Hydrological Modeling of Effect by the Impacts of Land Use and Land Cover Changes in Bago River Basin, Myanmar

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1. Introduction

Land use and land cover (LULC) changes are the fundamentals for the environmental problems because they are the main factors for monitoring the water balances. In the past decades, the impact of changing patterns of land use associated with the degradation of the forest environment and agricultural transformation on water resources have produced increasing concern in Bago River Basin, Myanmar as shown in Fig.1 [1]. The Soil and Water Assessment Tool (SWAT) model was used to analyze and predict water balance changes by proposing some scenarios of land use and land cover changes in this river basin. The objective of this study is to extrapolate the impact of land use and land cover changes on the hydrological processes in Bago River Basin using the hydrological simulation.

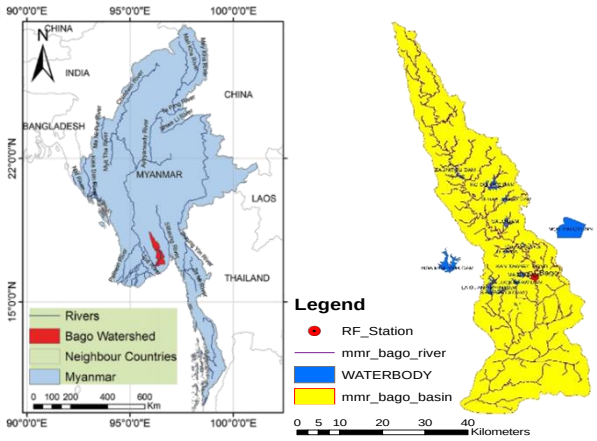

Figure 1. Location of Bago River Basin in Myanmar.

2. Assessment of Land Use and Land Cover Change in Bago River Basin

Assessments of LULC were undertaken using three Landsat images: Landsat-5 TM (February 1990), Landsat-5 TM (February 2000), and Landsat-8 OLI-TIRS (February 2013) with 30m resolution, respectively. The LULC classes were categorized as deciduous, forest mixed, water, agriculture, and residential areas. Accuracy assessment of each LULC image for the years 1990, 2000, 2013, and 2030 were performed by using overall accuracy and Kappa Coefficient. The overall accuracy and Kappa Coefficient for the analysis of future LULC forecast were well predicted with 95%, 96%, 96%, and 90% for the former one and 93%, 94%, 95%, and 86% for the latter one respectively. Land Change Modeler (LCM), CA-Markov, in TerrSet is a model that predicts the trend and the spatial structure of different LULC classes based on historical LULC images, transition probability matrix, and suitability images as a group file [2]. The driving factors considered in this study were DEM, slopes, and road data that were generated from the USGS (United States Geological Survey) data. The LCM model was analyzed by simulating 1990, 2000, and 2013 classified images to predict the future LULC map. CA-Markov considers the driving factors and prepares the suitability map for the future 2030 period. Fig.2 represents the LULC coverage in Bago river basin in 1990, 2000, 2013, and 2030 respectively.

