T.R.
VAN YUZUNCU YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF ENVIRONMENTAL ENGINEERING

TOURISM CARYYING CAPACITY ASSESSMENT AND THE IMPACTS OF NATURE-BASED TOURISM ON WATER QUALITY AND ECOSYSTEM, SHERANA VALLEY AS A CASE STUDY

M.Sc. THESIS

PREPARED BY: Araz Bahjat ABDULLAH
SUPERVISOR: Assoc. Prof. Dr. Zehra Sapci AYAS
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VAN-2021

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ACCEPTANCE and APPROVAL PAGE

This thesis entitled "Tourism Caryying Capacity Assessment and The Impacts of Nature-Based Tourism on Water Quality and Ecosystem, Sherana Valley as a Case Study" presented by Araz Bahjat ABDULLAH under supervision of Assoc. Prof. Dr. Zehra ŞAPCI AYAS in the department of Environmental Engineering has been accepted as an M.Sc./~~Ph.D~~. thesis according to Legislations of Graduate Higher Education on 30/06/2021 with unanimity/ majority of votes members of jury.

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THESIS STATEMENT

All information presented in the thesis obtained in the frame of ethical behavior and academic rules. In addition all kinds of information that does not belong to me have been cited appropriately in the thesis prepared by the thesis writing rules.

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Araz Bahjat ABDULLAH

ABSTRACT

TOURISM CARYYING CAPACITY ASSESSMENT AND THE IMPACTS OF NATURE-BASED TOURISM ON WATER QUALITY AND ECOSYSTEM, SHERANA VALLEY AS A CASE STUDY

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This study was placed in the Northern Iraq Sherana valley, which has a lot of tourist attractions, especially natural and historic ones, and recently a very large number of tourists have been doing their activities in the Northern Iraq. In this study 10 water samples are collected in the deferent time and places, the physicochemical (pH, TDS, EC, T, turbidity, calcium, magnesium, chloride, sodium, nitrate, nitrogen and phosphors) and heavy metals (arsenic, barium, chromium, cadmium, lead, iron, copper, manganese, zinc, strontium, silver, selenium and nickel) parameters of water samples are analyzed to determine the water quality of the study area, the number of tourists in last five year collected to improve local people's and tourists awareness of the value of nature conservation and increase their ecological literacy, as well as the tourism carrying capacity evaluated in order to promote sustainable tourism at the chosen location. The findings of this study indicate that some of water parameters are above water permissible standard prescribed by World Health Organization. The study results also showed that there is an increase on the number of tourists during the summer season while the number of tourist decline in the winter season every year, this increase of visitors number have economic benefits to the local people but such time have negative influence to the natural ecosystem particularly when the number of visitors exceeds to the capacity of the site. Moreover, during four touristic projects the physical carrying capacity (PCC) value, the real carrying capacity (RCC), and the effective carrying capacity (ECC) were determined as ranges from 1170 to 2598 visitors per day, from 563 to 1250 visitors per day and from 349 to 776 visitors per day, respectively.

Keywords: Nature-based tourism, Water quality, Carrying capacity, Environmental aspects, Sherana valley.

ÖZET

TURİZM TAŞIMA KAPASİTE DEĞERLENDİRMESİ VE DOĞA TURİZMİN SU KALİTESİ VE EKOSİSTEM ÜZERİNE ETKİLERİ, SHERANA VADİSİ ÖRNEĞİ

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Bu çalışma, birçok turistik cazibe merkezine sahip olan Kuzey Irak'taki Sherana vadisine gerçekleştirilmiştir. Bu vadide ki su kalitesini belirlemek için 10 farklı örneklem noktasından\ farklı zamanlarda alınan su örnekleri fizikokimyasal (pH, TDS, EC, T, bulanıklık, kalsiyum, magnezyum, klorür, sodyum, nitrat, azot ve fosfor) ve ağır metal (arsenik, Baryum, krom, kadmiyum, kurşun, demir, bakır, manganez, çinko, stronsiyum, gümüş, selenyum ve nikel) parametreleri analiz edilmiştir. Elde edilen bu veriler yerel halkın ve turistlerin doğayı korumadaki farkındalıklarını değerlendirilmek üzere irdelenmiştir. Bununla birlikte, yerel halkın ve turistlerin ekolojik okuryazarlıklarını bilimsel olarak ifade etmek için son beş yıldaki toplam turist sayısı ile yerüstü su kalitesi birlikte değerlendirilmiştir. Ayrıca, vadideki turizmin sürdürülebilir olması için turizm taşıma kapasitesi belirlenmiştir.

Çalışmanın su kalite bulguları göstermiştir ki bazı parametreler her iki sezonda da Dünya Sağlık Örgütü tarafından öngörülen standartların üzerindedir. Turist sayısındaki değişim irdelendiğinde, yaz sezonunda turist sayısında artış olduğu görülmüştür. Bu ziyaretçi artışının, yöre halkına ekonomik fayda sağlarken, vadinin ziyaretçi kapasitesinin üzerine çıktığı belirlenmiş ve tahmin edileceği gibi ekosisteme olumsuz etkisi tespit edilmiştir. Bu yüksek lisans çalışmasında, Sherana vadisinde sürdürülebilir turizmi sağlamayabilmek için gerekli fiziksel taşıma kapasitesi (PCC), gerçek taşıma kapasitesi (RCC) ve efektif taşıma kapasitesi (ECC) değerleri sırasıyla günlük olarak 1170-2598 ziyaretçi, 563-1250, 349-776 ziyaretçi olarak hesaplanmıştır.

Anahtar kelimeler: Doğa turizmi, Taşıma kapasitesi, Su kalitesi, Çevresel yönler, Sherana vadisi.

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2021

Araz Bahjat ABDULLAH

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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this study are presented below, along with descriptions.

Symbols	Description
S	Water Samples Label
NTU	Nephelometric Turbidity Unit
°C	Temperature Measurement Unit
µS/cm	Electrical conductivity Unit
Mg/L	Water Parameters Unit
TDS	Total dissolved solids
EC	Electrical conductivity
TU	Turbidity
Ca	Calsium
Mg	Magnesium
Cl	Chloride
Na	Sodium
NH	Nitrate
N	Nitrogen
P	Phosphorus
Mn	Manganese
Cu	Copper
Pb	Lead
As	Arsenic
Ba	Barium
Cd	Cadmium
Fe	Iron
Zn	Zinc
Cr	Chromium

Symbols	**Description**
Ag	Silver
Ni	Nickel
Se	Selenium
Sr	Strontium

Abbreviations	**Description**
TR	Turkish Republic
WHO	World Health Organization
FAO	Food and Agriculture Organization
WTO	World Tourism Organization
NBT	Nature-Based Tourism
UN	United Nations
PA	Protected Area
EPA	Environmental Protection Agency
TIES	The International Ecotourism Society
MOE	Ministry of Environment Iraq
CC	Carrying Capacity
TCC	Tourism Carrying Capacity
PCC	Physical Carrying Capacity
RCC	Real Carrying Capacity
ECC	Effective Carrying Capacity
RF	Rotation Factor
CF	Correction Factor
MC	Management Capacity of Staff
NTFP	Non-Timber Forest Products
APHA	American Public Health Association

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1. INTRODUCTION

Tourism has a long tradition dating back thousands of years. Since then, travel and tourism have grown, and it is now the world's biggest industry sector, employing over 230 million people worldwide (TIES, 2006). The large tourism industry is very diverse, with many different types of activities and tourists, and it includes players of all sizes, from multinational chains to independent, family-run companies. Natural resource depletion, pollution, and physical impacts are the three main areas of the impact caused by the tourism industry, according to the United Nations Environment Program (UNEP, 2010 and 2011).

