

Contamination of Watersheds, Micro-Watersheds and the Death of Ecological Niches in Huánuco Peru

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Abstract

Pollution is a problem of permanent concern to various scholars such as environmentalists, ecologists, educators, anthropologists, historians, geographers, journalists, administrators and researchers of different disciplines, who are all concerned with the preservation, conservation and defence of the environment; nevertheless, there are gaps in specific contexts such as that of the basins and micro-basins and the death of ecological niches in Huánuco. The study objective is addressed to the function of ecological niches in the way of life of the population of the Andean zone of Huánuco - Peru, to answer the questions: What are the main ecological niches with greater influence in the life of the population of the Andean zone of Huánuco - Peru, and how do the ecological niches influence the life of the population of this population? How do the ecological niches influence the economic activity of the region? What are the contaminated ecological niches with repercussions on the population? What is the social behavior of the inhabitants of this Andean zone? The following objectives were formulated to explain the role that ecological niches play in the way of life of the population of the Andean zone of Huánuco - Peru, while the specific objectives were proposed to identify the main ecological niches with greater influence in the life of the population, to determine the influence of the ecological niches on their economic activity, to identify the contaminated ecological niches with repercussions on the population of this region, and to evaluate the social behavior of the inhabitants concerning the ecological niches of their environment. The logical deductive method was used to analyze the studies published, and the inductive method allowed the generalization based on the observations; as a complementary part, the bibliographic file was used, and as materials, the photographic camera, altimeter, cartographic map of Peru, and Earth Google. The study results are the high contamination of the headwaters of the Upper Marañón Basin due to the mining tailings and the irresponsibility of the farmers living on the banks of the Lauricocha and Nupe Rivers. The conclusion is framed by highlighting the importance of ecological niches for living creatures, which have become the habitat of biodiversity, highlighting the flora, fauna and microorganisms in different climates and microclimates found in the riverbeds. These streams, lakes, lagoons, springs and ponds are being polluted, with a severe risk to their continuity in the headwaters of the Marañón River, especially in the headwaters of the Nupe and Lauricocha micro-watersheds.

Keywords: *Ecosystem, Ecological, Flora, Fauna, Ecological Floors.*

Introduction

The problem of environmental pollution is one of the fundamental concerns of humanity in the different contexts of the globe; it is a concern of environmental scientists, scholars of the social and natural sciences, politicians' agenda, a challenge for governmental and non-governmental organizations and institutions, a theme for anthropologists, historians, religious scholars, university academics, and even business people. There are several articles published in specialized journals with different denominations related to ecological niches, which are part of the environmental context. Some authors have dealt directly and indirectly with them, among them, Pastor (2006) and Mejía Novoa & Buitrago Duarte (2022) made an inventory of the various academic and political forums since June 1972, which was established as World *Environment* Day and, consequently, of the habitat and the preservation, conservation and defense of ecological niches. Two years later, Environment Day was celebrated under the slogan "only one earth"; in 1977, the United Nations *Environment* Program took as its agenda the substance that depletes the ozone layer; 1979 was celebrated under the slogan "only one future for our children"; In 1981, work was done on groundwater and food chains; in 1986, the global work agenda was launched with the slogan "a tree for peace" and continued with various programs such as the global awards in 1987; a year later, a new slogan was disseminated, "if people put development in the middle, it will last." In 1992, Brazil worked on the theme "Earth Summit," the priority issues being desertification, climate change and biodiversity. Between 1993 and 2015, several slogans were raised, such as: "a gift for the earth," "poverty and environment," "for life on earth save our

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seas,” “the millennium of the environment,” “green cities: planning for the planet,” “deserts and desertification,” “melting ice a hot topic,” does it include you? “raise your voice, not at sea level,” “seven million people,” “one planet”; all these topics were discussed in different forums with positive results in European countries, but with great concern in South American countries.

