

IMPACTS OF ECONOMIC ACTIVITIES TO THE WATER QUALITY OF HIEU RIVER IN CHAU HANH COMMUNE, QUY CHAU DISTRICT, NGHE AN PROVINCE

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SUMMARY

It has been widely accepted that there is a close relationship between the economic activities and water quality. This study aims to analyze the influence of economic activities, especially the various land use types on the water quality of Hieu river in Chau Hanh - a commune in mountainous areas of Vietnam based on the water quality indicator data with the characteristics of riparian buffer. The results indicated that there was significant correlation between land use in the riparian buffer and the water pollution. The loss of plant cover is proportional to the increase in the level of water pollution. The results can provide scientific reference for the local land use optimization and water pollution control.

Keywords: Economic activities, Hieu river, water pollution, water quality indicator.

I. INTRODUCTION

Water is a necessary resource and most important in river basin. It also help drain rainwater and provide habitats for many species of plants and animals. Today, water requirement is increasing in both quality and quantity but the amount of untreated waste water increasing so resulting in many areas, water resource was seriously polluted (<http://www.charitywater.org/>). In the world, hundreds of river catchment management organizations were established to integrate management of water, soil and other related resources in the river catchment to maximize the economic benefit and social welfare but without damaging the sustainability of environmental system in the catchment, maintain the environmental conditions for human life (I. Calder et al 2007). Water quality is affected by nature factors as well as human. Human impacts on water resource not only changes the amount of water, but also alter the water balance components, hydrological regime of water and especially changing its quality. The main types of economic activity that create largest influence on the change of quantity and quality of water resources are: demand for water for industrial and public needs, sewage dump, urbanization, building of

reservoirs, irrigation and flood the dry land, the activities of agricultural and forestry production... (MONRE, 2012). Water quality can be thought of as a measure of the suitability of water for a particular use based on selected physical, chemical, and biological characteristics. The measurement of water quality properties includes pH, DO, TSS, BOD, COD...

Hieu river is an important watershed in the Lam river system with an area of 5417 km² (Nguyen Thanh Hang, 1996). In recent years, the districts in Hieu river catchment are increasing resources for economic development with high growth rate and leading to the inconsequential use of water resource and create the risk of recession and water pollution more and more serious. If no control and protect, in the near future, Hieu river will become a “dead” river (Nghe An Department of Natural Resources and Environment, 2010). Therefore restoring the old situation of Hieu river and make measure to manage and protect the Hieu river catchment in a sustainable way, ensuring maximize economic benefit and social welfare but not harm the sustainability of environmental systems in catchment is a currently urgent problem. Objectives of the study are: (1) assess the situation of water

quality in the Hieu river; (2) assess the impacts of economic activities to the changing in water quality; (3) propose possible solutions for sustainable watershed management in study area.

Study area

Hieu river located in the northwest of Nghe An province is a major tributary of the Ca river

system. With an area of 5417 km², Hieu river accounted 20% of the Ca river basin (Nguyen Thanh Hang, 1996). The study was conducted at Chau Hanh Commune, Quy Chau District, Nghe An Province. Chau Hanh has an area of 129.6 km² belong to upstream of Hieu river. The total length of Hieu river in Chau Hanh commune is 12 km.