Tourism, on the other hand, will provide a significant economic boost to a developed world. According to the International Ecotourism Society (TIES), tourism is now one of the primary sources of foreign exchange for 83 percent of the world's developed nations and one-third of the world's poorest countries (TIES, 2006). Nature-based tourism (NBT), or recreational travel to natural zones, has grown dramatically during the final two decades (Balmford et al., 2009) and is projected to continue to expand, from an assessed 7% of worldwide tourism in 2007 to as much as 25% by 2020 (Honey, 2008). Ecotourism is generally presented as a win-win situation. Visitors have a wonderful time, tour operators make a good profit, environmental conservation monies are collected, and local populations' lives are strengthened. (Higham, 2007; Honey, 2008; Stronza & Durham, 2008). Tourists who enjoy nature will be more willing to become more interested in implementing pro-environmental practices if they have a positive experience (Ballantyne and Packer, 2011). Nature-based tours have been an effective tool for changing certain tourists' environmental behavior (Ballantyne and Packer, 2011; Powell, Brownlee, Kellert, and Ham, 2012; Abdullah et al., 2019). Through positive, firsthand experiences of nature, natural history, and conservation marketing, they can improve their environmental awareness, behaviors, and behavioral intentions (Ballantyne et al., 2011; Powell and Ham, 2008). Such activities, in which people are excited to learn new things and try new things, can help to prime long-term learning (Falk et al., 2012).

Water is a necessary component of life. It is perhaps the most important part of all living things. Rivers, lakes, ponds, oceans, glaciers, and ice caps occupy about 71 percent of the earth's surface. Because untreated wastewater from factories, households, urban plants, breeding farms, and other sources ends up in marine ecosystems, causing habitat degradation and eutrophication (Mutlu et al., 2018; Kumar et al., 2018; Belhouchet et al., 2019) (Wu and Yang, 2015; Fang et al., 2019). Watershed management and land-use policies affect the lands around wetland water bodies, determining the wetlands' quality (Chenchouni, 2007; Aliat et al., 2016). Around the globe, groundwater reservoirs have been used for commercial and domestic water production and irrigation (Mohammed et al., 2019).

Many types of tourism, such as winter tourism, agritourism, and wildlife tourism, indirectly depend on water (Gössling et al., 2010). The growth of new modes of tourism, such as shoreline tourism, along with a declin intrigued in homeopathic health medications as a result of the spread of modern medicine and solutions, has resulted in a steady decline in interest in hot springs, which have lost their medicinal appeal and have become less popular leisure and entertainment alternatives (Arcos et al. 2000). As a result, thermal tourism can withstand less seasonal restrictions and more extended average stays than other types of water tourism (Cerasela, 2015; Bakucz et al., 2013).

Even though thermal water events are acknowledged as the earliest and best example of water tourism's double reason and benefits, it must be pointed out that, from a commercial standpoint, this type of tourism has steadily declined due to a lack of interest among younger customers, who seek to preserve natural beauty rather than heal (Fernández et al., 2018). Tourism's effects on water quality are still little understood, and there is scarcely a distinction made between domestic and tourism water use. Beyond the issues associated with freshwater use, tourism's environmental effects on the hydrosphere have several aspects. The most severe issues are water contamination and the destruction of marine and coastal habitats.

Within visitor attractions, the generation of visitor destination zones is frequently not adjusted to appropriate preparation. to increase demand and satisfaction and boost tourist visits; tourism growth typically prioritizes tourist attractions and services. From the biophysical perspective, attempts to protect and maintain tourist attractions are often neglected by the management. In ecotourism, the carrying capacity issue is very relevant because it is closely linked to environmental harm (Fandeli et al., 2009). Despite its major limitations, the notion of carrying capacity remains "a valuable concept for environment protection, particularly in offering insights into the interplay between human activities and the environment" (Papageorgiou et al., 1999).

The key goal of the CC studies is to align the protection of the ecosystem used for operations with sustainable development administration . To put it another way, they can be seen as a competitive feature for keeping a site's appeal (Dias e Cordeiro et al., 2013). WTO introduced a concept of tourist CC in 1981, stating that it is "the maximum number of people who may visit a tourist destination at the same time without disrupting the physical, economic, socio-cultural ecosystem or causing an unreasonable decrease in visitor satisfaction." (UNEP/MAP/PAP, 1997). Consequently, to safeguard the destination physically, economically, culturally, and environmentally, the idea of carrying capacity covering all these dimensions is also used to establish sustainable tourism (Rodella et al., 2017; Syed Rashidul et al., 2014; Zacarias et al., 2011). Furthermore, capacity-carrying tourism studies are used to prepare and implement policies and measures for the security, prevention, and adaptation of tourism in a protected natural environment (Segrado Pavón et al., 2015).

According to Maciel et al. (2008), four different components are used in the majority of the methods for determining tourist carrying ability in natural environments:

a) Biophysical elements: connectedto natural resources.

b) Socio-cultural elements: considering the impact of tourism on the local people

c) Psychological elements of the visitor: apply to the maximum number of tourists that a location is in a position to support, over time, encouraging practical recreational experiences.

d) Elements of management and administration: refer to the number of visits that can be managed in a specific place and refer to the presence of human resource infrastructure and management services in the area concerned.

Management of tourist destination areas is carried out in an organized manner and prioritizes the modification of transport capability facilities. This idea affects the limitation of guest space and escalated and essential points to preserve supportability. The maintainable tourism model is at the heart of environmental, financial, and social components in which each calculates contributes emphatically to another element (Tsaur et al. 2006).

The North of Iraq is well known for its remarkable landscape diversity, cultural richness, and historical tourist attractions (Youssef et al., 2019). This diversity richness promotes an interesting and lucrative opportunity for investing in tourism/ecotourism activities (Tourist guide, 2005; IOI, 2014). Despite the benefits of nature-based tourism, these new and alternative activities in the North of Iraq are poorly known by the local people and poorly applied. This ecotourism concept has recently been challenged by local/rural people demonstrating the misunderstanding of the ecotourism opportunities to improve rural people's livelihoods. In fact, in many regions, nature-based tourism figures as an economical alternative to local families (Castro, 2013). In addition, the natural base has many benefits, such as increasing agriculture production. Before ecotourism becoming popular in North Iraq, the best strategies for the management of ecotourism should be determined based on the concept of a sustainable ecosystem.

There are numerous tourism sites in the north of Iraq, mainly historical and natural sites. In recent years, many tourists have visited these locations, particularly tourists from the central and southern parts of Iraq, who are drawn to the north of Iraq by the exhaustingly hot summer climate in the south of Iraq during the summer months. The North of Iraq enhances the tourists through their beautiful nature, rivers, diversity richness, historic places, and pleasant weather during summertime. However, these tourists' activities may negatively influence the environment.

Therefore the main objectives of this study are as following:

1) Determining the water quality, vegetation cover, and wildlife diversity of the study area.

2) Identifying the impacts of touristic activities on natural parameters (water quality, vegetation cover, and wildlife diversity).

3) Minimizing the impacts of tourists on water quality.

4) Improving the economics of local communities by nature-based tourism activities.

5) Assessing the tourism carrying capacity of Sherana valley.

6) Demonstrate the statistics of nature-based tourism activities and the number of tourists in the final five years.

7) Increase the environmental awareness among tourists.

2. LITERATURE REVIEW

2.1. Basic History of Tourism:

Exploring new lands and traveling are known to be among the most essential aspects of human experience. From the beginning of time, people have traveled to fulfill their diverse needs. The word "tourism" was coined in the nineteenth century, but it has a long history. The word is derived from the Hebrew word Torah, which means "to study," "to learn," and "to seek." Travel and tourism are now considered one of the most diverse global markets, stimulating international trade and commerce. The demand for travel and tourism is growing at a higher rate than the global population. 972 million international travelers invested a total of US $230 billion in 2011. As a result, tourism has emerged as the world's fastest-growing sector.

There are two types of tourism: mass tourism and alternative tourism. Natural, cultural, activity, and other types of alternative tourism exist. Adventure, indigenous, wildlife, and ecotourism are also the four categories of natural attractions.