On the other hand, several scholars have dealt directly and indirectly with ecological niches, ecosystems and the environment (Jankilevich, 2003; Pastor, 2006; Pérez-García & Liria, 2013; Pérez-García & Liria, 2013; Martínez-Urbina, 2022; Yuko Urushima et al., 2022; Rattia, 2022; Steven & Fandiño, 2022; De Rennes, 2015; Gonzáles et al., 2019). Each of the authors, according to their context and the subject of their studies, have proposed different approaches, such as culturalism, protectionism, aspects of pollution, environmental education, the responsibility of human beings towards the goodness that nature offers us, environmental education, the indifference of the politicians of the moment, the lack of adequate national policies, modernism and its collateral effects that have a negative impact on the protection of ecosystems and ecological niches. These studies respond to different contexts, but the only purpose is to protect the environment. In Peru, the importance of the environment, ecosystems, ecological niches and environmental education was dealt with in a dispersed and sectoral manner until the 1990s, when the Environmental and Natural Resources Code was promulgated, which served as the basis for generating an environmental policy. Political Constitution of Peru (1979) Art. 123, among others, recognized that Peruvians had the right to live in a healthy and ecologically balanced environment, preserving the landscape and nature, and later specified that everyone had the duty to conserve the environment. Environment and Natural Resources Code (1990). This document specifies a whole protocol for the preservation, care and treatment of the *environment*, including ecological niches. At the beginning of this century, Law No. 28245 was passed, the Framework Law of the National Environmental Management System (2004). The objective of this regulatory framework was to strengthen the environmental objectives of public entities. Congress of the Republic (2005) This same year, this regulatory framework was regulated; two years later, it was modified with Law No. 28804, which regulates the Environmental Emergency Declaration (2006). This law specifies some aspects of the environmental emergency that may occur due to natural effects, diseases, and technological or political decisions that may compromise the *environment*. Based on these legal frameworks, environmental policy was implemented in Peru, whose main purpose was the protection of the environment, environmental education, environmental pollution, and the protection of biodiversity and ecological niches. In addition to the normative devices, there are also scientific concerns about ecological niches, such as the studies of Navarro Guzmán et al. (2020), who describe the modeling processes of ecological niches of flora threatened by climate change, an article published by the Revista Forestal de Colombia in part of its conclusions states “to significantly improve the understanding of the dynamics of the ecological niches of the categorized flora species that inhabit coastal, Andean and high Andean ecosystems” (p. 63); this is a protectionist and conservationist approach; likewise, Garay-Crisanto et al. Garay-Crisanto et al., (2022) in another study on the toxicity of conventional pesticides on the ecosystem services that farmers use for the preservation of the cocoa crop are pesticides such as “cypermethrin (T1), carbofuran (T2), copper oxychloride (T3) and chlorpyrifos (T4) in a cocoa farm in San Martín” (p. 1). These theoretical arguments will serve as a study guideline since they relate to ecological niches and their contamination process. Meanwhile, in the Huanuco region, the studies of Bustamante-Paulino & Paragua-Morales (2022a), who in the Revista Investigación Valdizana of the Universidad Nacional Hermilio Valdizán describe and explain the processes of contamination of the basins and microbasins of Huánuco referred to the upper Marañón, understanding of the subject of study; another study is the thesis entitled Modeling of the effects of climate change on the potential distribution of six species of the genus *polylepis* in the Peruvian Andes; presented by the thesis student Quispe Rojas (2022) who, despite his limitations in the logical sequence of his explanations, in the summary of his research work states that “Climate change is an important driver of biodiversity loss, it is estimated that by the end of this century, there will be massive extinctions of alpine and Andean species, as is the case of the species of the *Polylepis* genus” (p. 10). Although its subject of study is indeed oriented toward climate change, it is a first-level reference.

The review of the preceding information, although it covers many topics according to their context, there are gaps and concerns, such as the case of contamination of watersheds, micro-watersheds and the death of ecological niches in Huánuco Peru, especially in the headwaters of the Marañón basin, specifically in the

sub-watersheds of Nupe and Lauricocha, located in the jurisdiction of the current province of Lauricocha. The first is the presence of mining through the Raura Mining Company, which has been exploiting minerals since the 1960s and, in those 70 years, has generated a high degree of contamination in the surrounding areas, such as the tailings beach of the Caballococha lagoon, where is the bloom of earth, remains of containers of chemical reagents used in the company's concentrator plant, whose tailings contain components of sodium bisulfate, zinc sulfate, copper sulfate, bichromate sulfate, xanthate, MC frothers, H 425 frothers, D 250 frothers. The meltwater streams carry these contaminated tailings to the Tinquicocha, Chuspicocha, Patarcocha, and Taulicocha lagoons, which deposit their waters in the Lauricocha basin, whose waters irrigate the agricultural areas and pasturelands of towns such as Lauricocha, Antacolpa, Gashancha, Antacolpa and Gashancha, Antacolpa, Gashanpampa, Corian, San Miguel de Cauri, Jesús, Son José de Ticra, Jivia and Huarín, poisoning the biodiversity and generating a severe risk to the continuity of the ecological niches and consequently the death of microorganisms, generating a serious disruption to the environment.

A second issue is a contamination caused by the farmers living in the Lauricocha and Nupe micro-watersheds, who use pesticides and insecticides for their crops and due to the effects of the rains, their particles are washed into the river, causing pollution and the extermination of microorganisms living in the small ecosystems that have generated ecological niches. Another issue is the dumping of sewage from the towns on both banks of the Lauricocha and Nupe rivers and their tributaries, which has poisoned and killed trout, catfish and batrachians that used to live in the river and its banks. On the other hand, the dry areas are accompanied by fires of extensive areas of straw, childcare, small forests, as well as the felling of native trees such as quinoa, quisuar, and other shrubs that generated life in the high Andean areas that for centuries were preserved thanks to the non-formal education of the peasants of yesteryear; After the 1970s, television antennas were installed in many communities that began to transmit new cultural patterns, where traditions, customs and ancestral ways of life are not respected, and gradually the new citizens have become indifferent to their surroundings, their environment and their culture and consequently, the ecological niches are in danger of being exterminated.

