学位論文の要旨

Abstract of Thesis

研究科 School	Graduate School of Environmental and Life Science
専　攻 Division	Environmental Science
学生番号 Student No.	77501152
氏　名 Name	VO NGOC QUYNH TRAM

学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

The impacts of droughts, local land-use policies, and anthropogenic activities against water resources in the upstream Sesan river basin, Central Highlands of Vietnam

ベトナム中部高原セサン川上流域の水資源に対する干ばつ，土地利用政策，人為的活動の影響評価

学位論文の要旨 Abstract of Thesis

Water resources management is considered based on quantitative and qualitative aspects. Managing water resources comprehensively requires an understanding of the vulnerability and sustainability of the current status of water resources. To develop water resources strategies, their impacts on water resources and agriculture should be discussed in the long-term period. With the increasing uncontrolled land-use changes, some policies were established by the governments and local governments to efficiently manage and reduce the negative effects impacting on water sources and water quality downstream. In which, the land-use change policy is one of the most noticeable policies concerning water resource management. Although the information of land-use change occurs on the local scale, its effects can damage the larger scales including the regional or global scales for a long time. The ineffectiveness of land-use change policies could impact dramatically the agricultural watershed's health. This phenomenon is extremely popular in Southeast Asian countries. Updating these important policies into the long-term watershed management strategies was not conducted comprehensively yet in these countries.

In recent years, the fast population growth leads to serious issues including deforestation, agricultural expansion, and urbanization in Southeast Asia. The cultivation expansion towards the steep-slope areas and the indiscriminate deforestation for agricultural purposes to ensure food and feed demand has been increasing vulnerability in these areas, especially in the intensive-farming areas. During the rainy season, excess discharge combined with intensive rainfall contributed to accelerating surface erosion and then increasing soil and nutrient losses deposited downstream. The nutrients cumulating from point and non-point sources of agricultural activities were the primary factors to increase the nutrient loads to watersheds leading to accelerating the extent of eutrophication on the aquatic environment. In the dry season, droughts coupled with water scarcity have increased pressure on water resources in these countries depending heavily on agriculture. If drought condition prolongs for a long time, it creates an enormous threat to agriculture leading to the decline of socio-economic development in regions. The poorer farmers are more vulnerable to drought when they had to struggle with drought conditions in the dry season as well as erosion and water quality degradation in the rainy season. The current irrigation, reservoirs, and crop conversion projects along with advanced agricultural applications are carried out to support local farmers. Nevertheless, some farmers still choose the traditional farming methods instead of converting advanced technology because of the expensive cost of equipment, operation, and maintenance fees. Changing human awareness to reduce fertilizer use and limit indiscriminate crop conversion in a short period is one of the obstacles for local authorities in implementing land-use change and crop conversion policies in reality.

Name	VO NGOC QUYNH TRAM

The overall objective of this research is to assess the impacts of droughts, local land-use policies, and anthropogenic activities against water resources in the upstream Sesan river basin, Central Highlands of Vietnam. The specific objectives are as follows: (1) Evaluation of historical drought features in the Dakbla watershed, Central Highlands of Vietnam; (2) The impacts of land-use input conditions on flow and sediment discharges in the Dakbla watershed, Vietnam; (3) Effects of local land-use policies and anthropogenic activities against water quality in the upstream Sesan river basin, Vietnam.

At first, the historical drought features in the DBW were evaluated in terms of severity, duration and lag time, and drought frequency based on a combination of hydrological modeling and drought indices. Previously, much more attention to meteo-hydrological drought assessment was paid in Vietnam. While agricultural drought was rarely assessed because of the lack of observed agricultural data on the watershed scale. The important role of agricultural drought along with meteo-hydrological droughts was emphasized because of their larger impacts on agricultural productivity in the long-term period. The higher drought risk was found in the southwestern area, especially in agricultural drought. Rice is one of the main crops in these drought-prone agricultural areas. Also, the other agricultural crops grown in these areas are peanut, corn, soybean, pepper, cabbage, potato, cassava, sugarcane, and coffee. According to the Vietnamese National standard, the total water requirement for rice in the Central Highlands is normally 1,020-1,200 mm/season. For coffee, the total water requirement is about 200-265 mm/season. Corn, peanut, soybean, and cabbage require about 120-200 mm/season. Nevertheless, these crops in drought-prone areas require a higher water requirement compared to the threshold of the national standard. These results can evaluate and visualize drought impacts on agriculture on a watershed scale in detail and support long-term drought management strategies (2021-2030), crop conversion and irrigation system planning. Farmers can understand drought characteristics in specific drought-prone areas to choose suitable crop types, soil characteristics, and irrigation methods.