2.2. Ecotourism

Ecotourism has a long tradition dating back to the 1950s, when it was not commonly recognized or understood as a form of attraction. A few countries on the African continent have been in the spotlight for forest safaris and wildlife viewing. With the legalization of hunting in Africa in the 1950s, tourism was encouraged in parks and sanctuaries under ecological tourism (Miller 2007).

When it comes to ecotourism, Ceballos-Lascuraine presented a well-researched definition of the concept. When looking for natural areas with little human influence or pollution, travel to relatively uninhabited or free of pollution areas with the goal of researching, appreciating, and enjoying the landscape and its wild plants and animals, as well as any present or previous human-created objects (such as structures, monuments, and artifacts) that can be found in those areas, according to the description. (Lascurian Ceballos, 1987).

Simultaneously, Laarman and Durst (1987) defined “hard” and “soft” aspects of ecotourism, taking into account the existence and motives of eco-tourists. Wallace and Pierce (1996) concluded that real ecotourism could be promoted where negative impacts are minimized and positive effects are maximized. Ecotourism allows residents to participate in the decision-making process early and on a long-term basis. He also recommended raising knowledge and appreciation of the environmental and cultural system's values and their commitment to protecting and managing protected and other natural areas to provide more direct economic and other benefits to residents.

According to Tickell (1994), it is a journey to admire the world's incredible richness of natural life and human society while bringing no harm to either. Wheat (1994) emphasized that ecotourism is a niche market for environmentally conscious visitors who want to see nature.

Buckley (1994) established an ecotourism concept focused on four key dimensions: nature-based ecotourism, conservation-oriented ecotourism, sustainably controlled ecotourism, and environmentally educating ecotourism. Orams (1995) refers to visitors taking an active role in demonstrating constructive or responsible behavior that respects the atmosphere and contributes to local society.

Ecotourism is described by the World Conservation Union (1980) as "responsible travel to natural areas that conserves the environment and supports the well-being of local people. The world trade organization (WTO, 1995). It's worth noting that there's only one mention of protected areas, where ecotourism has been described as an excellent way to strengthen relations between local communities and park managers.

Ecotourism nowadays is a booming business, as declared by Andrew Holden (2000) in his book "Environment and Tourism." Products that have achieved an eco-label have more consumer demand, as seen by higher retail values. When it comes to ecotourism, it is also true that sponsors and well-intentioned groups give support, creating a very successful consultancy market.

Ecotourism expansion in North India has reached a crucial tipping point, according to Bhartari (2008). At the same time, cooperative ventures that involve the country's states located in the Himalayas, as well as the countries that surround Bhutan, have tremendous potential for sharing information and increasing operations.

When David and Fennell (2000) stressed the need of developing quality tourism, for example, eco-friendly tourism, there is an opportunity to maximize profits while protecting the physical and social qualities of the destination.

In the book "Tourism Management- A Global Perspective," Batra and Chawla (1994) claim that ecotourism is viewed as a means of creating economic advantage from tourism while having little damage to the environment and society, and a high benefit to the inhabitants of the area.

According to Santhosh Yadav, ecotourism is vital for long-term survival and biodiversity (2010). Despite its obviousness, ecotourism has been more of a wish than a reality in most protected areas, and the links between ecotourism expansion and conservation are little understood. Despite the emphasis on infrastructural development, ecotourism growth has met with limited success, according to the author.

Kerimbergenovich et al. (2020) is started. Here is a large body of literature on strengthening the aknalytical basis for the growth of ecotourism, the fair utilization of natural resources, and the development and improvement of ecotourism regulatory frameworks. The effect of tourism on the climate, keeping a balance between nature and tourism, and creating a model for the growth of ecotourism has all been studied. According to Alimov (2018), various critical activities must be completed, including assessing the role of sustainable tourism on the national economy and the economic effect of ecotourism.

Kerimbergenovich et al. (2020) reported that ecotourism protects the climate, society, culture, and economies of tourist destinations and local communities and is the best long-term option for preserving and promoting regional ecological and cultural diversity.

Furthermore, Edwards, Mclaughlin, and Ham (2003) filtered three critical features of ecotourism concepts in studying ecotourism policies and planning documents in North America. Both are (1) ecotourism as a tool to promote environmental health and education, and (2) ecotourism as a tool to boost the wellbeing of communities, and (3) ecotourism as a medium for raising environmental consciousness among visitors and locals the total of the reviews as mentioned above aids in the construction of a comprehensive ecotourism concept.

2.3. Nature-Based Tourism

According to Yuxi et al. (2020), designing spatial regulation strategies is essential for nature-based tourism. This practice may be more realistic and scientific if the spatial distribution of conflicts between tourism production and ecological conservation is understood. Based on a combination of landscape beauty and ecological sensitivity, we established an Indicator of Conflict Propensity between Nature-Based Tourism Production and Ecological Protection (ICTP) in this research.

Reports of exponential growth in nature-based tourism and recreation add considerable weight to the economic argument for biodiversity conservation. Still, they seem to refute commonly expressed fears that humans are increasingly disconnected from nature, according to Balmford et al. (2009).

Because of the dynamic interaction in environmental consequences caused by tourism, understanding the coupling relationship between tourism and the climate is critical. This paper introduces an indexing scheme and establishes an integrated method for evaluating tourism-environment pairing coordination (Tang, 2015).

According to Corbau et al. (2019), tourism has multiple environmental consequences, which are announced to preserve biological and environmental assets. The long run goal of Protected Areas might be difficult to achieve because the protection of a site does not conflict with user access rights or the nature of visitor encounters. As a result, options can be sought to balance sustainability and leisure uses that are sustainable, given the area's natural wealth. We suggest an approach in this report to assist park managers in developing appealing, sustainable tourism.

The study of (Wolf et al., 2019) started the regions set aside around the world for their outstanding environmental qualities, such as high biodiversity. Visitation by nature-based visitors is also a source of financial, political, and community support for these protected areas.

Liddle (1997) reported that a detailed and systematic analysis of the ecological effects of outdoor recreation and ecotourism on terrestrial, coastal, and marine ecosystems is addressed. The processes that cause environmental impacts are identified, and management strategies for reducing the effects on habitats.

While NBT tourism is frequently promoted as benefitting local communities by providing revenue, employment, and direct conservation support, it is also considered to impact visitors' environmentally conscious attitudes, skills, and behaviors, according to Ardoin et al. (2015).

Fredman & Haukeland (2016), reported that many land-use changes may have a detrimental influence on the landscape as a venue for nature-based tourism, recent environmental laws in Scandinavia have stressed the need of integrating outdoor leisure and nature-based tourism with environmental conservation.

According to Hawkins and Khan (1998) and Mehmetoglu (2007), nature-based tourism mostly attracts rich visitors from industrialized nations. These visitors are from a wealthy family. As a result, they have more money and free time to spend on outdoor activities.

In addition to the demand for nature-based tourism products, many destinations and regions continue producing and selling eco-friendly and nature-related products (Verdugo et al., 2016; McKercher, 2010; Walter, 2013; Weaver and Lawton, 2007).

2.4. Water-Based Tourism

Water is essential for daily activities such as drinking, washing, and cooking, but it is also necessary to grow the food we rely on for survival and economic growth (Chenoweth, 2008). However, several nations are in the middle of a global water crisis, with almost 1.2 billion people currently without secure access to water and more than 2.6 billion lack proper sanitation. This poses a significant challenge to implementing growth and poverty reduction targets (Jacobson and Tropp, 2010). On a global scale, it seems that there is ample water to meet human needs at the moment, as withdrawals account for less than 10% of the total natural freshwater supplies (Oki and Kanae, 2006).