The reality described in the preceding lines allowed to carry out a research project to learn about the problem of contamination of watersheds, micro-watersheds and the death of ecological niches in Huánuco - Peru, and for this, the following questions were formulated: What is the function of ecological niches in the ways of life of the population of the Andean zone of Huánuco - Peru? And as specific questions, what are the main ecological niches with more significant influence in the life of the population of the Andean zone of Huánuco - Peru? How do the ecological niches influence the economic activity of the population of the Andean zone of Huanuco-Peru? and What is the social behavior of the inhabitants of the Andean zone of Huanuco-Peru concerning the ecological niches of their environment?

Methodology

During the second semester of 2021, field work was carried out for the project "The contamination of watersheds, micro-watersheds and the death of ecological niches in Huánuc" (Hanson et al., 2005). The general objective is to explain the function of ecological niches in the lifestyles of the population of the Andean zone of Huánuco, Peru; for the specific work, the following specific objectives were selected: To identify the main ecological niches with greater influence in the life of the population of the Andean zone of Huánuco - Peru; to determine the influence of the ecological niches in the economic activity of the population of the Andean zone of Huánuco - Peru; to identify the contaminated ecological niches with repercussion in the population of the Andean zone of Huánuco and, to evaluate the social behavior of the inhabitants of the Andean zone of Huánuco - Peru in front of the ecological niches of their environment.

In this process, the research team agreed to set the work area in the Lauricocha and Nupe sub-basins, located in the province of Lauricocha; understanding of the Department of Huánuco was set as a sample work scenario Nupe sub-basin from the Wuayhuash mountain range, In the other sub-basin, from the Lauricocha lagoon to the source of the Marañón River, located in the towns of San Francisco de Huarín, Jivia and Rondos, respectively: In the Lauricocha watershed they comprise the towns of San Miguel de Cauri,

Jesus and Jivia respectively. The study sample was defined according to the events and events occurring with pollution and the various ecological niches in the micro-watersheds of the Nupe and Lauricocha rivers in the province of Lauricocha. This sample defined the confluence watersheds of the Calparragra and Nupe rivers in the first sub-basin, and the second was fixed adjacent to the ancient Wari archaeological complex known as Chiquia in the town of Corian in the district of Jesus in the Lauricocha sub-basin. These samples were fixed per the proposal defined by Hernández et al. (2014).

Once the sites were selected, studies and reports from official and private entities on the sub-basin contamination were collected. These data were complemented with reports in specialized journals, for which Scopus, Science Direct, Wiley online, Taylor and Francis, EBSCO and academic Google were visited. Similarly, the virtual libraries of the Universidad Nacional Hermilio Valdizán, Biblioteca de la Nación del Perú, and UNESCO Library was complemented with the use of the selection of information sources from the physical library of the Universidad Nacional Hermilio Valdizán, the archives of newspapers such as the newspaper Ahora and the private library of the Bustamante family; for the selection of sources the bibliographic manager Mendeley was used, where articles, books, book chapters and specialized files were stored, in order to facilitate the work of the researchers. An important fact in the field research was to find abundant information on the contamination of the basins and micro-basins, as well as the existing complaints against Minera Raura and the population's attitude related to the poisoning of the water resources in the area. Throughout the process, the work material used was the personal computer of those involved as researchers, where the data was stored. Tablets and cell phones were also used for taking photographs and records of cards that were complemented with electronic bibliographic cards stored in the corresponding computers. As a method in the planning process, the inductive method was used, complemented by the bibliographic card technique; in the cabinet work, the deductive method was used to review and systematize sources, starting from the complex to the simple. Finally, the logical deductive method was used in office work to process and systematize the information.

In the process of the work, the following procedures were followed: the researchers agreed to use only reliable sources of official origin and recognized institutions with national prestige; the work team had to go to the place of the facts to verify the information of the existing data in the newspapers and specialized magazines, and finally, it was put to ethical consideration of those responsible for the project; for a visit to the places fixed in the preceding lines the inhabitants of the area were notified for the consent of the collection of the information, whose data was kept confidential.