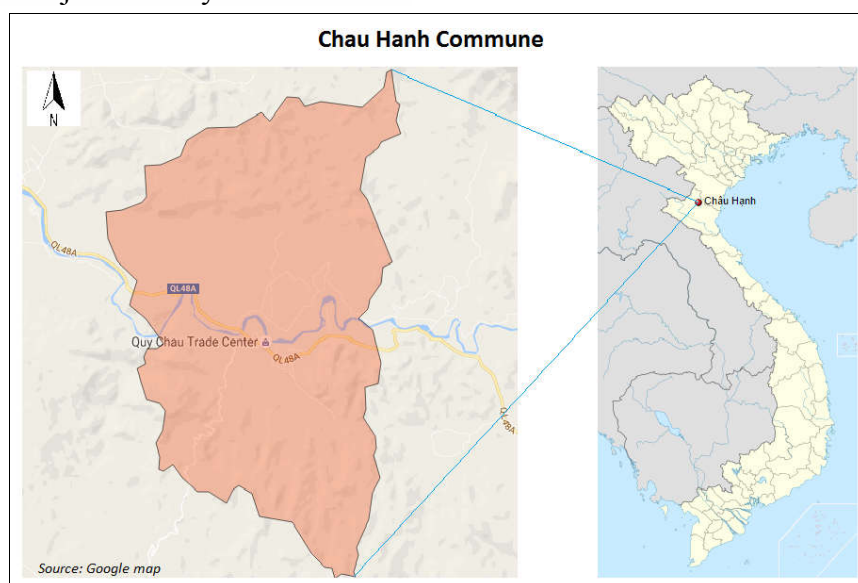


Figure 1. Location of Chau Hanh commune

II. MATERIALS AND METHOD

Data for this study was collected through questionnaire survey in the People's Committee of Chau Hanh commune, Hieu river from Quy Chau hydrology station mainly focusing on types of farming, cultivation methods or economic activities. And other relevant documents, policies, management and protection of forest resources and water quality

in the study area, the report on forest planning was accumulated.

The techniques employed in this study for data analysis and presentation include:

Water sampling

The study took samples at 12 points in the stream. All sample were taken at 30cm depth below the surface, 1m from the bank in 2 separate time (8:00 am and 10:00 am).

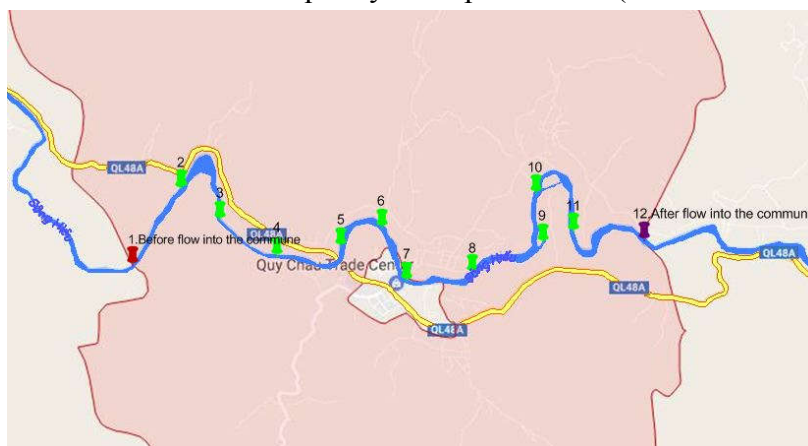


Figure 2. Sampling positions

Water sampling was collected in clean bottle 500ml capacity. While sampling should clean the bottle and sampling at any location have to rinse 3 times with water at that location. Additionally, when conducting sampling, it is required to prepare tapes, markers, paper label cockroaches, sealed barrel sponge... All water samples in bottles have to cool about 4°C and transport to the laboratory, separate target pH, temperature and TDS measured directly in place. Make cold and put in the dark place, most of the samples usually durable to 24 hours.

Analysis of water samples

- Temperature was measurement by using a thermometer directly at the sampling location and record the results.

- pH was measured by pH-meter to determine the pH of water and follow the standard TCVN 6492: 2011 – Water quality – Determination.

- Used Electrochemical sensor to analysis dissolved oxygen and followed TCVN 7325:2004 (ISO 5814:1990) Water quality – Determination of dissolved oxygen.

- Total Suspended Solid (TSS) was measured by using vacuum filter machine or pressure machine to filtering water samples through glass fiber filter. Drying at 105°C and determine the sediment by scale.

Calculate Total Suspended Solids as follows:

$$TSS = \frac{(A - B) \cdot 1000}{V}$$

In which:

A = weight of filter and dish + residue in mg;

B = weight of filter and dish in mg;

C = volume of sample filtered in ml.

