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ABSTRACT OF DOCTORAL THESIS

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Title: Modeling hydrological and sediment responses to human activities and climate variability in the Upper Blue Nile basin, Ethiopia

(青ナイル川上流域における人間活動と気候変動に対する水文学的応答および堆積物応答のモデリング)

Soil erosion-caused land degradation is a serious global environmental challenge, and this is more severe specifically in the least developed countries like Ethiopia. The rate and impact of soil erosion are more visible in the Ethiopian highlands, particularly in the Upper Blue Nile basin that even affects downstream countries like Sudan and Egypt. This is mainly because of unsustainable human activities such as land use/land cover (LULC) change and poor soil and water conservation (SWC) practices being driven by population growth and climate variability. These human activities and climate variability are strongly influencing the hydrological and sediment responses. This study, therefore, examined the hydrological and sediment responses to changes in human activities (LULC change and SWC), climate variability in different agro-ecological environments of the Upper Blue Nile basin. The watersheds include Guder, Aba Gerima and Debatie, which represent highland, midland and lowland agro-ecologies of the basin, respectively. Hydro-meteorological data such as discharge, sediment sample and rainfall were monitored in the watersheds since 2015. LULC changes were analyzed by integrating field observations, and aerial photograph [1: 50,000 scale] and very high-resolution [0.5–3.2m] satellite images. The hydrological responses were analyzed after calibrating the empirical models (runoff coefficient and evapotranspiration (ET)) based on experimental data from fifteen runoff plots, which were established in different land uses and slope ranges in the three watersheds. Thereafter, the SWAT model was used to evaluate the impact of SWC practices on runoff and sediment in Aba Gerima watersheds. Results showed that from 1982 to 2016/17, natural vegetations remarkably decreased as the expanse of cultivated land. In contrast, between 2006 and 2017, plantation coverage increased due to *Acacia decurrens* expansion by 262% in the highland (Guder) watersheds. The observed LULC changes caused an increase in runoff in the range between 4% in Aba Gerima to 28.7% in Guder. Climate variability in terms of change in annual rainfall had no significant effect on runoff; whereas both LULC change and climate variability had significant effect on estimated ET. Though climate variability increased ET from 33.6% in Aba Gerima to 42.1% in Guder, the LULC change related to the reduction in natural vegetation had an offsetting effect, which led to overall decreases in ET ranging from 15.8% in Guder to 32.8% in Aba Gerima watershed. Implementation of SWC practices reduced the surface runoff and sediment yield by ~28–40%, and ~51–68%, respectively, in Aba Gerima watershed. SWC practices had twice higher impact on surface runoff, flow and sediment yield than the combined effects of changes in land use and climate. As changes in land use and climate are expected to intensify in the future, it is important to further under their hydrological impact to devise appropriate sustainable land and water management strategies.

"* In addition, some of the figures, etc., have been omitted."