Results

The findings are based on the data from official documents of public and private entities warning about the pollution process that is generating the sub-basins of the Lauricocha and Nupe rivers in the province of Lauricocha in the department of Huánuco. These data are shown in the following order:

According to the fieldwork, the most important ecological niches in the province of Lauricocha are located in the sub-basins of the Nupe. Among them are the places that cross the entire Carhuacocha micro-basin, which extends to the confluence of the Carhuacocha and Wuayhuash rivers, the ecological niche of Murmunya, which extends from the Wuayhuash snow-capped mountains, through Murmunya, to the confluence with the Carhuacocha river. Another important ecological niche is located between the Alpacoto and Colparragra areas, which flows into the Wuayhuash River. Another essential niche is the one that originates in the heights of the Ninacaca ranch, which passes through Yuraqyacu and extends to the Tranca area and flows into the Nupe River. In these areas, there is a wide variety of native and wild fauna, such as mammals. For example, Rivera (2003) highlights the following: weasel or huayhuash known as *mustela frenata*; wildcat (*oreailurus jacobita*); river wolf or gara lobo (*lontra longis candis*), puma leoncillo or American lion (*feliz concolor*); taruca (*hippocamelus antisensis*); white-colored gray deer or luichu (*odocolleus virginianus*); vicuña (*vicugna vicugna*); vizcacha or wishcacha (*lagidium peruvianum*); skunk (*mephitis macroura*); fox or atog (*Dusicyon culpaus*).

The most important ecological niches in the high Andean zone of Huánuco are located in the surroundings of the Raura mining company and are the following: the snow-capped mountains of León Dormido, Niño Perdido and consequently, the Niñococha lagoon, Santa Ana and the small lakes and lagoons where the dumping of mineral has poisoned all types of life remains into the waters of the snow-capped mountains and lagoons. The same phenomenon can be observed in Caballococha, where the Raura Mining Company has converted the old mine clearing site called Nieve Ucuro, which has collapsed, causing the death of water resources and, of course, flora and fauna. Furthermore, the waters of Caballococha and Nieve Ucuro discharge their waters into the Tinquicocha lagoon and consequently have contaminated almost all of them, causing the death of animal and plant life in the area. These degrees of poisoning of the basins and micro-basins are located at the headwaters of the Marañón Basin, where the erosion system has generated diverse ecological niches that the Raura Mining Company is irresponsibly polluting. Currently, the beach of mining tailings is observed in much of the environment of the Caballococha lagoon, where the remains of containers of chemical reagents used in the concentrator plant of the company can be seen at the surface of the earth, whose remains of tailings with components of sodium bisulfate, zinc sulfate, copper sulfate, bichromate sulfate, xanthate, MC foaming agents, H 425 foaming agents, D 250 foaming agents. The meltwater streams carry these contaminated tailing to the lagoons of Tinquicocha, Chuspicocha, Patarcocha, Taulicocha, Lauricocha, and the Lauricocha and Marañón rivers, which are doomed to die, according to the studies by Encuentra (2003). According to studies by Encuentra (2003) on the behavior of the Raura Mining Company, the degree of contamination is 0.064 mg/l, which exceeds the maximum permissible limit of 0.050 mg/l. Since 2003, contamination has been gradually worsening. Osinergmin (2009) asserts:

Lead in the rebound of Niñococha lagoon yields a result of 0.04 mg/l, which is higher than the 0.03 mg/l limit for this parameter. Niñococha lagoon is located at a higher elevation (upstream) than Caballococha lagoon. Cadmium in the overflow of Laguna Santa Ana shows a value of 0.007 mg/l, higher than the limit of 0.004 mg/l (p. 8).

In another part of the explanation, Osinergmin specifies the presence of zinc as follows:

upstream of the Caballococha lagoon have higher zinc values as seen in the overflows of the lagoons: Locococha (Point E 11) is 0.14 mg/l; Niñococha (point E-1) is 1.78 mg/l; Niño Perdido (Point E 6) is 0.26; Santa Ana (Point E-2) is 4.27 mg/l it is noted that mining metallurgical effluents are discharged into this lagoon (p. 8).

The company's policy continues with its irresponsibility towards the environment and continues with the attack against the various ecological niches in the area and with serious harm to the local inhabitants. The Environmental Evaluation and Oversight Agency (2019) applied a sanction to the mining company that generated a rebellion of the company. On the contrary, the contamination spread to the other lagoons that bathe the small micro-basins of the towns of Antacallanca, Lauricocha, Antacolpa, Gashanpampa, Yachasmarca, San Miguel de Cauri, Corián, Jesús, Son José de Ticra, Jivia, San Francisco de Huarín and the poisoned waters run all along the Marañón river.

In the studies of Becerra Ventura (2017), the process of environmental disturbance in the Marañón watershed is evident:

The degree of contamination of the waters of the Marañón River due to direct discharges from the *El Muyo* population center, as far as physical and chemical parameters are concerned, for the iron and turbidity components, we can conclude that the concentration of iron in the water is moderately high, with a difference of 0.25 mg/l and 1.0 NTU, respectively, with respect to the upstream sampling point. 25 mg/l and 1.0 NTU respectively, as both sampling points do not comply with the National Environmental Quality Standards, in category 1-A1, consequently, the water subject of the investigation cannot be used for the production of drinking water, which can be made potable with disinfection (p. 54).