Secondly, surveying and assessing land of the whole country and regions have been evaluated once every five years in Vietnam because of the dramatic changes in the relatively short period. Previously, the impacts of land-use changes have been evaluated by using a single static land use map in different periods. In another case, the delta approach is applied to analyze the land-use change impacts in two periods by using the simulation results derived from different static land use data. Nevertheless, the frequent land-use changes in a relatively short-term period could not be assessed appropriately in the watershed by these approaches. Also, one of the most challenges is lack of the spatial location information for these LUC policies leading to insufficient long-term land use planning and watershed management strategies. The impacts of land-use input conditions on flow and sediment discharge in the DBW were assessed by updating the different land-use conditions in the hydrological model. The best performance scenario with updating the four land-use conditions was chosen for further analysis. It means updating different land use input conditions had led to more realistic conditions in the modeling instead of using a single static land use map. Differences in flow and sediment simulation will affect the long-term land use plan in the target area.

Lastly, the effects of local land-use policies and anthropogenic activities on water quality in the upstream Sesan river basin were evaluated by updating land-use conditions following the local policy decision and local agricultural practices information into the model in the different periods. Applying the different local land-use change policies along with the extensive anthropogenic activities from 2005 onwards had significant effects on the aquatic environment downstream compared to before applying land use policies. The annual sediment, TN, and TP loads were higher than in the northwestern area where the range land predominated, and in the southwestern area where arable land and permanent cropland predominated. If the changes in the 2005-2009 period do not apply, the huge amount of sediment, TN, and TP in the southwestern area will not estimate leading to significant impacts on the local land use strategies. Similarly, if the changes in the 2010-2014 period continuously apply for the 2015-2018 period, the large amount of sediment, TN, and TP in the northwestern and southwestern areas will consider leading to the inaccuracy assessment of water quality downstream.

This dissertation is divided into six chapters. Chapter I illustrates the general introduction of some remarkable issues in water resources management in Southeast Asia. This part focuses on what the main issues are, what the existing difficulties

Name	VO NGOC QUYNH TRAM

are, how to tackle these phenomena, and which these approaches to solve these issues. The objectives for each issue were also mentioned in this part. Chapter II reviews the literature on the drought status and the characteristics of different droughts on a global/ regional scale. Understanding the impacts of drought on meteorology, hydrology, and agriculture in the different regions in Vietnam were summarized in this chapter. Another important part is that the impacts of local land-use policies and anthropogenic activities on the aquatic environment downstream were discussed. And then, the important role of updating multiyear land-use changes policies and agricultural practices in the hydrology modeling and its advantages were emphasized. Chapter III characterizes the historical drought features on meteorological, agricultural and hydrological aspects, and understands their spatial distribution on each subbasin. Chapter IV concentrates on establishing different updated land-use input conditions by using the developed land-use maps and then evaluates to what extent the updating land-use input conditions can improve the flow and sediment outputs of the model. Chapter V expands the scale of the target area including the PKW and DBW belonging to the upstream Sesan river basin. The impacts of different land-use policies and agricultural practices on the aquatic environment in the different periods were evaluated and then determined how to improve erosion and water quality in the target river basin. Chapter VI draws out the general conclusions based on these above results before proposing the recommendation on water resource management for the target area in particular and the Central Highlands region in general.

In summary, an image of popular issues concerning water resources and agriculture aspects in the upstream of the Sesan river basin was shown based on the spatio-temporal analysis on the watershed scale. The specific areas occurring the different issues such as droughts, erosion, and nutrient losses were described in this dissertation. These findings could support policy-decision makers in implementing more effective local drought management strategies, land-use planning policies, soil conservation plans, and water resource management strategies for the watershed in the future accordingly by considering local water resource availability and suggesting crop conversion planning for the local farmers.