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学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

A combined approach to study meander migration in a river of the Bolivian Amazon basin: The Case
of the Ichilo River

(ボリビアアマゾン盆地における Ichilo 川の平面形状変遷に関する研究)

The Amazon basin is constituted by a large river network, where we find meandering rivers with the fastest migration rates. Large rivers in the Amazon basin have caught the attention of many researchers. Their planform shape and the changes that they experience depend on many factors such as the climate, human interactions, vegetation, etc. However, rivers in the southern part of the Amazon basin have not been as much studied as the large tributaries of the Amazon river. These rivers exhibit different characteristics compared to the larger tributaries such as short inundation periods and high fluctuation in the water levels. There is still the need to keep studying these rivers in order to answer important questions about their planform characteristics.

This thesis examines the characteristics of a small meandering river in the southern part of Bolivian Amazon: the Ichilo river. The work is based in satellite imagery analysis, field observations and numerical simulations. First, a spatiotemporal analysis is performed using satellite imagery. Different meandering characteristics such as migration rates, cutoffs, widths, oxbow lakes are qualitatively and quantitatively analyzed in order to understand what are the main controls of meander migration. Water levels collected for a period of 30 years, are statistically analyzed showing patterns with high variability. Planform shapes of the river for along 30 years (1988-2018) show different meandering mechanisms. Ten neck cutoffs (1 human-induced) were identified along 150 Km of river reach. This analysis suggests that neck cutoffs play an important role in the planform development of the Ichilo river. Also, I recognize the effect that El Niño La Niña Southern Oscillation (ENSO) could have played in the migration rates observed in the year 2008. As cutoffs were identified as main controls on meander migration a field survey was performed to obtain detailed information in one bend where a cutoff is expected to occur.

The topographic surveys in the river were performed by using a combined methodology of Structure from Motion (SfM) photogrammetry using Unmanned Aerial Vehicles (UAVs) and a Multibeam Echosounder (MBES). The combined methodology allows us to obtain topographic data such as DEMs and orthophotos with high accuracy in a relatively shorter period of time in the location where tradi-

tion topographic works would have been more expensive and riskier. The bank profiles show a river with cohesive banks and dense vegetation with bank failures mainly in the outer banks. Also, the bathymetry shows riverbed scouring in two points in the river: the confluence and the area near the port.

Now consider the current planform shape of the Ichilo River. What are further changes expected in the river? Here, I present a numerical model that captures important characteristics that have been observed from the results of the spatiotemporal analysis (such as neck cutoffs) and the field works to reproduce the trends of meander migrations in the Ichilo River including the development of cutoffs. The model considers the following characteristics: a) Planform shape evolution after cutoff occurrence, b) Profile change due to cutoff occurrence and c) Inner bank accretion and outer migration as a result of the water level variation.

The model is tested in three parts of the Ichilo river, showing its ability to reproduce the trends of meander migration in terms of the planform shape evolution, location of cutoffs and area of abandoned oxbow lakes, being these, one of the first results that show meandering evolution including the development of cutoffs. The purposed model can be applied to assess the trend of planimetric changes of meandering rivers at the scale of the Ichilo river due to climate change and/or other perturbations.