In the diagnostic part of the Huanuco Regional Sanitation Plan, 2018 - 2021, the regional government states that the waters of the three most important river basins in the region (Huallaga, Marañón and Pachitea basins) continuously receive discharges of polluting and toxic liquid and solid waste from mining and population

springs, contaminating the water sources of the Marañon River (p. 17). On the other hand, in their interesting thesis Valle et al. refers to:

High levels of contamination in the Huallaga, Marañon and Pachitea river basins affect water quality in the region. No soil quality studies were conducted, but 301 environmental liabilities were identified in the region, most located in the province of Ambo and Lauricocha (p. 152).

In another interesting piece of information provided by Esteban (2019), who in part of his conclusions, says:

The frequently used pesticide types were identified as insecticides, fungicides and herbicides. The presence of FURADAN 5 GY ESTERMÍN 600 SL, DESCIS 25 CE AND CAPORA 540 EC, which have been related to poisoning incidents, were identified as the most dangerous active ingredient used in pesticide formulations. The formulations containing the combination determined were cypermethrin and methamidophos; chemical groups were identified as organophosphate, carbamates, dithiocarbamates and pyrethroids. In the provinces of Yarowilca and Lauricocha, the survey referred to sex and age, with the youngest age (30-40 years old) and the youngest (15 years old). Farmers' experience in pesticide management is relative, with 1 to 2 years and others with 40 to 50 years, respectively (p.67).

The representatives of the community of San Miguel de Cauri through the Regional Government of Huanuco, exposed before the Congress of the republic the contamination of the lagoons of the environment of the Raura Mining Company, whose document in its virtual version of slides was published on the website under the title of contamination of the Lauricocha Lagoons and through Encuentra (2018) say:

The results show the presence of chromium in concentrations higher than those established by the general water law in the Caballococha and Tinquicocha lagoons, which are within the scope of mining operations; the levels of chromium found in these lagoons represent a serious risk to the public and environmental health in the province of Lauricocha" (p. 50).

Fish, batrachians and ophidians include catfish (*pigydium orayae*), chalhua (*orestias* sp); trout (*oncorhynchus mykiss*); frog; toad or rachac (*bufo spinulosus*); chjacarera snake; puna snake; lizard or shulac (*lacerata muralis*).

In the field of flora, there is a variety of resources that are in the process of extinction, as stated by Rivera (2003). The following: nostoc or cushuro, onguina (alga cladopora / alga espirogira), in mushrooms there is tuclish or fungus; in lichens and mosses gagachira; cut paper in herbaceous species is chard, antarraga, watercress or oguro (*nasturtium officinale*), calhua calhua, cashahuaman, rosa cahsa, congona, horsetail or mogu mogu (*equisetum fluvis*) curpa curpa, chogo or chilhuar (*calamagrostis*), escorzonera (*homioiantus multifloras*), estrella or cuncush (*distichis muscoides*), gallu gallu (*stangea henricli*), gapachinya, garbanzo, garbancillo, ilauro, huachangana, huamanripa (*senecio tephrosioides*), huiru huiru (*culcitium canescena*), jancarragacha, jaramulaca, jircanpureg (*gentianella alborosea*), lancahuasha (*senecio rhizomatus compuesta*), llantén (*plantago major*); macha macha, mascón or cachu, purun mashwa or wild mashwa, ñupo, purun olluco, ortiga or ishanca (*urtica cannabina*), pachamulaca, pachamuña, ichu or ochsa (*stipa festurcasp*), rimas rima, rhubarb or putaga (*rheum officinale baillon*), shagapa, sietlabios, taya gaya (*bomarea dulcis*), totora or rush (*scirpus riparius*), uluyma (*opuntia floccosa*), verbena, walmish. Also noteworthy are shrubs such as cantuta or gantu Huayta (*cantus buxifolis*), capulí or shupla, thistle, cortadera or laya (*cortaderiasp*), chamana, chilca de puna (*baccharis latifolia*), chipas, chipe or mutaya (*cassia* sp), chuná (*cactus ovinus*), guava (*psidium guajava*), huamanpinta (*chuquiragua spinosa*), marco or artemisia (*ambrosia poeruviana*), matara, muña (*Mintostachys mollis*), murmunya (*ribes cunieifolium*), taya (*baccheris odorata*), tuna (*opuntia tuna*); tuyo and among the trees there are quinal, quenuel queñoa (*polilepys weberbaueri*), quisuar (*buddleia coriacea*, sauco, chilca, cabuya, huaguro); there are also food plants such as potato, shiri, maca, and medicinal plants such as lemon balm, papchamuña, chimú, antarraga, huamanripa, mint, plantain; etc.

