four sampling sites (Sites B, T, S and P) along a salinity gradient in a drained coastal wetland, the Yellow River Delta, China. The salinity of these four sites ranked in the order: B (8.68 ± 4.25 ms/cm) > T (5.89 ± 3.17 ms/cm) > S (3.19 ± 1.01 ms/cm) > P (2.26 ± 0.39 ms/cm). Soil total carbon (TC), soil organic carbon (SOC), and soil microbial biomass carbon (MBC) were measured. Based on these data, soil organic carbon density (SOCD) and soil microbial biomass carbon density (MBCD) were calculated at four sites. The results showed that the mean concentrations of TC and MBC showed a general deceasing tendency with increasing salinities in the top 30 cm of soils. The values of SOCD and MBCD exhibited similar tendency along the salinity gradient. As for profile distribution pattern, The C/N ratios ranged from 8.28 to 56.51. The microbial quotient values at four sampling sites were quite low, ranging from 0.06 to 0.19. Higher C/N ratios were found in samples with high salinity. Correlation analysis showed that the concentrations of TC and MBC at four sampling sites were significantly negatively correlated with salinity ($P < 0.01$ or $P < 0.05$), indicating that salinity could inhibit soil carbon accumulation and microbial activities.

1. Introduction

As an ecological entity, salt-affected soils occupy more than 7% of the earth's land surface and play an important role in the landscape of semi-arid and arid regions of the world (Pathak and Rao, 1998; Tian et al., 2004; Setia et al., 2011a). Soils having a high concentration of soluble salts, and an electrical conductivity (EC) of the saturation extract (ECe) greater than 4 ms/cm are defined as saline soils (US Salinity Laboratory Staff, 1954). Salinity is an important driver of land degradation and poses threat to soil microbes (Wichern et al., 2006; Mavi et al., 2012). Excessive amounts of salts would pose adverse effects on soil physical and chemical properties and microbiological processes (i.e. carbon mineralization, organic matter decomposition, nutrient release and microbial activity) (Pathak and Rao, 1998; Kaur and Gupta et al., 2000). As a major stress, salt is more potent than heavy metals in influencing soil microbial community (Sardinha et al., 2003). Accumulation of organic matter is controlled by the balance of inputs (organic matter produced in situ and ex situ) and outputs (decomposition and erosion) (Bernal and Mitsch, 2008). Salinity could inhibit the degradation processes of organic matter, slower transformation of organic substrates and finally accumulate organic matter in the saline soil (Lal, 2001; Mamilov et al., 2004; Rasul et al., 2006). Simultaneously, soil salinity could decrease plant productivity and carbon inputs. Thus, salinity would finally influence soil carbon accumulation. According to the modeling results, salinity would decrease global carbon stock in the long run (Setia et al., 2013). SOC in salt-affected soils is controlled by two contrasting factors (i) reduced plant growth and thus C input, and (ii) reduced microbial activity and thus C turnover (Setia et al., 2011b). However, soil organic carbon values alone cannot sensitively indicate the changes undergone by the organic matter in soils, researches on other carbon indices (i.e. microbial mass carbon and microbial quotient) are needed (Yuan et al., 2007).

Acting as a source and sink of the plant nutrients and regulator of soil system functions, the soil microbial biomass is considered a labile pool of organic matter and plays a crucial role in long-term soil fertility (Kaur et al., 2000; Yuan et al., 2007). Previous researches have shown that microbial biomass carbon (MBC) was lowest in those soils with low CO_2-C emission, suggesting that MBC could not only indicate soil microbial activities but also serve as a sensitive indicator of changes in soil organic matter (Wick et al., 1998; Li et al., 2004; Yuan et al., 2007).

* Corresponding author.
E-mail address: junhongbai@163.com (J. Bai).

http://dx.doi.org/10.1016/j.pce.2016.08.008
1474-7065/

Please cite this article in press as: Zhao, Q., et al., Effects of salinity on dynamics of soil carbon in degraded coastal wetlands: Implications on wetland restoration, Physics and Chemistry of the Earth (2016), http://dx.doi.org/10.1016/j.pce.2016.08.008

The microbial quotient is defined as the ratio of the SMB-C to SOC (C_{mic}/C_{org}), indicating the ratio of the living fraction of SOC relative to the non-living fraction. This ratio has been proved to be responsive to land management practices and can function as indicators for the substrate availability and stress borne by the microbial population (Anderson and Domsch, 1989; Aceves et al., 1999; Wong et al., 2008).

Although researches on the physicochemical properties of saline soils and their amelioration have been undertaken, the effects of salinity on C dynamics are not as well understood (Rietz and Haynes, 2003; Wong et al., 2009). Understanding the effects of salinity on soil carbon is critical for environmental management (Wong et al., 2008). The aim of our research was to investigate how a salinity gradient affects soil carbon contents and stock in degraded wetlands and to propose guidelines for coastal wetland restoration.

2. Materials and methods

2.1. Site description

This study was conducted in degraded coastal wetlands located near Dongying Port, Dongying City, Shadong Province (Fig. 1). The degradation was mainly caused by drainage. This area has a temperate monsoon climate with adequate sunshine, rain and heat over the same period. And, there is a clear distinction between the four seasons. The annual average air temperature, the annual average precipitation and the annual average evaporation is 12.4 °C, 551.6 mm and 1928.2 mm, respectively (Cui et al., 2008, 2011; Gao et al., 2012). Dominant plant species are Suaeda salsa, Tamarix chinensis and Phragmites australis.