And the results used TCVN 6625:2008 - Water quality - Determination suspended solids to analysis.

- Used TDS measuring instrument to measure the amount of dissolved solid directly at the sample positions.

- The samples analyzed were considered are very high levels of BOD₅, they are diluted to the appropriate factor before analysis. Water used to dilute the oxygen was bubbled to saturation and the nutrients necessary.

$$BOD_5 = (DO_0 - DO_5) \cdot f$$

In which:

BOD₅: BOD values after 5 days (mg/L);

DO₀: DO values at 20°C after diluting (mg/L);

DO₅: DO values at 20°C after 5 days incubating at 20°C (mg/L);

f: dilution factor.

- Following the TCVN 6491:1999 (ISO 6060:1989)-Water quality - Determination of Chemical Oxygen Demand to analyze COD of study area.

III. RESULTS

3.1. Water quality

pH

pH parameter of Hieu river water in Chau Hanh commune ranged from 6.7 to 7.8, averaging about 7.2, satisfy with required quality of surface water for domestic purpose.

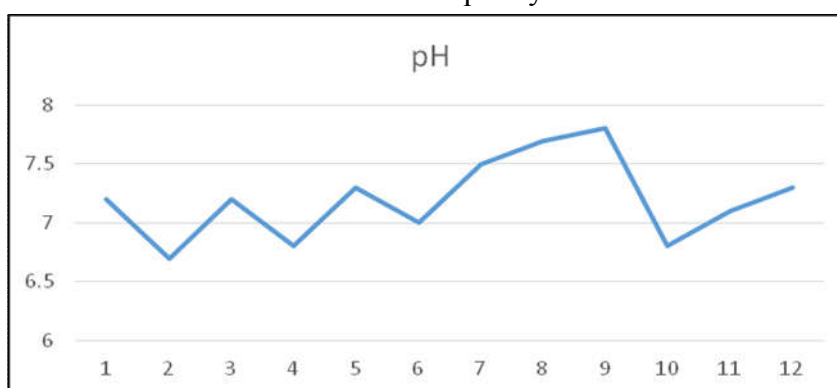


Figure 3. pH parameter of Hieu river

Dissolved oxygen (DO)

shown in the following graph:

Measured values of DO in study area are

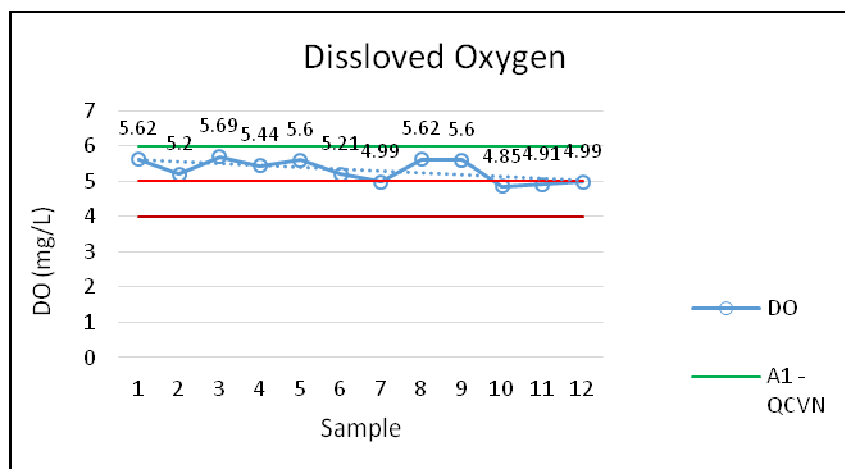


Figure 4. The analytical result of DO

On average, DO value of Hieu river water in study area is satisfy with the A₂ standard (water quality for domestic purpose). However, after flow into Chau Hanh commune, DO value tend to decrease from

5.62 mg/L to 4.99 mg/L.