In relation to the behavior of the population in ecological niches, we have the studies of Bustamante-Paulino & Paragua-Morales (2022), who indicate that contamination generates “The deterioration of water sources affects the community that causes it, as well as all the inhabitants downstream, since it changes their social, economic and productive life, and also degrades their physical and mental health” (p. 24). In another passage of the study, the same authors describe the population’s indifference concerning the preservation and conservation of the ecological niches in the headwaters of the Marañón Basin.

Discussion

About the General Objective

This study identified that the main source of the presence of ecological niches is the watersheds and micro-watersheds and that they play a fundamental role in the population’s way of life in the high Andean zone of Huánuco. The small watersheds and micro-watersheds along their course have established diverse ecological niches, serving as habitats to a group of living beings according to the ecological levels composed of flora, fauna and a group of microorganisms that historically gave a special aspect of life to human beings and other species. These ecological niches are being systematically polluted by two actors, directly and indirectly, the first by the Raura Mining Company, which pollutes water resources through the waters of mine tailings that flow into rivers, streams, lakes, lagoons, springs and ponds, from their origins in the Cordillera Raura to the mouth of the Amazon River into the Atlantic; and second by the irresponsible action of the citizens who are possessed around the Nupe River, such as the towns of Lupaq (Tupac Amaru), San Juan de Nupe, Leoncio Prado, Concepción, Santa Rosa, Paragsha, Condorcancha, Baños, Rondos and San Francisco de Huarín; as well as Queropalca, and Quishuarcancha which tributan their sewage to the Carhuacocha River and finally to the Nupe, but also by the use of chemical components, as very well asserted by Esteban (2019) about the use of insecticides, fungicides and herbicides such as the presence of *furadan* 5 G and *estermín* 600 SL, *decis* 25 CE and *copora* 540 EC, which are related to incidents of intoxication and deaths of microorganisms in the soil. The issue of ecological niches has been little studied in Peru and Latin America. Martinez-Urbina (2022) in an interesting comparative study about Psittaciformes: Psittacidae and Quiscalus mexicanus Passeriformes in one of his conclusions says, “about ecological niches, the study can add data to a problem of great relevance in terms of species protection” (p. 13). Although the author indeed mentioned above talks about the problem of two natural species that compromise the ecological niche, our study is focused on the contamination of basins and micro-basins that have been poisoning the ecological niches, as an effect of human behavior, either by the attitude of the officials of the Raura Mining Company or by the attitude of the people that inhabit the margins of the Nupe, Carhuacocha and Lauricocha rivers, as it is very well specified by Rattia (2022) in his study on environmental culture:

That citizen training represents a very important aspect of environmental culture; people may have the necessary knowledge but not apply it. Hence, an individual’s training includes his environmental awareness and behavior. However, it should be based on a change of knowledge and behavior from an early age, contributing to generating a daily environmental protection action from an environmentalist culture (p. 336).

The attitude and human behavior are transcendental factors to preserve the environment and consequently the ecological niches, as has already been specified in the results; the process of contamination of the basins and micro basins, as well as the extermination of the ecological niches, are in serious risk due to the irresponsibility of the human beings that inhabit and exploit their resources in the described area. In the last 50 years, the ecological niches have been deteriorating, despite these spaces being sources of life for human survival in the Andean zone of Huánuco - Peru. Hence the importance of environmental culture and valuable attitudes of preservation, care and defense of the environment. This means having a different behavior on the part of the citizens who live on both banks of the Carhuacocha, Nupe and Lauricocha rivers and return to emulate the ancestral experiences of the pre-Incas and Incas who cared for and protected the resources of their environment as described very well by the geographer Pulgar Vidal (2014) when he refers to the eight natural regions of Peru, or the same Brack (2010) when he describes in his work entitled Perú:

País Maravilloso, Manual de Educación Ambiental (Peru: *Wonderful Country, Environmental Education Manual*). He highlights the need for its care and protection, referencing the ancestral culture, an argument shared in this study.