Around the globe, groundwater reservoirs have been used for commercial and domestic water production and irrigation. Agricultural flow out, industrial and residential pollution, geological composition, land use activities, rate of infiltration, and rainfall patterns are all factors that influence the consistency of groundwater (Federation and American Public Health Association, 2005; Mohammed et al., 2020)

Climate change is expected to jeopardize the quantity and quality of water sources by stretching existing climate fluctuations and intensifying extremes such as droughts and floods (World Water Assessment Program, 2009). This suggests that non-climatic factors such as population increase, economic expansion, technical advancements, and behavioral improvements are expected to have a significant effect on water withdrawals and management (Sophocleous, 2004; UN-Water, 2010), perhaps much more so than climatic changes (Vorosmarty et al., 2000).

Domestic, industrial, and agricultural uses of fresh water are the three primary industries of the economy. Agriculture is the largest water user globally, accounting for 70% of all intakes, followed by agriculture at 19% and household consumption at 11%. (FAO, 2011). Since much of this simulated water was evaporated during development, it isn't even present in the final version. This definition has been used to develop the concept of a "water footprint" (Hoekstra, 2003), which, like the concept of a "carbon footprint," has been used to quantify water consumption on a global (Chapagain and Hoekstra, 2004; Hoekstra and Chapagain, 2007) or corporate (Ercin et al., 2011) scale and to propose future water savings. The water footprint hypothesis has emphasized that the agricultural stages of development account for the vast majority of global water consumption, implying that consumers and retailers would need to get more active in the farming stages of production (Ridoutt et al., 2009).

In specific prominent tourist destinations, the tourism industry is a big water user, placing more strain on water supply in areas where water shortage already exists. Official water use figures, on the other hand, do not necessarily reflect this. The water footprint idea is a great way to think of the amount and kind of water used in the tourism industry (Hadjikakou et al., 2013).

The lack of analysis on the subject may be attributed to a lack of evidence, which makes it difficult for academics and policymakers to make accurate estimates of water intake from tourism (Gössling, 2002). Another explanation for this may be because tourism's cumulative effect on a global scale continues to be marginal, with tourism accounting for just 0.04 percent of total water withdrawals (Gössling, 2005). Moreover, even in countries where tourism consumes a large amount of water, the use of water by the tourism industry can be intermittent, masking the real burden placed on the local water supply by the tourist sector. During peak tourism seasons, conflicts over water supplies are frequent, particularly in drought years when residents and farmers have limited access to water while tourist establishments' supply remains unaffected (Holden, 2000).

Due to its close ties to other sectors of the economy, tourism growth is frequently correlated with a water demand multiplier impact (Emmanuel and Spence, 2009). One of them is an agricultural effect on ecotourism. Tourists consume local agriculture products in addition to the water used in hotel facilities and sports such as swimming pools and golf courses, as discussed in the previous section. Food accounts for about one-third of all visitors spending (Torres, 2003; Gössling et al., 2010), implying that summer population growth in some resorts greatly raises demand for food, which is either grown domestically or must be imported.

Over the period 1995-2020, tourism arrivals are forecast to rise at a 3 percent annual pace worldwide (Becken and Hay, 2007). Over 70% of foreign arrivals currently originate in Europe and North America (UNWTO, 2010). Still, an uptick in travelers from developing economies such as China and India is expected to put additional strain on established common destinations while also possibly opening up new ones.

According to Santarém (2018), the growth of ecotourism operations in places with plentiful water sources necessitates further study so that tourism sector requirements might be reconciled with environmental priorities while eliminating uses that can harm these delicate socio-ecological structures.

Two viewpoints on water describe the link between water and tourism: as a valued resource and as a tourist attraction. Water is a valuable and rare resource, and researchers have conducted studies to define practical and commercial strategies for establishing water-based tourism without affecting the quality and availability of water sources. In this way, the link between water and tourism is focused on long-term sustainability (Gössling et al., 2015;Lavanchy et al., 2017)

On the other hand, water represents a resource with a high potential for attracting visitors as a tourist attraction. Beach tourism, river tourism, reservoir, bath, natural pool tourism, and hot water tourism are examples of different modes of tourism that can be sustained by different types of bodies of water (Fernández et al., 2018).

As a result, compared to other types of water tourism, thermal tourism can withstand less seasonal restrictions and more extended average stays (Cerasela et al., 2015; Bakucz et al., 2013). As a result, compared to other types of water tourism, thermal tourism can withstand less seasonal restrictions and more extended average stays (Gössling et al., 2015). As a result, water-based tourism projects are being proposed in response to current market demand. Furthermore, new groups of visitors are becoming interested in these activities, such as groups of friends, families with children, and young people (McKay et al., 2012; Hunt et al., 2008; Kruger et al., 2017).

2.5. Wildlife Tourism

Interaction with wildlife is becoming increasingly common around the world, according to Reynolds and Braithwaite (2001). According to a survey published by the International Ecotourism Society in 1998, between 40 percent and 60 percent of visitors worldwide are nature tourists. Of these, between 20 percent and 40 percent were visitors interested in nature. Wildlife tourism hotspots include the United States, New Zealand, Australia, China, Kenya, Tanzania, Zimbabwe, and South Africa. As a result, there is a need for sustainable nature tourism in various locations that primarily benefit the local population while also providing a planned management system for wildlife and forests.

Stakeholder preparation can arise during the planning period, and local communities, on the other hand, should be active and recognized as core groups, according to Newsome et al. (2002). As a result, adequately operated wildlife tourism has a large market to reach, but systematic coordination and participation of stakeholders and the local community are critical.

According to Higginbottom et al. (2001), wildlife tourism may have various beneficial impacts on wildlife populations and their environments, but there has been relatively little rigorous study on these effects.

Wildlife tourism is a form of special interest tourism where visitors go to a specific destination to get a wildlife experience. Governments should usually allow tourists to study and admire nature watching or any other non-consumptive practices that can offer economic benefits and profits to protect natural environments and wildlife conservation in areas where the population of wildlife is comparatively higher (Higginbottom et al., 2001).

According to Conway (1995), wildlife tourism is focused on experiences with non-domesticated animals in their natural habitat or captivity. It encompasses all non-consumptive activities such as watching, filming, feeding, and wasteful hunting and recreational angling activities.

According to Yuan et al. (2004), wildlife tourism is depicted as intelligent with non-domesticated creatures in their characteristic territories or imprisonment. Nature-based tourism, uncommon intrigued tourism, and ecotourism are the three fundamental components of natural life tourism. Most concepts of natural life tourism incorporate expanded levels of intrigued in a specific category of natural life, specialization of natural life tourism, appreciation of natural life concerns, natural understanding, and recognizable proof of synergies between natural life tourism and preservation.

Duffus and Dearden (2003) linked the growth and development of a recreational relationship with wildlife to several concerns, including the societal revaluation of biodiversity, the developments in nature and wildlife-related tourism, and evolving attitudes toward specific species as a result of increased interest in wildlife education.

One of the most compelling reasons for continuing to build wildlife tourism attractions is to contribute to a long-term management approach that allows wildlife and biodiversity to thrive in their environments without running out of food (Higginbottom, 2004; Newsome et al., 2004; Reynolds and Braithwaite, 2001; Wilson and Tisdell, 2001).

This viewpoint's substance has a special significance. There has been a steady rise in visitors visiting natural areas and growing demand for wildlife tourism experiences (Balmford et al., 2009; Curtin and Kragh, 2014; Holden, 2016; Steven et al., 2020).

At this time, and in nearly every country worldwide, thousands of local guides provide visitor facilities and various lodges and hotels that cater to wildlife tourism (2020, Newsome).

Newsome (2020) reported that the worldwide nature and natural life tourism industry places critical and vital dependence on the common environment's respect, the require for simple get to to secured ranges, and the significance of ensuring natural life living spaces.

There has been recent debate regarding the deterioration of tourist sites and conservation areas due to increased congestion and excessive usage (Newsome and

Hughes, 2018), over-tourism (Ruck, 2012; Tourism-Review, 2016; Capocchi et al., 2019), and the cumulative impacts of unregulated tourism access and construction (Ruck, 2012; Tourism-Review, 2016; Capocchi et al., 2019; (Newsome et al., 2013; Schulze et al., 2018).