Total dissolved solids (TDS)

Measured values of TDS in study area are shown in the following graph:

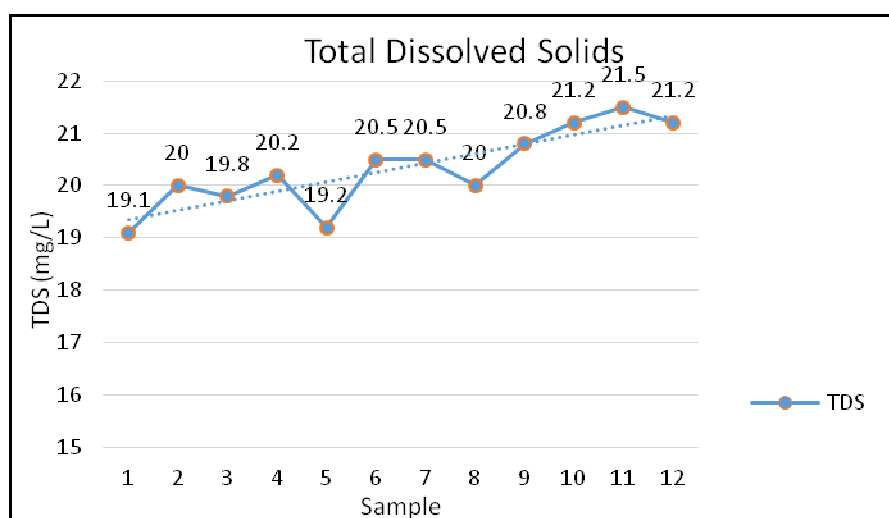


Figure 5. The analytical result of TDS

Average TDS value of Hieu river is low about 20.3mg/L where threshold of acceptable aesthetic criteria for human drinking water is 500 mg/l (WHO/SDE/WSH/03.04/16) and Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l

(Phyllis K. et al, 2007). After flow into Chau Hanh commune, DO increased from 19.1 mg/L to 21.2 mg/L.

Total suspended solids (TSS)

Measured values of TSS in study area are shown in the following graph:

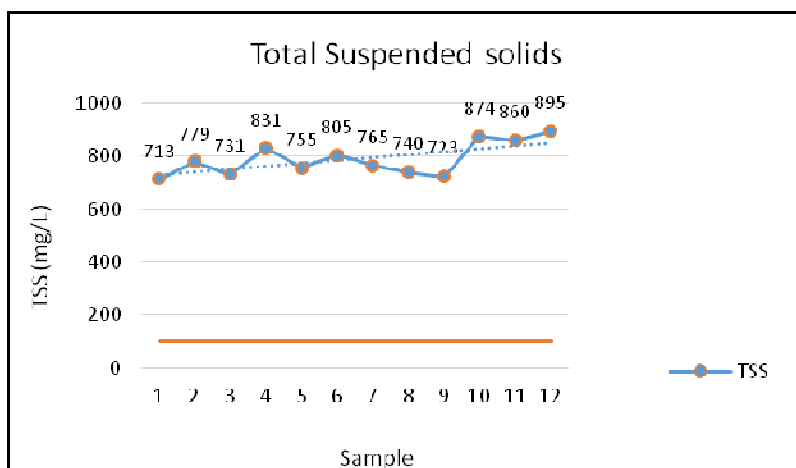


Figure 6. The analytical result of TSS

Hieu river in study area is seriously polluted by suspended solids. Total of suspended solids indicator of Hieu river water in Chau Hanh commune is high and ranging from 713 mg/L to 895 mg/L. These values are higher about 7-8

times than the standards of QCVN 08-MT: 2015/BTNMT.

