Effects of extreme events on carbon cycling along a terrestrial-aquatic continuum at the catchment scale

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Project Objective

The project (Dec 2013-Nov 2016) will quantify the re-accumulation and stabilisation of organic carbon (OC) in terrestrial ecosystems, and characterize the processing of exported biomass-,soil-, and rock-derived OC in freshwater ecosystems.

Introduction

Globally, extreme events are increasing in frequency and magnitude. Landslides export large amounts of terrestrial OC into fluvial ecosystems[1,2]. Terrestrial and aquatic processes can physically or chemically modify the exported OC. Hence OC can be stabilized, destabilized or buried for longer term storage in deposited sediment, or be transported to the ocean and partly be respired to the atmosphere[3,4]. The rates and extents of these processes and their driving forces are still poorly understood and scarcely quantified but are recently understood to be of major significance at global scale[5].

Study Area

The watershed area of Tsengwen river basin is 1.176 km^2. Elevation ranges from 126 m to 2610 m. The lithology is homogenous, consisting of sandstone and shale.

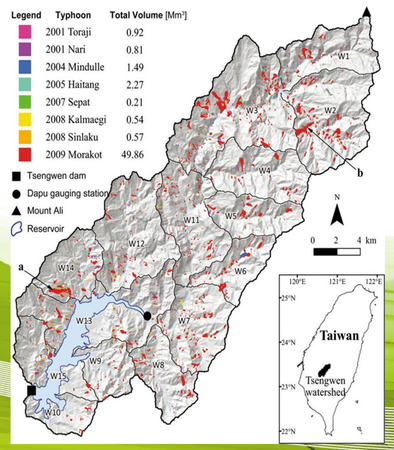
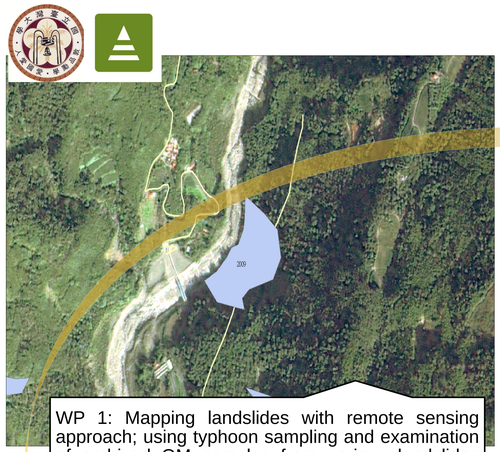
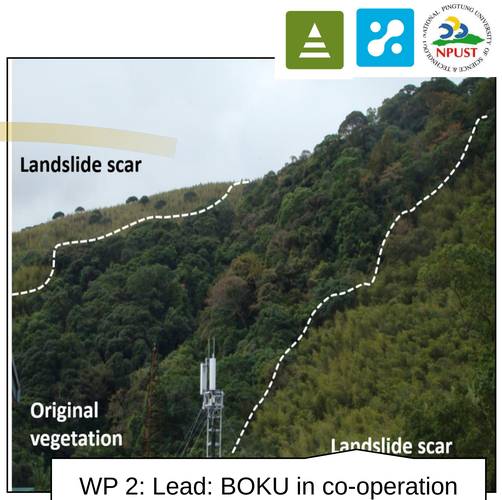


Fig: Catchment of Tsengwen reservoir.[6]

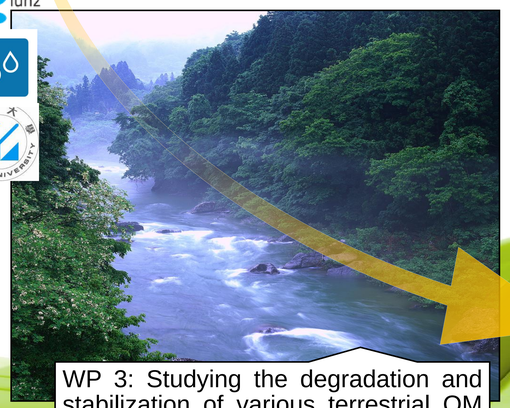
The project structure consists of four work packages (WPs). The logos reflect the institutions involved in the respective WP. WPs 1 and 4 are being led by the Taiwanese partner, WPs 2 and 3 by the respective Austrian institution.



