論文 / 著書情報
Article / Book Information

題目(和文)	統合モデリングアプローチによる亜熱帯島嶼での沿岸流域からの負荷評価
Title(English)	Assessment of Terrestrial Discharges from Coastal Watersheds in a Subtropical Island using Integrated Modeling Approaches
著者(和文)	SithRatino
Author(English)	Sith Ratino
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10687号, 授与年月日:2017年9月20日, 学位の種別:課程博士, 審査員:灘岡 和夫,大佛 俊泰,鼎 信次郎,鍵 直樹,中村 隆志
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10687号, Conferred date:2017/9/20, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

Thesis Title: Assessment of Terrestrial Discharges from Coastal Watersheds in a Subtropical Island using Integrated Modeling Approaches.
（統合モデリングアプローチによる亜熱帯島嶼での沿岸流域からの負荷評価）

Thesis Summary

In subtropical–tropical regions, agricultural activities have caused high levels of nonpoint–source (NPS) pollution brought by large amounts of rainfall and typhoon occurrences. The increased NPS may frequently affect the quality of streams and the downstream ecosystem such reef ecosystems due to excessive sedimentation and its associated pollutants. Therefore, long-term monitoring and modeling of environmental process are the key determinant in minimizing and completely reducing the terrestrial discharge from coastal watersheds. This study was undertaken to quantify and evaluate the terrestrial discharge from coastal watersheds into reef ecosystem in Ishgaki Island, Japan by using filed measurements (monitoring), and numerical modeling approaches. Chapter 1 gives an introductory overview about the background and motivation for this research. The rational and objectives of the study are also provided in this chapter. Chapter 2 analyzes the temporal variability in sediment discharge using continuous, long-term and high resolution monitoring data. The relationships between the rainfall, runoff, and sediment variables were analyzed and the suspended sediment concentration-discharge hysteresis was used to interpret the mechanisms of sediment transport dynamics. A total of 227 flood events were derived from long-term high resolution discharge and sediment data that had been collected over the period of 2000-2015. The results showed that there are highly variable hydrological and sedimentological responses on inter-annual, annual, seasonal scales. The rainfall, runoff, and sediment variables showed significant correlations with each other. However, antecedent rainfall strongly influenced the efficiency of runoff generation, which further affected the sediment transport. The results also confirmed the complexity and heterogeneity of both the hydrological and sedimentological responses in the studied watershed. Even though the analyses revealed the efficiency of the soil erosion-reduction schemes that had been implemented in the studied watershed, the red soil outflow is still relatively high. Therefore, additional measures are necessary to minimize or completely reduce soil erosion and sediment discharge. Chapter 3 examines the comparison of watershed models' performances (SWAT and GSSHA) for high time resolution prediction of stream flow and suspended sediment concentration (SSC). The results showed that both models successfully estimated hourly stream flow and SSC in a satisfactory way. For the short-term simulations, GSSHA model performed slightly better in simulating stream flow as compared to SWAT during both calibration and validation periods. GSSHA only gave better accuracy when predicting SSC during calibration while SWAT performed slightly better during validation. For long-term simulations, both models yielded comparable results for stream flow and SSC with acceptable agreement. However, SWAT predicted the overall variation of long-term SSC better than

GSSHA. This study revealed the performance of two hydrologic models and proved the strength and weakness of each model for the applications in specific watershed scale and condition. Chapter 4 assesses the long-term terrestrial discharge from coastal watersheds using agro-hydrological modeling approach (SWAT). The agricultural watersheds in Ishigaki Island have been served as pathway in transporting large amount of NPS loads into the downstream reef ecosystems, resulting in reef degradation. Therefore, it is very essential to quantify the terrestrial loads from those watersheds and its impact on reef systems in order to understand and seek for the possible mitigation measures to minimize or completely reduce the loads. Long term and continuous monitoring data was used for the model development, calibration, and validation in selected watersheds. The calibrated parameters were used for other watersheds to completely estimate the terrestrial loads during a period (2000-2015) from all major watersheds in the Island. The possible impact of terrestrial loads were assessed together the coral cover changes from 2000 to 2015. The water quality parameters sampled near the shoreline were investigated 1 day and 1 week after typhoon revealed the impacts of terrestrial discharges on coastal water quality. Chapter 5 evaluates the efficiencies of best management practices (BMPs) in reducing terrestrial load and concentration level (sediment, nutrients). The satisfactory performance of the watershed model was applied to assess effectiveness of selected 23 BMP implementations. Some of BMPs were selected from Okinawa Prefecture, and some were adapted from previous studies in the same regions. Therefore, the BMPs were regarded feasible and realistic. Beside from reduction in loads, the concentration levels were also assessed using percentage of time exceedance curve to achieve the statutory target for pollution level in comparing with the water quality status. In this study, the results from both the watershed and HRU scales were presented to evaluate the effectiveness BMP implementations for entire watershed and specific farmland (sugarcane farmland), respectively. Chapter 6 explores the submarine groundwater discharge (SGD) driven by tidal fluctuation using modeling approaches from highly permeable aquifer dominated by limestone geological condition into reef ecosystems. In this study, a density variable numerical code (SEAWAT), which was integrated between groundwater model (MODFLOW) and ground solute transport model (MT3DMS) was applied to simulate SGD. The model was calibrated against hydraulic head from two monitoring wells. The satisfactory model was applied to evaluate the influence of tidal pumping (range) and terrestrial discharge (inland water table) on SGD and fresh SGD. Chapter 7 offers a summary of the outcomes from this PhD research and prospects for future research.

Thesis Contents