BOD₅ and COD

Measured values of BOD₅ and COD in study area are shown in the following graphs:

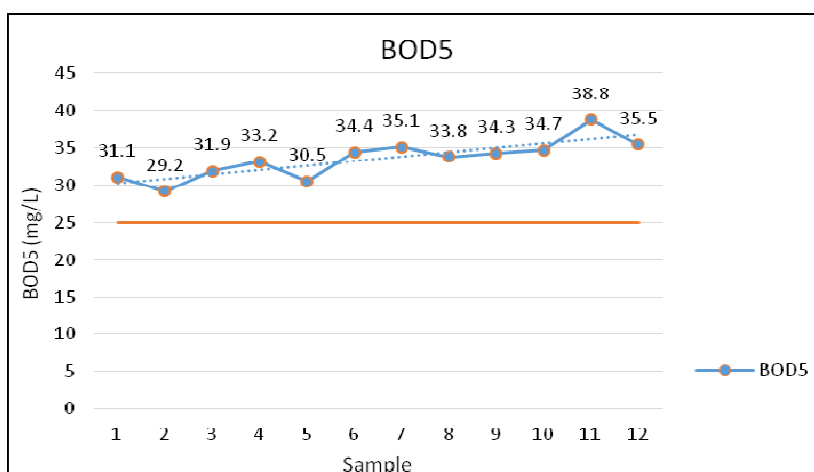


Figure 7. The analytical result of BOD₅

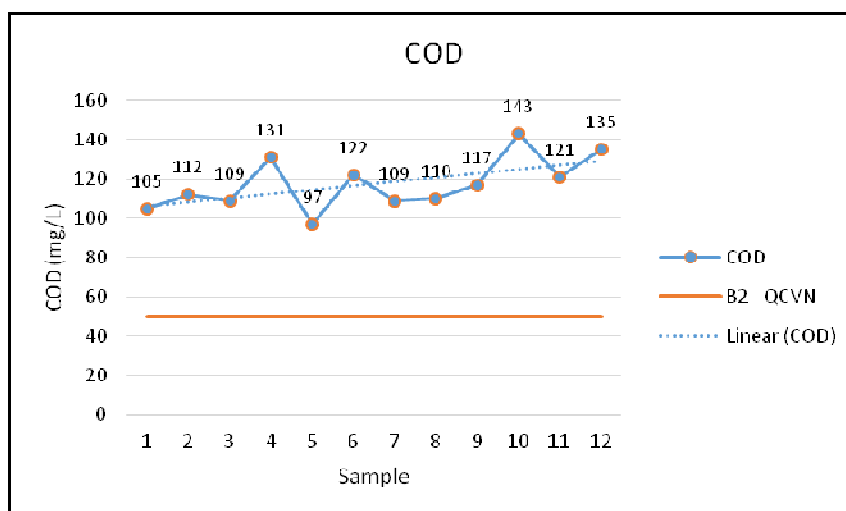


Figure 8. The analytical result of COD

Values of BOD₅ and COD of Hieu river water in Chau Hanh commune is higher than the standards. In which, the values of BOD is higher about 1.2 – 1.5 times than the B₂ standards, ranging from 29.2 to 38.8 mg/L. The values of COD is higher about 2 – 3 times than the B₂ standard, ranging from 97 to 143 mg/L. Both values of BOD₅ and COD increased after flow into Chau Hanh commune.

Thus, Hieu river water after flowing into Chau Hanh commune has been changed in the adverse trend. Although the pollution levels is not high but this water source only can used for irrigation activities, cannot use as domestic water.

3.2. Economic activities

Farming

Farmland accounted for most of the riparian area of Hieu river in Chau Hanh commune. The main cultivation method of people who lives here is shifting cultivation. People go to the forest to slash and burn forest for plantation crops (rice, cassava, maize...). Forest clearing affecting soil erosion and reduce forest cover. Post-harvest phase: people burning after harvest to give the soil nutrients more natural, making the development of microorganisms and faster land reclamation. Agricultural can impact on water quality through the release of nutrients. (as a result of soil management) and other chemicals (e.g. pesticides) into the water environment through biological contamination



Figure 9. Gold mining activity in Hieu river

(e.g. from microbiological organisms in manure) and via soil being eroded and washed off farmland (The UK Water Partnership).