2.6. Tourism Carrying Capacity

Despite its origins in the 1970s and 1980s, the idea of tourism carrying capacity has gotten a lot of traction in recent years as part of a successful plan for addressing environmental, fiscal, and social (Rios Jara et al., 2013; Coccossis et al., 2004).

Many efforts have been made to define carrying capacity (CC). Tourism CC, it was said, is a form of environmental CC that refers to the environment's biophysical and social ability concerning touristic action and growth (Cifuentes, 1992). CC is described as "a measure of the resilience with which a site or building is open to tourist activity and the limit above which an area can suffer from the negative impacts of tourism (Middleton and Hawkins, 1998)". Tourism CC can also be defined as "the maximum number of people who can visit a tourist attraction without having an unreasonable impact on the environment while satisfying demand"(Hens L, 1998).

“The amount of human activity an area can tolerate without the area degrading, the resident population being adversely affected, or the quality of the tourist experience declining,” according to Chamberlin (1997). CC is a "certain threshold amount of tourist activity above which environmental degradation, including natural ecosystems, can occur. Clark (1995)".” He also claims that the “actual CC maximum in terms of tourist numbers or some other quota or metric is normally a judgment call depending on the amount of adjustment that can be tolerated, in terms of resource sustainability, resource customer satisfaction, and socio-economic impact” (Clark, 1995). “The highest level of tourist usage that a region can sustain, that is, the limit of human activity: if this level is surpassed, the resource will deteriorate,” says the tourism CC (Lascurain H, 1996).

The term "tourism's CC" applies to the idea of "environmental support," which is used to describe the advancement of natural resource conservation programs and the creation of a sustainable environment (Renjaan et al., 2020). Its goal is to keep natural resources from degrading to survive, work, and be sustainable. Around the same time, the user or society continues to be prosperous or unaffected (Irna, 2015).

As a plan for sustainable land use, the Protected Area (PA) will benefit from sustainable tourism, which seeks to conserve the landscape, offers leisure services for tourists, and encourage environmental education (Becken and Job, 2014; Glyptis, 1991), with an uptick in visitors affecting system resilience or tourist satisfaction (Becken and Job, 2014; Glyptis, 1991). The outcome is measured by an acceptable degree or percentage of tourism (Pavón et al., 2015) rather than an actual number of tourists (Cifuentes et al., 1999).

In general, two dimensions of recreational usage are central to the meanings of carrying capacity: resource safety and leisure experience efficiency. In its broadest sense, CC refers to the volume and type of usage that can be accommodated in parks and associated areas without causing unacceptable impacts on park facilities or visitor experience quality (Manning, 2001; Sayan and Atik, 2011).

In the words of the World Tourism Organization (WTO), tourism CC is defined as the greatest number of individuals who can visit a visitor goal at the same time without crushing the physical, financial, and socio-cultural environment or bringing down the standard of visitors' fulfillment to an unsatisfactory level. It is essential that tourism operations in protected areas are strategically managed and monitored on a daily basis in order to ensure that they are sustainable in the long run. In any other case, such acts will have negative consequences, and tourism would exacerbate the already dire situation in these locations. Many protected areas have promoted tourism as a means of improving the social, economic, and livelihood prospects available to local populations (Lascurain H, 1996; Salerno F. et al., 2013).

3. MATERIALS AND METHODS

3.1. Study Area

This research was carried out in the Sherana Valley, Duhok Province, in the year 2020. The province of Duhok is situated northwest of Iraq (N 36o 52” 03’, E 42 o 59” 34’). Duhok is the only city surrounded by three mountains, from a geographical perspective it is indirectly the bridge between Iraq and the West. The main towns are Duhok, Zaxo, Akre, Kani Massê, Faidê, Sêmêl, Amadya, Manguish, Zawitta and Shixan. Duhok city is the capital of Duhok governorate and it covers about 10715 km² of area. Furthermore, Duhok city's population is made up of around 1050000 inhabitants in 2020. Moreover, the city is an economic and commercial value to the region e.g. agricultural, petrol, and tourism activities. Dohuk has a long and illustrious history stretching back to Mesopotamia. More than 40 archaeological ruins dating back to 700 B.C. have only recently been uncovered (Tourist guide, 2005). In Duhok, there are many historical and tourist attractions to see. There are still numerous places in Duhok that are yet to be discovered and show signs of ancient civilizations. The most well-known examples of these ancient artefacts can be found in Khanis, a small village. The various artefacts are thought to be about 2700 years old. The town of Amadya is one of Duhok's most interesting sights. It is located 1400 meters above sea level on top of a hill. According to historians, during the 14th century, Amadya was a town populated by Jews, Arabs, and Christians (Tourist guide, 2005).

The Sherana valley is located about 92 kilometres northeast of Duhok. This valley is located within two villages, Harike and Sherana, in the Amadya district's Deraluk town Figure 3.2 and 3.3. This valley, after becoming a popular tourist destination in the past 10 years, was designated as a protected area, and locals reported seeing carnivores or predator animals (meat-eating animals) such as brown bears and wolves. After the stakeholders of this location developed the road and touristic facilities, it is now one of the most popular summer tourist destinations in the Duhok province of northern Iraq, and it was recognized as a tourist site by the government the last five years. The climate is mostly continental and Mediterranean with mild, wet winters and warm dry summers. The precipitation mainly falls in late autumn to late spring i.e. from December to March (Youssef et al., 2018 and 2019). The precipitation ratio is available in Figure 3.1. During the summer season from June to September, the average daily maximum temperature is 36°C, and the average daily minimum temperature is 18°C (Meteorology Directorate Duhok, 2020), row data of pricipitation ration in (appendix 1), which is one of the reasons that draw tourists to semi-arid areas since 90% of visitors come from the south of Iraq, where the climate is extremely hot in the summer. This valley has one of the most beautiful rivers with a length of 5.675 km, but only 4.25 km used for tourism purpose and four touristic projects (Sherana, Avasheen, Navdar, and Chinar) which are situated alongside the river as shown in Figure 3.2. The number of tourists has increased by 35% since 2018, according to statistics from the Duhok Tourism Directorate. In the summer, about 5000 people visit these resorts on a typical day, but that number rises to 11000 on weekends and holidays. This valley is renowned for its breathtaking natural beauty, including mountains, landscapes, and a magnificent river. With its blue water and stunning views, Sherana Valley has been dubbed "the paradise of northern Iraq" on social media Figure 3.4. The water is very cold (due to the temperature of about 18.5°C in the summer season) andhas a crystal blue color. In the valley, people engage in a variety of tourism activities such as swimming, hiking, picnic, etc.

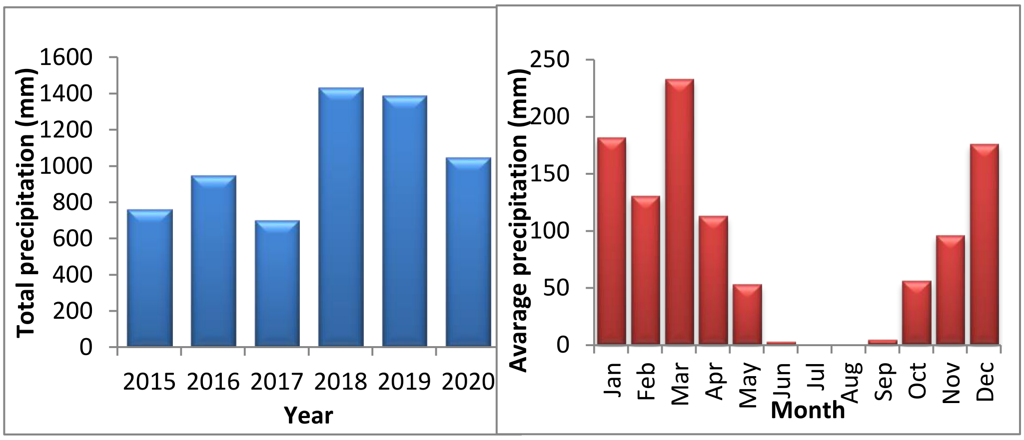

Figure 3.1. Total yearly precipitation and average monthly precipitation ratio of the study area from 2015 to 2020.