OE1

One premise of the study has been the identification of the main ecological niches with the greatest influence on the life of the population of the Andean zone of Huánuco - Peru. In this area are the micro-watersheds of *Carhuacocha*, *Murmunya*, *Nupe*, *Colparragra*, *Yurayacu* and, on the other margin, *Lauricocha*. A variety of ecological niches have been created in these micro-watersheds. In the surroundings of the lagoons of the Raura and Wuayhuash mountain ranges, which have generated a diversity of lagoons, small lakes, springs and ponds located above 4,500 meters above sea level, fish such as Challhua, catfish, batrachians and a variety of microorganisms, which give a particular look of life to the area, among the larger animals are the tarugos and cervids and, in birds highlights the huachhua, the yanavicu, high altitude ducks, bandurrias and the condor, which are being exterminated by the effects of pollution and, when moving to different climates have difficulty adapting and die. Likewise, the mountain ranges are melting, such as the majestic snow-capped peaks of Jirishanca, Jurao, Rondoy, Silla Grande and Yerupajá. Garayar (2003) states that it is “framed by enormous mountain ranges that separate it from the departments of Ancash, Lima and Pasco (Huayhuash, Raura and La Viuda mountain ranges” (p. 133). Further on, he describes the presence of cetaceans and a diversity of adapted plants, which provide the resources for fauna with a high degree of endemism. Indeed, this author’s description is valid, but he forgets that these resources are in the process of extermination due to the phenomenon of mining pollution as in the case of *Raura* and human activities of little protection of the environment. A second ecological niche is between 3,500 and 4,500 meters above sea level. In this area, there is a second group of ecological niches, where the deer, tarugos, birds of diverse genus stand out, among them the partridge, the cutupuy, the akakllo, the hawk, dominicos, sparrow hawks, lacones, high altitude hummingbirds, goldfinches; rodents such as mice, foxes, and among the most outstanding are the guanaco, llama, alpaca and vicuña, which are today affected by contaminated water resources and the deterioration of their habitat due to the indiscriminate use of pesticides, which also affects pasturelands and the drainage of ecological niches. To this, the burning of the ichu or hard straw gramineae, the chilwar (calamagrostissp), the extermination of the totora, quinal known by the natives as the snow trees, and the quishuar, the cespó of pajonales, the champa and the plants called criptocauls, the uluyma (opuntia flocosa), variety of bushes as of culli. About the goodness of the flora and fauna, already Pulgar Vidal in his book the Eight Natural Regions of Peru (2014), described in detail; however, when he wrote flora and fauna and the diversity of microorganisms were preserved; in the current context the habitat of animals and the variety of ecological niches, for a long time have been affected by the work and grace of modern man.

A third group of niches in the study area is located between 3,500 and 4,500 meters above sea level and is the space best used by man for the practice of agriculture, livestock and the habitat of a diversity of birds that are described in the results of this work, as well as the presence of microorganisms of plant and animal origin and, of course, of the man himself. Finally, in this area, there is a group of small foothills characterized by the presence of immense abras, slopes, small plateaus, pampas and peaks of greenish spaces in the Peruvian winter (January, February and March) and dry areas in April, May, June, July and August, known as the Peruvian summer; in which context ecological niches have been configured for the habitat of living beings that human beings have constituted towns and regions thanks to the benefits of ecological niches that enclose wonderful biodiversity, which is mostly expressed in organisms and microorganisms that nourish life, such as Pulgar Vidal (2014) describes quite accurately about the presence of flora and fauna resources. However, the author omits the risks in which the ecological niches are found. Likewise, Rivera (2003), when describing the goodness of the landscape aspect of the Cordillera Raura and Huayhuash, stays in the inventory of flora and fauna. These two authors published their studies even when the Raura Mining Company had not contaminated the area and, as well, the attitude of the high Andean population of Huánuco had a strong identity with the Andean culture of preservation, care and defense of life resources and, in this case, of the ecological niches.

OE2

The second premise is the influence of the ecological niches in the economic activity of the population of Huánuco- Peru Andean zone. As specified in the section on results, the presence of ecological niches has enormous importance in the life of the inhabitants of the area because they constitute sources of life, as already specified by Lorenzo (2016) in his interesting thesis on Integrated Water Resources Management and its Relation to Sustainable Development in the Lauricocha River Sub-basin, who “affirms that Integrated Water Resources Management significantly influences biodiversity conservation in the Lauricocha River sub-basin” (p. 88). Agreeing with the author, the adequate management of any resource will be of vital importance, in this case water resources, because thanks to them, the ecological niche is generated and directly influences the life of the inhabitants of the study area. The proof of them is that in both margins of the rivers *Carhuacocha*, *Murmunya*, *Nupe*, *Colparagra*, *Yuraqyacu* and *Lauricocha*, diverse towns have been constituted, thanks to the benefits of the ecological niches that are established and positioned according to the altitudinal floors and in each space they have configured biodiversity, giving origin to the life of animals, plants, bushes, and a variety of microorganisms, that historically were constituted in sources of consumption of the living beings. The natural resources that serve as sources of life were the main attraction for men to settle in these high Andean places since there was a variety of ecological niches to exploit and care for them and, unfortunately, in recent years, have been contaminated by the men themselves who entered an apparent culture of modernity and to the detriment of the ancestral culture conservationist and protectionist.