Livestock

The increased losses of nutrients, farm effluents (particularly livestock wastes), pesticides such as cow-dipping chemicals, bacterial and protozoan contamination of soil and water are some of the main concerns regarding water quality degradation. By interviewing people in Chau Hanh commune who lives near the the Hieu river, most of their families has cattle, number of cattle from 2 to 10. Their main feeding method is graze freely. Cattles are often graze along the riverbank, this livestock method create bad effect to the system of vegetation in riparian buffer of Hieu river.

Mining:

Mining activities on both sides of Hieu river has been happening disorderly and create huge impacts to the Hieu river water pollution. The use of water in mining has the potential to affect the quality of surrounding surface water and groundwater. In Chau Hanh, besides cutting down forests for farmland, the mining activities can be said is one of the main causes of TSS pollution in Hieu river in Chau Hanh commune. In addition, mining activities can make changes in soil structure and lead to landslides and erosion of the river bank.



Figure 10. Farmland in Hieu river

3.3. Effects of land use on water quality

In agriculture practices, people use the water to irrigate crops and although a large percentage of the water returns from the fields, often it has been changed and is carrying soil and dissolved compounds. Since most water that falls on the land eventually makes its way to either a ground water or a surface water source, anything that happens on the landscape can have a big impact on the quality of the water. There may be surface runoff of pesticides, fertilizers and manure, or leaching of nitrogen into groundwater, the fate of which is discharge to surface water bodies.

Livestock practices that can cause impacts to water quality depending on feedlots, pasture, watering sites for cattle. Waste management and disposal can also impact water quality. Livestock density is not the only factor affecting water quality as siting and management are also important considerations. Water quality parameters related to livestock production include nutrients (nitrogen and phosphorus), microorganisms (e.g. bacteria,

faecal coliforms) and organic material such as livestock wastes. Water quality concerns include impacts on receiving streams and aquatic life, and reuse of the water downstream for agricultural, recreational and drinking water purposes.

Mining operations use water for mineral processing and metal recovery, controlling dust, and meeting the needs of workers on site. The amount of water required by a mine varies depending on its size, the mineral being extracted, and the extraction process used. For instance, metal mines that chemically process ore to concentrate metals such gold use much more water than non-metal mines such as coal, salt, or gravel mines.

Comparison results of each indicators show that:

DO: the average value of DO in samples which near forest land is highest and smallest in the samples which near roads.

TDS, TSS, BOD₅ and COD in sample which near roads are highest and smallest in the sample which near forest lands.