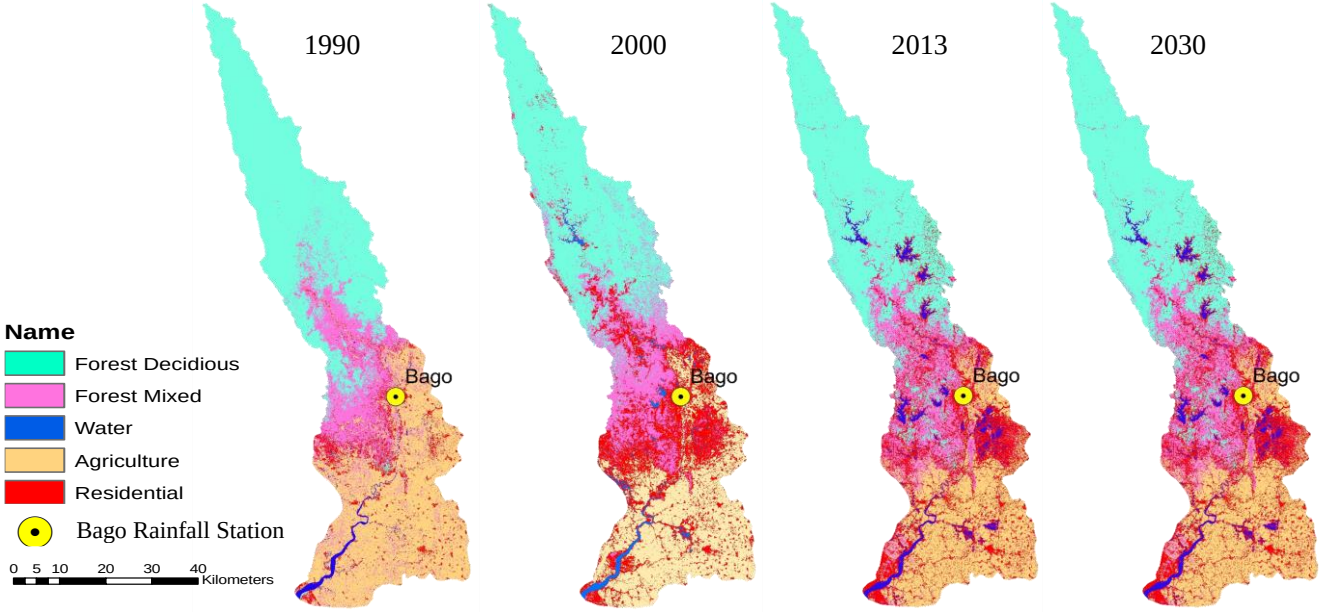

Figure 2. LULC coverage in the Bago River Basin through 1990 to 2030 periods

3. Hydrological Modeling of Bago River Basin

LULC maps were major components of the SWAT Model. The results of calibration (2010-2013) and validation (2014) process in SWAT model were almost identical and generated by the good performance of statistical evaluation of Root Mean Square (RMSE), and Nash-Sutcliff efficiency (NSE) such as 0.85, 0.65 for RMSE and 0.8, 0.6 for NSE respectively. Fig.3 shows the observed and simulated discharge in calibration (2010-2013) and validation (2014) at Bago Station.

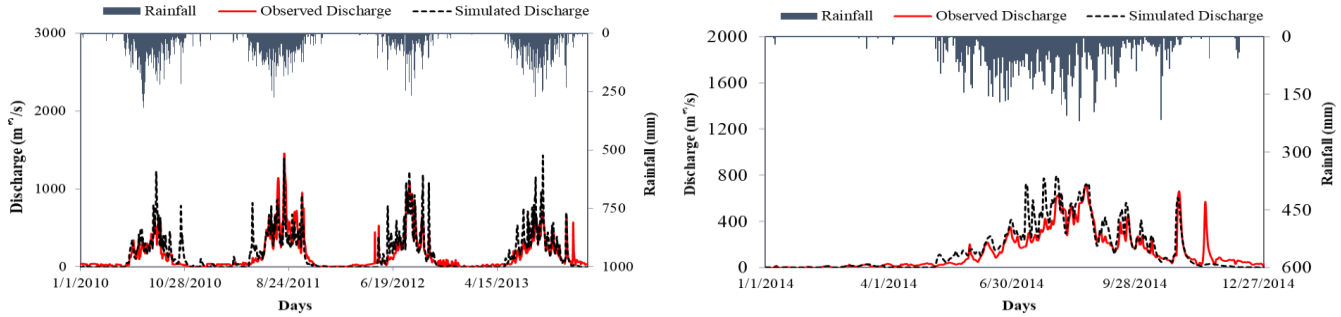

Figure 3. Observed and simulated discharge in calibration (2010-2013) and validation (2014) at Bago Station

The diversified, predicted and analyzed LULC change of the Bago river basin for the period of 1990, 2000, 2013 and 2030 is shown respectively in Fig.4. The impact of LULC changes corresponding to the increase in residential area, agricultural area, and water area in the future period in 2030 describe a significant change in comparison with LULC 1990.

