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Charcoal in sediment layers: A way to estimate impact of land use intensification on reservoirs siltation?

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Fig. 1. Soil auger points (●) and profile pits (○) under land use maize

Introduction

Worldwide, siltation of water reservoirs is a common problem resulting in a decrease of buffer capacity causing flooding or water shortage for irrigation purposes. Charcoal, resulting from slash and burn practices, will accompany sediments derived from erosion events and settles down in reservoirs. Charcoal composition is influenced by plant characteristics such as lignin, which makes it possible to use it as a finger print for reconstructing land use history.

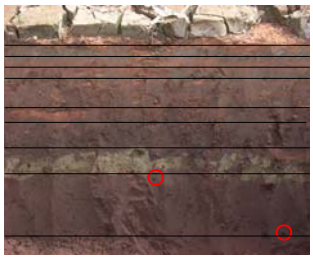

Fig. 2. Charcoal occurrence (○) in lake sediment

Objectives

- To link charcoal occurrence in lake sediments to historical land use patterns;
- To reveal the contribution of each land use system to reservoir siltation;
- To estimate the decrease in buffer capacity of the reservoir since land use cultivation started.

Preliminary results

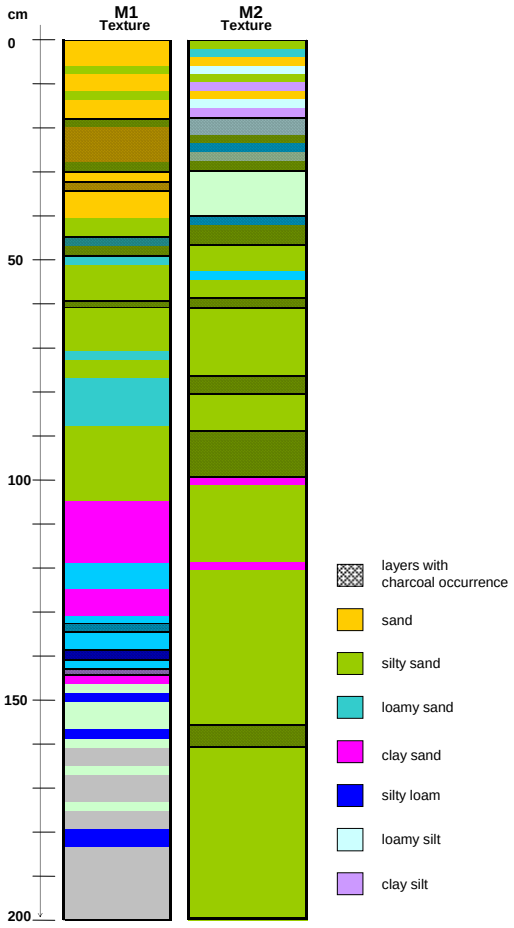

Fig. 3. Charcoal findings in soil profiles M1 and M2

Methods and Materials

- In Chieng Khoi commune, Son La Province, Northern Vietnam, the lake functions as a reservoir for irrigation of paddy rice during the dry season. Heavy rainfall events in the rainy season (Apr. – Sept.) can cause severe erosion on steep cultivated land, leading to sediments translocation into the reservoir.
- Main land use systems around the lake are sole or intercropped maize and cassava, agroforestry and secondary forest (bamboo). Below each land use, two profiles 10 m apart were ex cavated to 2m in the lake bed (Fig. 1). Visible distinguishable sediment layers were investigated regarding thickness, colour, texture, particle size distribution and total organic carbon (TOC).
- Charcoal isolated in sediments (Fig. 2) were analyzed by Differential Scanning Calorimetry (DSC) and compared with the results of pure charcoal of teak, maize, cassava and bamboo.
- Land use history maps of 1963, 1968, 1974 and 1995 were created in a participative workshop with elderly farmers of Chieng Khoi.
- Bathymetric survey was carried out by means of DGPS.

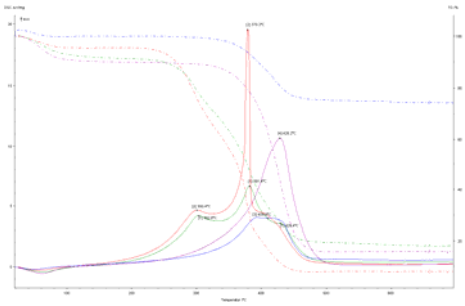

Fig. 4. Differential Scanning Calorimetry curves of different plant materials: ___ Bamboo _____ Teak _____ Maize _____ Cassava
Pointed lines: mass loss

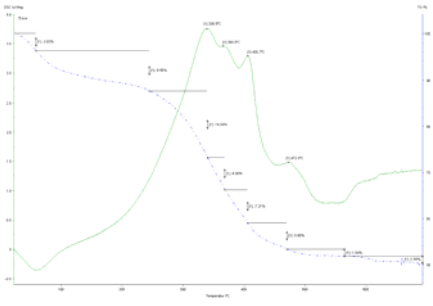

Fig. 5. DSC of charcoal found in 25-29 cm depth in the lower maize profile (M2)

- Distinctive DSC peaks for charcoal from bamboo, cassava and forest occurred with calibration plant materials (Fig.4).
- DSC analysis of M2, cm 25-29, revealed 3 peaks (Fig. 5) of which second and third were at similar temperatures as bamboo and maize/teak respectively (Fig.4).
- As the distinctive forest charcoal peak (428°C) was not present in sediment sample (Fig. 5) the isolated sediment charcoal was probably derived from disturbed (bamboo) natural or planted teak/maize systems.
- Land use change started with planting of teak in 1995. Since 1999 there is maize cultivation on M2 adjacent upland plot (Fig. 1) suggesting that erosion from these plots led to min. 30 cm sedimentation yield.
- Assuming that there was no teak burning a minimum annual sediment yield of approximately 2.5 cm from maize plots occurred.
- Future analysis of charcoal present at lower soil depth will allow to better approximate annual sediment yield associated with land use change.

Conclusions and further outline

- Preliminary results show that there is a relationship between combustion peak, mass loss and charcoal origin; however not all charcoal provided defined strong peaks and more work is needed to verify the potential of charcoal DSC fingerprinting.
- Further analysis of the charcoal is required to estimate the sediment contribution of different land uses to siltation in order to reconstruct the decreasing buffer capacity over the years.
- Estimation of the contribution of land uses to siltation can help to calculate future decrease of the reservoir's buffer capacity.

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