2.2. Sample collection and analysis

In the drained wetlands, four sampling sites (i.e., bare land (B, N38°03′23.08″E118°55′01.72″), *Tamarix chinensis* (T, N38°03′20.90″E118°54′55.10″), *Suaeda salsa* (S, N38°03′20.68″ E118°54′56.94″), and *Phragmites australis* (P, N38°03′19.79″ E118°54′40.85″)) were selected in August 2013. The four sampling sites exhibited different salinity following the order: B (8.68 ± 4.25 ms/cm) > T (5.89 ± 3.17 ms/cm) > S (3.19 ± 1.01 ms/cm) > P (2.26 ± 0.39 ms/cm). Soil samples with three replicates were collected to a depth of 30 cm at each sampling site. These samples were stratified at 10 cm intervals. The collected soil samples were later placed in polyethylene bags. A part of each soil sample was stored in portable refrigerator for microbial analysis. All the rest of the soil samples

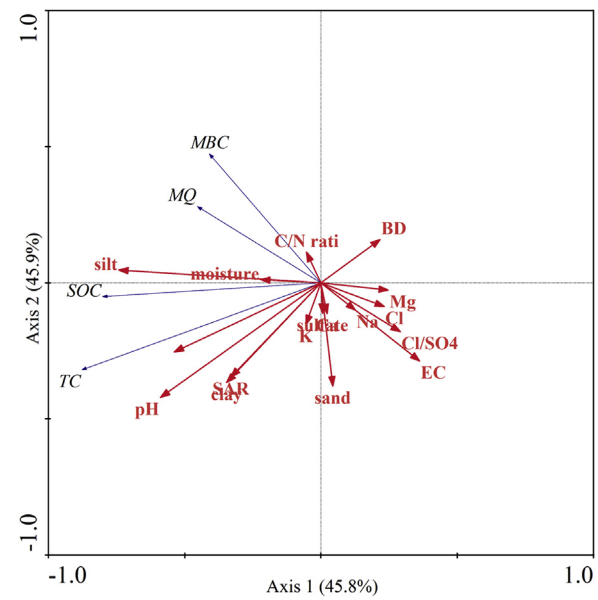

Fig. 2. Redundancy discriminate analysis (RDA) plots of soil carbon (blue arrows), using soil properties as environmental factors (red arrows). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

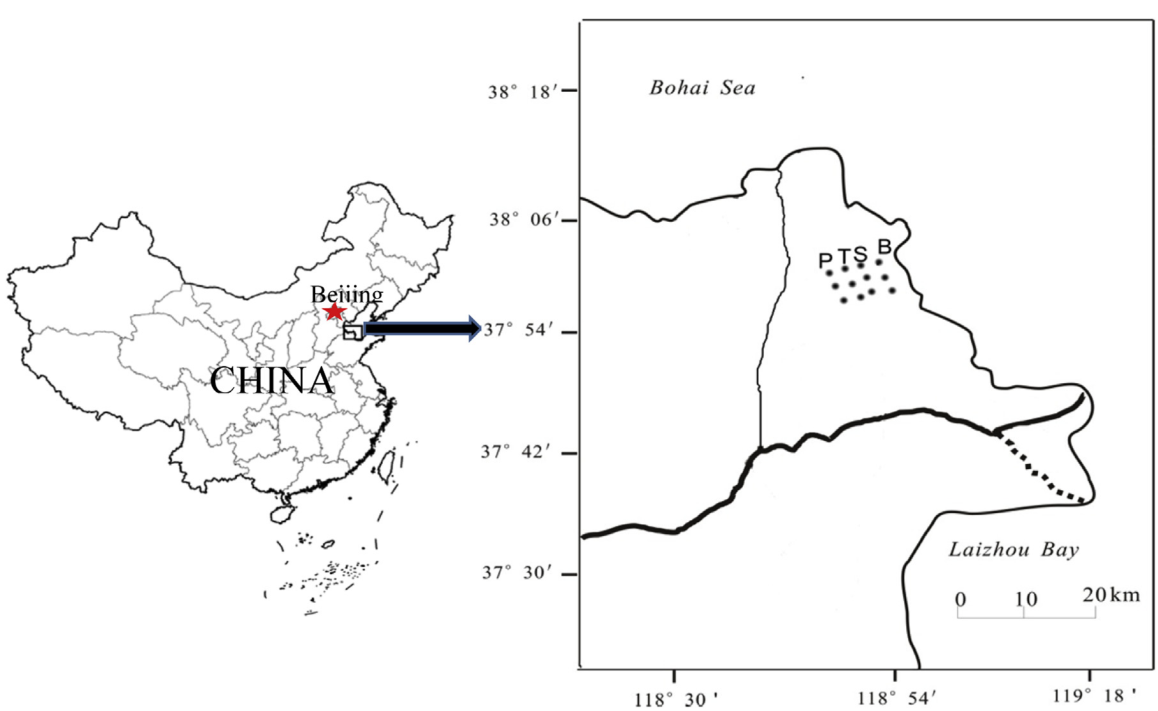

Fig. 1. Location map of sampling sites.

Please cite this article in press as: Zhao, Q., et al., Effects of salinity on dynamics of soil carbon in degraded coastal wetlands: Implications on wetland restoration, Physics and Chemistry of the Earth (2016), http://dx.doi.org/10.1016/j.pce.2016.08.008