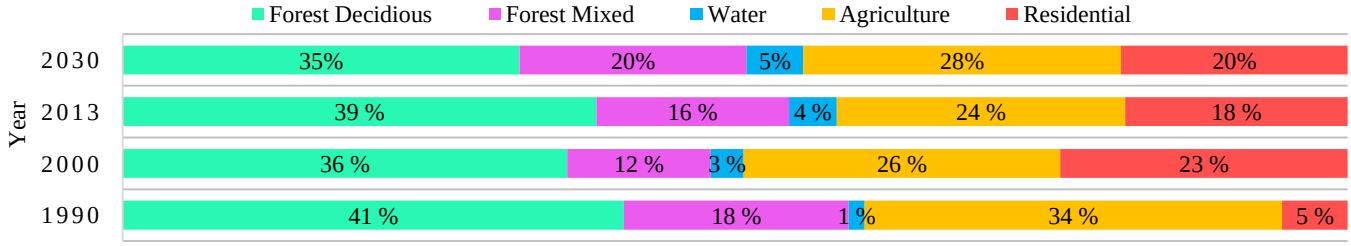

Figure 4. Area of LULC (%) in Bago River Basin from 1990 to 2030

Fig.5 expresses the hydrological components' change under the land use and land cover changes. Surface runoff of the basin increase 6%, 8%, and 9% in 2000, 2013, and 2030 respectively, compared to the base of LULC 1990. On the other hand, it can be observed that the percentage of ground water flow tends to decrease gradually by decades. Therefore, the residential area and agricultural area will be estimated to be expanded which will result in increasing the surface runoff in 2030.

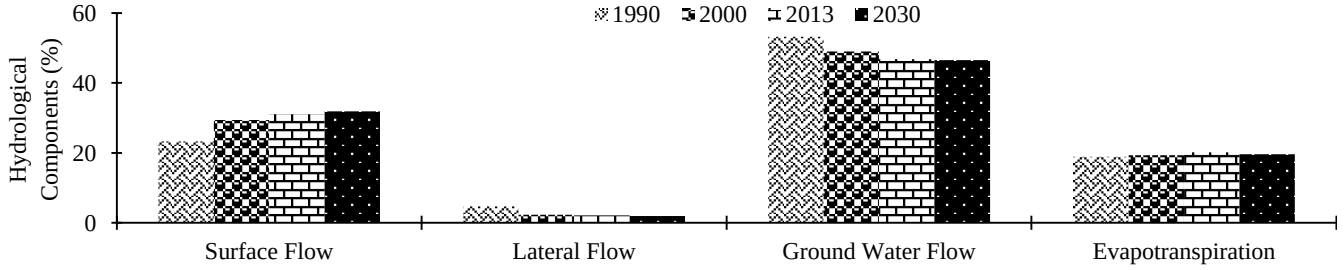

Figure 5. Hydrological components' change under land use and land cover changes

4. Conclusion

1) The investigation was conducted to analyze the impact of LULC changes on different hydrological components with the past, present and future LULC periods by utilizing the SWAT model in Bago River Basin. According to the analysis of LULC changes, a gradual increase in residential area and agricultural area are observed in the future prediction based on the temporal data of LULC changes.
2) LULC changes effect the relation of LULC categories and hydrological components. It displays that the surface runoff was highly attributed to change in the residential area and agriculture area in Bago River Basin.

5. References

[1] A. K. S. W. Win Win Zin, "River flood inundation mapping in the Bago River Basin, Myanmar," *Hydrological Research Letters*, pp. 9(4), 97-102, 2015.
[2] C. Labs, Idrisi Selva Help System, USA: Clark University, 2012.