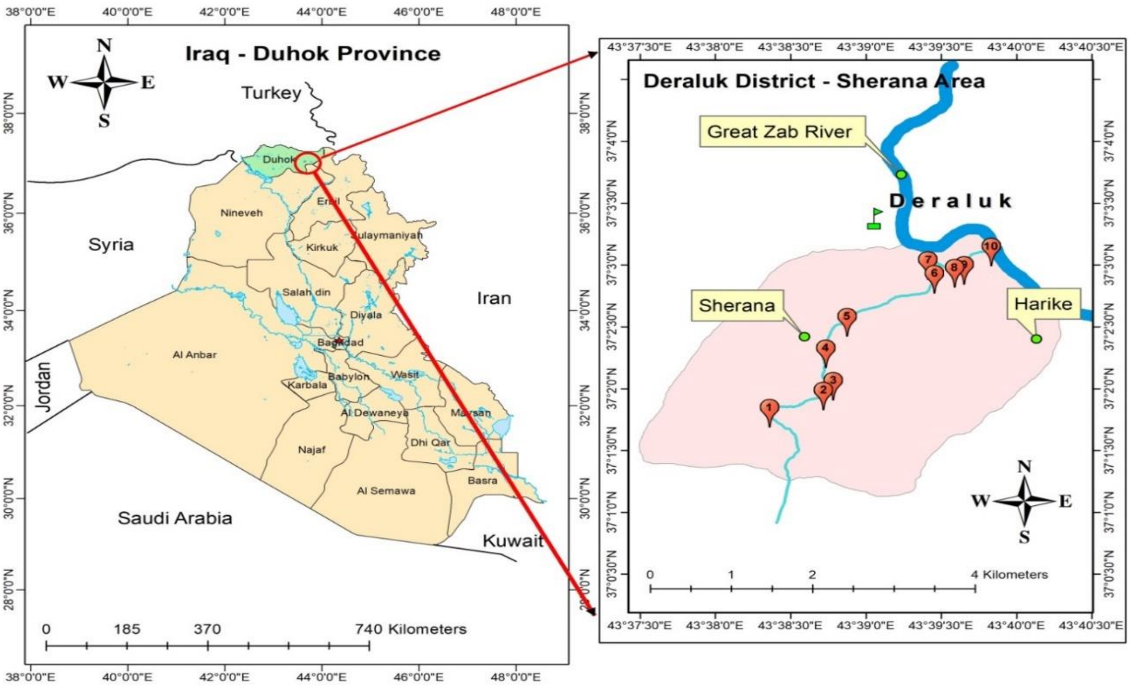

Figure 3.2. Study area (Deraluk district – Sherana valley), map with the locations of water samples and resort names (point 1 control of the river, point 2, 3 Sherana resort, point 4, 5 Avasheen resort, point 6, 7 Navdar resort, point 8, 9 Chinar resort and last point outlet of the river.

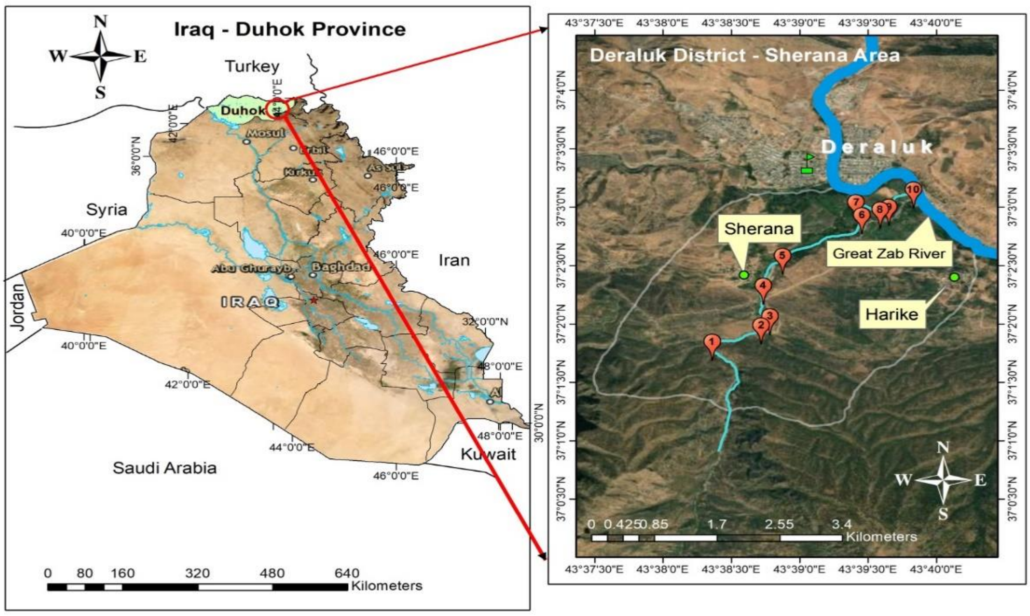

Figure 3.3. Study area on satellite.

Figure 3.4. Study area pictures

3.2. Water Quality Assessment

In this part, 10 water samples have been collected from different locations of the river two times, the first time on 9 June 2020 this consider a non-touristic period because of the Cov-19 pandemic and announcement of curfew the visitors cannot visit this place, and the second time 13 Sep 2020 this time consider the tourism season but also did not show a huge number of visitor. The first sample of the control area of the river (N 37.029991, E 43.639351) with (706 m) altitude are labeled a;s S1, two samples in Sherana resort are labeled as S2-S3, two samples in Avasheen resort are labeled as S4-S5, two samples in Navdar resort are labeled S6-S7, two samples in Chinar resort are labeled as S8-S9, and the last sample in the outlet of the river (N37.051740, E43.663906) with (604m) altitude is labeled as S10 as shown in (figure 3.2 and Table 3.1). All samples are taken at least 25 cm under the water's surface by a (1-litre) glass bottle and stored in a cold fridge of temperature around 4°C and transported to the laboratory on the same day Figure 3.5. Physicochemical and heavy metals parameters of these water samples were analyzed to calculate the water quality of the Sherana river and evaluate the impact of touristic activities on water quality. The parameters include (pH, TDS, EC, T, turbidity, calcium, magnesium, chloride, sodium, nitrate, nitrogen, phosphors, arsenic, barium, chromium, cadmium, lead, iron, copper, manganese, zinc, strontium, silver, selenium and nickel). Physicochemical parameters (pH, TDS, EC, and temperature) have been measured in a field by a portable multi-meter (Trans ISO 9002) instrument. Significant ions and heavy metals parameters were measured in the laboratory by (ICP_OES) instrument.

Table 3.1 Altitude, Latitude, and locations of all samples.

Sample points	**Latitude**		**Altitude (m)**	**Sample area**
	N	E		
S1	37.029991	43.639351	706	Control of river
S2	37.032337	43.645295	674	
S3	37.033627	43.646391	669	Sherana resort
S4	37.038001	43.645572	647	
S5	37.042237	43.64792	640	Avasheen resort
S6	37.048041	43.657614	637	
S7	37.049896	43.65687	621	Navdar resort
kS8	37.048856	43.659852	613	
S9	37.049266	43.660887	610	Chinar resort
S10	37.05174	43.663906	604	outlet of river

Figure 3.5. Pictures of water samples collections in the study area.

3.3. Number of Visitors

The aim of collecting this information is to increase both tourist and local people's ecological awareness and to increase their understanding of the value of nature conservation. The first step toward achieving this goal is to present information on ecotourism activities and visitor numbers. The number of tourists who visited the Sherana valley in the last five years, from 2016 to 2020, was collected from the statistical department of the general directorate of tourism, Duhok governorate. In this phase, the structured interview technique was used to collect data from the general directorate of the tourism, statistic department in the Duhok governorate. The data collection process necessitated planning and preparation ahead of time. Row data of number of visitors in (appendix 2).