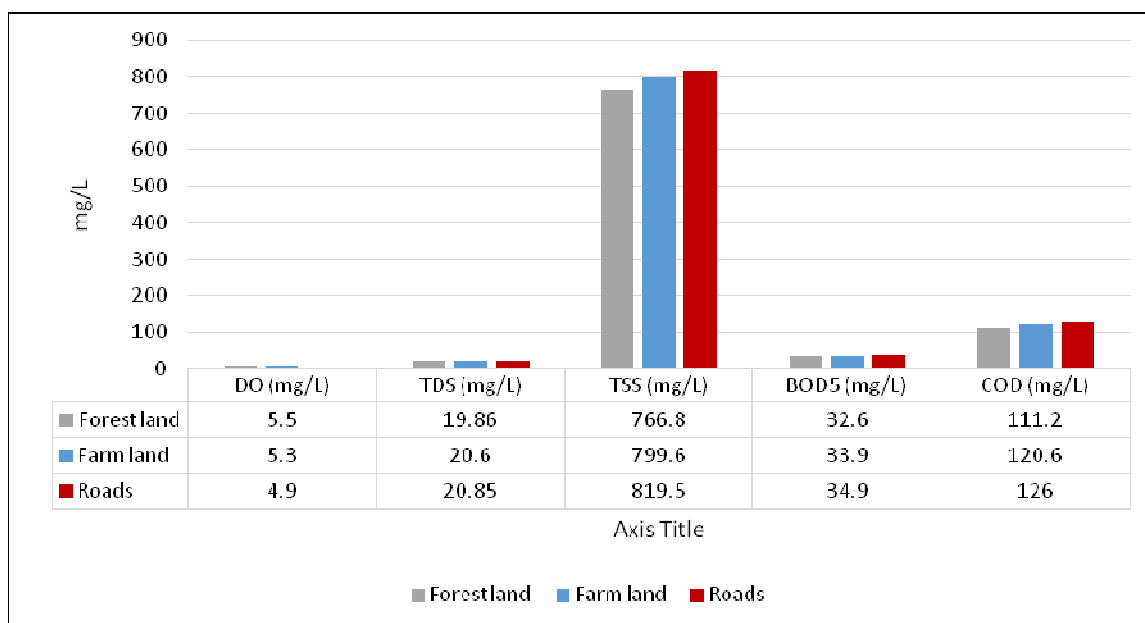


Figure 11. Analytical results of water indicators and sampling locations

The quality of water samples which collected near agriculture land and roads are lower than the quality of water sample which

collected near forest land. This may be explained by the land cover in forest land is higher than agriculture land. At the time of

sampling, Nghe An province has suffered a heavy rain. Therefore, loss of forest cover, resulting from other land uses such as farmland and roads make increases human-accelerated erosion and leading to decrease water quality of Hieu River. In addition, agriculture may affect water quality directly from soil, nutrients and pesticides being transferred from fields to watercourses during rainfall events.

The quality of water samples which collected near roads is lowest because of besides the low plant cover density, the dust and waste from vehicles directly impact on the quality of river water.

IV. CONCLUSION

Water quality of Hieu river in Chau Hanh commune is not satisfied. The indicators of TSS, BOD and COD are exceed standard B2 - QCVN. Hieu River water is cannot used for the purpose of domestic water, only can used for irrigation purpose.

To improve water quality and sustainable water use in Chau Hanh commune, the study propose that commune authorities need to promulgate the following policies: Strict forbidden all illegal mining activities on Hieu river; Forest protection policy, especially

riparian forest; Policies to encourage economic development in forestry, sustainable farming on slopes.

Due to limit of time and budget, this study focuses on impacts of economic activities on water quality. Some factors related to water quality, such as the climate, precipitation, and density of population should be considered in further researches.

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ẢNH HƯỞNG CỦA CÁC HOẠT ĐỘNG PHÁT TRIỂN KINH TẾ ĐẾN CHẤT LƯỢNG NGUỒN NƯỚC SÔNG HIẾU KHU VỰC XÃ CHÂU HẠNH, HUYỆN QUỲ CHÂU, TỈNH NGHỆ AN

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TÓM TẮT

Nhiều kết quả nghiên cứu đã thừa nhận có một mối quan hệ chặt chẽ giữa các hoạt động phát triển kinh tế và chất lượng nước. Nghiên cứu này nhằm phân tích ảnh hưởng của các hoạt động phát triển kinh tế, đặc biệt là các loại hình sử dụng đất khác nhau đến chất lượng nguồn nước của sông Hiếu khu vực xã miền núi Châu Hạnh, dựa trên các chỉ số chất lượng nước với các đặc điểm của lưu vực sông. Kết quả phân tích cho thấy các chỉ số TSS, BOD và COD đều vượt quy chuẩn cho phép. Các hoạt động sử dụng đất trong vùng đệm ven sông có ảnh hưởng rõ rệt đến tình trạng ô nhiễm nguồn nước. Việc mất lớp phủ thực vật là tỷ lệ thuận với sự gia tăng mức độ ô nhiễm nước. Kết quả nghiên cứu tài liệu tham khảo tốt cho việc tối ưu hóa sử dụng đất ở địa phương và kiểm soát ô nhiễm nguồn nước.

Từ khóa: Chỉ số chất lượng nước, hoạt động kinh tế, ô nhiễm nước, sông Hiếu.

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