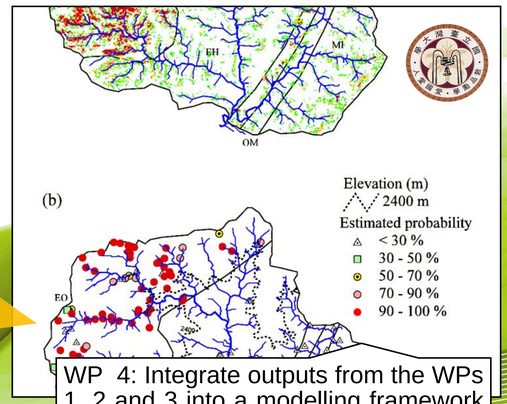
WP 1: Mapping landslides with remote sensing approach; using typhoon sampling and examination of archived OM samples from various landslides magnitude to characterize *in situ* instream transport under extreme events, find out the effect of high frequency versus high magnitude on exporting different terrestrial OC.



WP 2: Lead: BOKU in co-operation with NPUST



WP 3: Studying the degradation and stabilization of various terrestrial OM pools (biomass/litter-, soil-, rock-derived) in fluvial systems by means of *in vitro* incubation experiment.



WP 4: Integrate outputs from the WPs 1, 2 and 3 into a modelling framework for an improved assessment of the impacts of extreme events on C cycling at catchment scale

WP 2: Recovery of organic matter (OM) in terrestrial ecosystems

Mass wasting caused by typhoons may mobilize large amounts of rock-derived (fossil) as well as soil and biomass OC along with the debris materials!

Research Questions

How fast does terrestrial organic carbon re-accumulate and get stabilized after extreme effects (i.e. on landslide scars) in different climate zones?
How effectively can this process be accelerated through active landslide restoration measures (e.g. reforestation)?

Methods

WP 2 follows a chronosequence approach. Eight study sites have been selected for soil, litter and biomass carbon stocks analysis. Landslide scars could be dated back to 1963, 1974, 1989, 2004 and 2009. Three reference sites (1963-1989) are accessible.
The parameters to be investigated are:
Soil: BD, C/N, rock content, pH, pyrolysis GC/MS, soil aggregate stability, (carbon isotopes)
Litter: water content, dry biomass, C/N
Biomass: Above and below-ground biomass estimations

Importance of expected outcomes

The outputs from WP 1,2 and 3 will be integrated into a modelling framework for an improved assessment of the impacts of extreme events on carbon cycling at the catchment scale. Together this shall yield fundamentally new insights into the fate of organic carbon at the terrestrial-aquatic continuum impacted by extreme events, and provide needed inputs for improved modelling of the effects of extreme events on carbon cycling at regional scales.

References

1. Liu, J. T. *et al.* From suspended particles to strata: The fate of terrestrial substances in the Gaoping (Kaoping) submarine canyon. *Journal of Marine Systems* **76**, 417-432 (2009).
2. Lin, K. C., Duh, C. T., Hsu, C. C. & Huang, C. M. Above-ground carbon accumulation of subtropical natural broadleaf forests in the Liukuei Experimental Forest of southern Taiwan. *J. Exp. For. Nat. Taiwan Univ.* **20**, 153-164 (2006).
3. Liu, J. T. *et al.* Cyclone-induced hyperpycnal turbidity currents in a submarine canyon. *Journal of Geophysical Research C: Oceans* **117** (2012).
4. Wu, Y. *et al.* Biogeochemical behavior of organic carbon in a small tropical river and estuary, hainan, china. *Continental Shelf Research* **57**, 32-43 (2013).
5. Cole, J. J. *et al.* Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget. *Ecosystems* **10**, 171-184 (2007).
6. Liu, K.F. *et al.* Large scale simulation of watershed mass transport: a case study of Tsengwen reservoir watershed, southwest Taiwan. *Nat hazards* **67**, 855-867 (2013)

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FWF Der Wissenschaftsfonds.