3.4. Data Analysis of Tourism Carrying Capacity

The capacity of a tourist destination is crucial in assessing the effect of tourism on the environment and natural areas. Many research studies on evaluating CC are available (Cifuentes, 1992; Cifuentes et al., 1999; Segrado Pavón et al., 2015; Sayan and Atik, 2011; Zacarias et al., 2011; de Sousa et al., 2014; Rodella et al., 2017; Corbau et al. 2019). However, no research focusing on carrying capacity assessment to promote sustainable tourism in northern Iraq has yet been conducted in the Sherana Valley River. This technique is recommended by the World Tourism Organization (1998) (Ceballos-Lascuráin, 1996; Eagles et al., 2002).

The Cifuentes method (1992 and 1999) is based on six main steps that involve a detailed understanding of the territory (Corbau et al. 2019):

- Analysis of the PA's visitor management policies.
- Analysis of the PA's planned objectives.
- An evaluation of the site's current state.
- The concept, extension, and potential recharging of management policies.

- Identification of unique components and characteristics that influence the PA's management.
- Calculation of the site's CC.

This system aims to calculate the maximum number of visits that an area can obtain based on the area's physical, biological, and management conditions, taking into account three levels;

The physical carrying capacity (PCC)

The real carrying capacity (RCC)

The effective carrying capacity (ECC)

PCC is the maximum number of visitors who can physically fit into a given location for a given period (Zacarias et al., 2011).

The following equation determined PCC:

PCC = A /Au x R.F ………. (1)

where: A= available area for tourists use; Au= Area required per tourist (Space required to allow people to move freely), According to researches (Bera et al., 2015; Rodella et al., 2017; Zacarias et al., 2011), an area needed per tourist (Au) ranging from 5 to 10 m2 was required. R.F = Rotation factor corresponding to the number of visits per day.

R.F= daily open period/average time of visits. ……… (2)

RCC is the permissible number of visitors to a given site that can be made after correction factors resulting from the site's particular characteristics have been added to the PCC (Cifuentes et al., 1999).

The following equation determined RCC:

RCC=PCC x (Cf1 x Cf2 x Cf3 …….Cfn) …….. (3)

Where: C.f = corrective factor expressed as a percentage.

Tourism is, in turn, affected by environmental factors such as sunlight, rainfall, soil erosion, ecological disruption, beach quality, land slope, disturbance of fauna and flora. These correction factors control tourism practices and determine the area's tourist viability (Cifuentes et al., 1999; Fernández Juan and Bértola Germán, 2014; Navarro Jurado et al., 2012; Segrado Pavón et al., 2015; Syed Rashidul et al., 2014; Zacarias et al., 2011; Sari et al. 2018; Corbau et al. 2019; Jangra 2021).

Correction factor calculated from equation (4).:

$Cfx = 1 - Lmx/Tmx$ ……… (4)

where: Cfx is variable correction factors; Lmx is liming magnitude; Tmx is total magnitude. Four correction factors were used in this study are rainfall, wind speed, excessive sunshine, and Mammal’s diversity. These variables are intertwined with the special circumstances and characteristics of each location or activity.

Rainfall (Cf1) is the most critical corrective factor since it significantly affects swimming events. A rain time series of 6 years (2015–2020) recorded by the weather station at Deraluk town was used to estimate the number of rainy days. The climatic trend of the Sherana Valley is exciting during four months: December, January, February, and March, with the highest rain patterns of more than 130 mm on average (Figure 3.1).

Wind speed (Cf2) indicates strong winds prevent boats from arriving at protected areas, significantly when the wind speed exceeds 5.5 m/s. The number of windy days was calculated using data from the weather station in Deraluk over six years (2015–2020).

Excessive sunshine (Cf3): this may be the most important factor for tourism, as few people visit the river for recreational activities if it is not sunny. This factor is marked by a hot and dry summer that lasts from June to September. During the summer, the maximum temperatures are registered between the hours of 11:00 and 16:00. Since the high sunshine during this period may induce harmful UV radiation, visitors and bathers were scarce (Pasko, 2018).

Mammal’s diversity (Cf4) is a correction factor. This correction factor is appropriate since adequate conservation of the protected area fauna is needed to avoid their extinction and deterioration. For obtaining this correction factor, at least 50 questionnaires were set out and interviewed with the local people to determine the number of individuals and species of mammals before and after building touristic resorts in Sherana valley. This correction factor was used although by (Renjaan et al., 2020), but the author used bird diversity.

The actual allowable number of visitors or the optimal number of visitors that a site can accommodate depending on RCC and management capability availability is known as the ECC. The present condition of tourism management is expressed in the Management Capacity. This final parameter is determined by the facilities, financial support, utilities, employees, and equipment that are available. These components can be limiting factors since they are variable (Dias e Cordeiro et al., 2013; Maciel et al., 2008; Segrado Pavón et al., 2015; Syed Rashidul et al., 2014). Various authors have mentioned this (Rodella et al., 2017; Zacarias et al., 2011).

The ECC is determined by equation (5).

ECC= RCC x MC ……... (5)

RCC is real carrying capacity; MC is the management capacity of staff. The MC index ratio of the optimal management capability negotiated with the Sherana valley projects authority to the actual or real management capacity. The considerations taken into account for management capability are those needed for tourist security and surveillance and the conservation of flora that tourists could harm (Corbau et al., 2019).

3.5. Vegetation Cover and Wildlife Diversity

On the planet, vegetation is an important environment. It has a variety of effects on the Earth's system. Any influences on this sensitive variable should be investigated, particularly when the temperature changes. Plants can be influenced positively or negatively by humans (Marck Oduber et al., 2015). To meet the growing nature tourism demand, the landscape and vegetation cover and wildlife are critical. Therefore, this part aims to identify the impacts of touristic activities on natural parameters (vegetation cover and wildlife diversity). The vegetation cover (trees and shrubs) of the study area was described.

Concerning the wildlife interviewed with the rural people by setting 50 Questionnaire in (Appendix 3), to ask them about wildlife biological activities before the touristic project and after Sherana Valley be the touristic place to assess the wildlife (mammals) diversity of study area, to determine the impact of touristic project construction on mammal’s activity.

4. RESULTS AND DISCUSSION

4.1. Water Quality Analyses

4.1.1. Physicochemical analyses of water samples

The findings of several physicochemical analyses performed on natural water in the Sherana area is shown in Table 4.1 and 4.2. This research is critical in identifying water quality and assessing the effects of tourism on water quality. The interpretation of our findings was based on the WHO water quality guidelines (Table 4.3).