OE3

The study has identified the contaminated ecological niches with repercussions on the population of the Andean zone of Huánuco; among them is the Lauricocha sub-basin which is bathed by the river of the same name, contaminated by the effects of the mining tailings of the Raura Mining Company. This contamination extends along the entire route of the sub-basin, from its origins in the Leon Dormido Lagoon; Niño Perdido, passing to the Niñococha Lagoon, Santa Ana, Tinquicocha, the creek of the Luta Grande and Tadis streams that flow into the Lauricocha Lagoon, Tinquicocha, Chuspi, and very close to them, the Jaico lagoons, which flow into Patarcocha, are in the same situation. Likewise, the Pucacocha lagoons flow into Huacacocha, which feeds Tactapata, Luta Grande, Añaspampa, and tributary to Taulicocha, passing through the Pampamachay ravine and flows into the Lauricocha Lagoon and from this water deposit, the Lauricocha River is born. The Nupe sub-basin and the Carhuacocha, Murmunya, Colparagra, and Yuraqyacu micro-basins originate in the Wuayhuash chain the contamination of their ecological niches is moderate. In this context, we share the opinion of Pérez-García & Liria (2013). The presence of the fundamental or potential ecological niche, characterized by the native physical and environmental conditions, where biodiversity coexists in its natural state and allows species to live according to the laws of nature, but these are at serious risk due to pollution processes. In another context, contamination is caused by farmers who use pesticides and insecticides. González Mesa (2002) points out that “third-world countries have been targeted by the large companies that manufacture pesticides because they do not have sufficient regulations or resources to evaluate the impact of their residues on the environment” (p. 83). In the case of Huánuco and Peru, there is no regulation or control about the contamination of the ecological niche habitat. In any case, the presence of sewage dumped by the towns located on the banks of the Lauricocha and Nupe rivers. A second group of ecological niches in these micro-watersheds is what is known as effective or real, as described by Arriols (2022), which is characterized by the subsistence of one species in the presence of others. This group is present in the habitat of the river environments, places and populated centers such as Lauricocha, Anatcolpa, Anatcolpa (2022): Lauricocha, Anatcolpa, Gashanpampa, Yachasmarca, San Miguel de Cauri, Corián, Chinchipampa, Jesús, San José de Ticra, Jivia and Huarín and in the sub-basin of the Nupe the towns of Queropalca, Tupac Amaru, Quisiuarcancha, Leoncio Prado, Concepción, Santa Rosa, Condor Cancha, Paragsha, Villa Mercedes, Baños, Pilcocancha, Rondos and the confluence with the Lauricocha River, which flows into the Marañón River where it joins the Nupe River, giving rise to the Marañón River with contaminated water. In this journey, there are a series of ecological niches such as small forests, a variety of grasslands, pampas, moyas, rivers, lagoons, small lakes, streams, springs, and areas of grass and shrubs known as small terrestrial ecosystems; along the Lauricocha River, there are freshwater aquatic ecosystems, including trout, catfish, frogs, and a variety of batrachians. Also, in the context of this area, there are scrublands, such as shrublands,

xerophytes, and moorlands; grasslands, such as meadows and alpine meadows; and the terrestrial ecosystem without vegetation that is located at the top of the mountain ranges. On ecological niches, Pastor (2006) says that “it is a matter of not eliminating all the microorganisms on Earth, but of coexisting with them peacefully, limiting the activities to the rational care of the sick, the prevention of infections and conservation” (p. 178). The author’s warning is pertinent, but for another culture where environmental awareness has more attention. In Peru, especially in rural Huánuco, the deterioration of the ecological niches is worrisome, given a false culture of modernity, and the little identity with the habitat of the ecological niches, the preservation of the ecosystems and the almost total absence of environmental education in the high Andean communities of the country.

Conclusion

As a result of this study, the following conclusions were reached

Ecological niches play an important role for living beings, which have become the habitat of biodiversity, including flora, fauna and microorganisms found in riverbeds, streams, lagoons, ponds, springs and ponds, which are in the process of contamination with serious risk of continuity in the origins of the Marañón River, specifically in the headwaters of the Nupe and Lauricocha micro-watersheds.

The main ecological niches located in the Nupe sub-basin include the Wuayhuas natural complex, and the micro-basins of Carhuacocha, Murmunya, Colparragra, Yuraqyacu and the entire area between the Wuayhuash mountain range and the source of the Marañón River at the confluence with Lauricocha in the district of Jivia and San Francisco de Huarin. Moreover, the second group is located between the sub-basin of Lauricocha that covers from its origins in the Raura mountain range to the confluence with the Nupe River, whose path encloses beautiful niches that serve as habitat for a set of living beings.

The ecological niches enormously influence the economic activity of the population of the Andean zone of Huánuco - Peru since these are the habitat of flora and fauna and a group of microorganisms, which in turn are sources of life for the practice of livestock, agriculture and to a lesser extent, fishing and hunting, being the main sources of life for the inhabitants of the area.

The behavior of the inhabitants of the area is indifferent to the preservation, conservation and defense of the environment, especially among young people who are linked to the issues of modernity and the lack of identity with their space and culture.

The main responsibility for the contamination of the micro-watershed and the death of the ecological niches in the Lauricocha sub-watershed is the *Raura* Mining Company, which irresponsibly contaminates the entire ecosystem of the *Marañón* headwaters.

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