Topographic Evolution of Creek Watershed: Cases Study in Putanpunas and Salitung Creeks, Taiwan

Yu-Wen SU[1*], Ji-Shang WANG[1], Kuei-Lin FU[2], Kun-Che CHAN[3] and Yih-Chin TAI[1]

[1] Department of Hydraulic and Ocean Engineering, Cheng Kung University, Taiwan

[2] Soil and Water Conservation Bureau, Council of Agriculture, Taiwan

3 Department of Civil Engineering, National Taiwan University, Taiwan

[*]Corresponding author. E-mail: sywen2013@gmail.com

INTRODUCTION

The process of the topographic evolution of creek watershed is special interest to the people who are in charge of soil and water conservation. The satellite images of Salitung Creek taken in 1966 have revealed the multiple landslides have taken place since 50 years ago. However, we found these landslides were almost recovered from the images taken in June 1996. Nevertheless, in August 1996, the typhoon Herb cause heavy rainfall and induced several severe landslide events, so that the environment of watershed was found to be getting worse. Till now, the environment recovery over these landslide sites seem still insignificant.

METHODS

Putanpunas Creek belongs to Gaoping River Basin with 592.7 ha areas, annual rainfall is 2,836 mm, average temperature is 18.6 ℃. The other one, Salitung Creek, belongs to Chou Shui River Basin with 199.8 ha areas, annual rainfall is 2,147 mm, average temperature is 21.4 ℃. This study collected satellite images, aerial photographs, and the long-term historical topographic maps (**Tab. 1**). Besides, the identification of landslides in the maps and photographs, the environmental evolutions and the correlated damages are analyzed with respect to the collected records of hydrological data. These maps clearly represent the specific characteristics at the different stages and reflect the evolutions of the topography. Apart from the historical maps, we also collected satellite images in 21 periods. By reviewing these images, thus we could know the topographical evolution of the landslides. With the stereo photography technology, it is now feasible to make digital elevation model (DEM) with these aerial stereo photographs. The DEMs in 3 years are made in Putanpunas Creek and 4 years are made in Salitung Creek, so that we could investigate the impacts of typhoons (1996, 2001 and 2004) as well as earthquake (1999) on study areas. As the evolution of topography is highly related to the sediment discharge, the records of rainfall as well as the water level variation would provide with helpful information in analyzing the response to the hydrological records. The rainfall data covers 1980 to 2016, water discharge included 1985 to 2016, and water level variation data is from 1972 to 2016.

Tab. 1 Periods of images at the each creeks

Creek	Satellite image	Aerial photograph	Historical topographic map
Putanpunas	1996~2015	1989, 2001,2004	1907, 1956
Salitung	1966, 1996~2015	1996, 1999,2001,2004	1898, 1907, 1956

RESULTS

In Putanpunas Creek, the historical topographic maps in 1907 have drew the special pattern on the maps (left panel of **Fig. 1**). It revealed this place have multiple landslides 100 years age. The satellite images taken in 2000, we found small scale landslide in Putanpunas Creek (middle panel of **Fig. 1**), but the heavy rainfall during the typhoon Morakot also induced several severe landslide events in that area (right panel of **Fig. 1**). The long-term historical topographic maps and satellite images reveal that many landslide sites in Salitung Creek watershed can be identified in the satellite image taken in 1966 (left panel of **Fig. 2**), which did not exist in maps/images in 1898, 1907 or 1956. Remarkably, these landslide areas were found to be almost recovered (middle panel of **Fig. 2**) in 1996, before the typhoon Herb. During the typhoon Herb many landslides are induced in that area and the watershed condition was not recovered in the following 10 years. In 2008, after the typhoon Kalmaegi, the images illustrate the fact the environment of watershed was found to be getting worse (right panel of **Fig. 2**), where the pattern is similar to the one in 1966.

Fig. 1 Historical topographic map of Putanpunas creek watershed in 1907 (left panel), Satellite images in 2000 (middle panel), and 2009 (right panel)

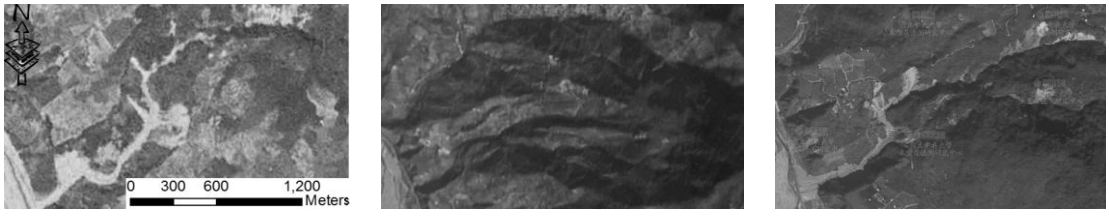

Fig. 2 Satellite images of Salitung creek watershed in 1966 (left panel), 1996 (middle panel), and 2008 (right panel).

In Putanpunas Creek, we compared the cross-section profiles with the analyzed DEMs with respect to 3 periods. From 1989 to 2004, the river bed elevation increased about 45 m. In Salitung Creek, we compared the cross-section profiles with 4 periods of the analyzed DEMs. Taking the profile in 1996 as reference surface, the river bed elevation increased about 7 m in 1999. This is suspected to be the impact of the severe earthquake “921-Chichi-earthquake”. After that, in 2001, the river bed elevation decreased about 12 m after typhoon Toraji. Otherwise, the hydrological data reveals the coherence that the water discharge increases together with the increase of the rainfall. However, with the increasing water discharge the water level goes downwards. Hence, we could conclude that the bed of Salitung Creek is eroding, where the river bed should be suffering from increasing sediment discharge. At Putnapunas Creek, the upstream riverbed was eroded, and the section of downstream was deposited in 2004.

CONCLUSIONS

According to the results of this study, the topographic evolution can therefore reproduced with the support of the hydrological analysis. The hydrological analysis provides with solid evidence for confirming the correctness of the mimicked topographic evolution of the watershed. Even in different watershed, it could be as a powerful tool for soil and water conservation, environment protection, or hazard assessment.

Keywords: Historical topographic maps, stereo photography technology, topographic evolution