Table 4.1. Physicochemical analyses of water samples during Non-tourism period

Parameters	**Sample ID**									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
TDS (mg/L)	493	374	370	370	346	380	385	428	372	394
EC (µS/cm)	800	627	620	622	630	619	631	674	607	648
pH	8.7	8.1	8	8.3	8.4	8.2	8.1	8.1	8.2	8.2
T (°C)	19.5	17.5	18.6	17.9	19.9	20.7	20.1	20.4	20.2	20.4
Tu (NTU)	0.5	0.2	0.1	0.5	0.2	0.1	0.5	0.2	0.3	0.2
Ca^{2+} (mg/L)	89	79	95	121	59	97	142	55	62	75
Mg^{2+} (mg/L)	55.45	71.14	62.47	64.66	89.14	64.15	91.54	49	79	84
Cl^- (mg/L)	45	80	50	75	60	55	70	45	39	71
Na^+ (mg/L)	35	24	24	19	29	36	51	35	43	64
NO_3^- (mg/L)	5.5	9.1	5.1	8.5	8.4	9.5	7.1	6.8	5.5	7.5
N %	0.2	0.5	0.5	0.3	0.5	0.9	1.4	0.4	0.5	0.8
P %	0.314	0.158	0.345	0.275	0.534	0.129	0.108	0.145	0.226	0.471

Table 4.2. Physicochemical analyses of water samples during Tourism season

Parameters	Sample ID									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
TDS (mg/L)	516	509	544	430	508	472	528	396	477	372
EC (µS/cm)	845	783	930	695	775	782	852	645	759	588
pH	7.9	7.2	7.5	8.1	7.9	8.1	8	8.3	8.5	8.7
T (°C)	20.3	18.9	19.7	19.3	21.1	21.1	21	20.8	21.6	21.9
Tu (NTU)	0.3	0.4	0.8	0.4	1	0.1	0.4	1.1	0.4	1.5
Ca^{2+} (mg/L)	54	38	95	45	119	57	67	121	71	124
Mg^{2+} (mg/L)	47	57	47	39	41	54	64	51	64	73
Cl^{-} (mg/L)	25	25	18	15	30	35	10	20	35	20
Na^{+} (mg/L)	18	55	36	29	37	64	55	48	59	57
NO_3^{-} (mg/L)	10	8.2	15.8	10.2	5	10	18.5	5.5	10	14.9
N %	0.4	0.1	0.8	0.1	0.3	0.2	0.8	0.2	0.1	0.2
P %	0.25	0.27	0.29	0.18	0.34	0.27	0.37	0.24	0.14	0.32

Table 4.3. Minimum, maximum, average and standard deviation of physicochemical water parameter and comparing with WHO standards

Parameters	Non-touristic period				Tourism Season				WHO standards
	Min.	Max.	Average	SD	Min.	Max.	Average	SD	
pH	8	8.7	8.23	0.2002	7.2	8.7	8.02	0.4417	6.5 - 8.5
EC (µS/cm)	607	800	647.8	56.583	588	930	765.4	101.42	1500
TDS (mg/L)	346	493	391.2	41.493	372	544	475.2	58.102	500
T (°C)	17.5	20.7	19.52	1.127	18.9	21.9	20.57	0.9922	-
Tu (NTU)	0.1	0.5	0.28	0.161	0.1	1.5	0.64	0.4402	5
Ca^{2+} (mg/L)	55	142	87.4	27.865	38	124	79.1	32.996	200
Mg^{2+} (mg/L)	49	91.54	71.05	14.413	39	73	53.7	10.904	150
Cl^{-} (mg/L)	39	30	59	14.344	10	35	23.3	8.3	250
Na^{+} (mg/L)	19	64	36	13.686	18	64	45.8	15.031	200
NO_3^{-} (mg/L)	5.1	9.5	7.3	1.576	5	18.5	10.81	4.369	45
N %	0.2	1.4	0.6	0.3496	0.1	0.8	0.32	0.2699	-
P %	0.108	0.543	0.2705	0.1467	0.14	0.37	0.267	0.0699	-

pH

It is one of the most important operational water quality parameters. The pH in water indicates how acidic or basic (alkaline) it is. The negative log of the hydrogen ion concentration is what it's called. Water gets more acidic as the pH reduces. The pH of water rises as it becomes more essential. To prevent contamination of water mains and channels in family water frameworks, the pH of the water entering the conveyance framework must be regulated. Alkalinity and calcium management help keep the water stable and reduce its corrosiveness to pipes and appliances (WHO, 2011).

The pH value of water samples from this study ranges between (8 – 8.7) with an average of 8.2 in the non-touristic period, and this range will be different during the touristic season (7.2 – 8.7) with an average value of 8 (Table 4.3). This means that the water samples of the study area are slightly basic or alkaline water because the average pH in two different seasons is slightly above 8. According to WHO (2008), the safe range of pH for human consumption is 6.5 – 8.5; it affects mucous membranes in the eyes, nose, throat, appendix, and anus if the pH is not within the limited range. Only two samples exceed this range, S1 non-touristic period as shown in Table 4.1, and S10 during tourism season as shown in Table 4.2.

Electrical Conductivity (EC)

EC may be a degree of the capacity of water to carry an electric current, and more prominent EC values show salt concentration of groundwater. Higher EC can be connected to the tall saltiness and mineral substance of groundwater tests, which are actuated by geochemical forms such as particle trade, vanishing, silicate weathering, and solubilization inside aquifers, among others (Water Resources Control Board, 2010).

EC of this study water samples ranges from 607 - 800 µS/cm with an average of 647.8 µS/cm in non-touristic period and ranges from 588 - 930 µS/cm with an average of 765.4 µS/cm during the touristic season (Table 4.3). At the same time, none of the samples exceeded the maximum permissible limit of EC (1500 µS/cm) set by WHO (2008).

Humans can experience gastrointestinal discomfort as a result of the higher EC. According to the WHO classification of EC, it can be classified to three forms, form I, permissible (EC < 1,500 µS/cm); from II, not permissible (EC: 1,500 and 3,000 µS/cm); and form III, hazardous (EC > 3,000 µS/cm). In the study area, 100 % of the total groundwater samples come under type I (permissible). The spatial distribution of EC of the study area is shown in Figure 4.1.

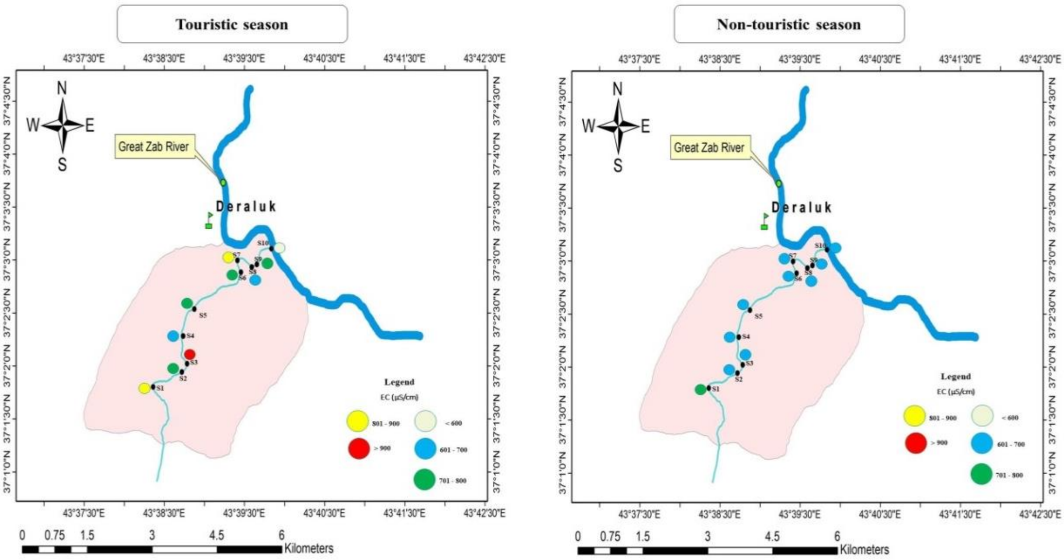

Figure 4.1. The spatial distribution of EC in the study area.

Total Dissolved Solids (TDS)

It is essential to characterize ground waters based on their hydro-chemical properties and TDS values to determine their suitability for any reason (Davis et al., 1966). The spatial distribution of TDS of water in the selected area is given in Figure 4.2.

The TDS of the water samples of this study ranges from 346 to 493 mg/L with an average value of 391 mg/L in non-touristic period and runs between 372 to 544 mg/L with an average of 475 mg/L during the touristic season, the acceptable value of TDS for drinking water is 500 mg/L (WHO, 2008). During non-tourist, there are no sample exceeds this value but during the touristic season, there are five water samples exceeded permissible value (Table 4.2). This may be due to the presence of high levels of dissolved ions, organic material from the sample field, the high mineral salt content of soil dissolved minerals, and a semi-arid climate (Mohammed and Bamarni, 2019). This signifies that the high number of visitors affects the TDS value of water.

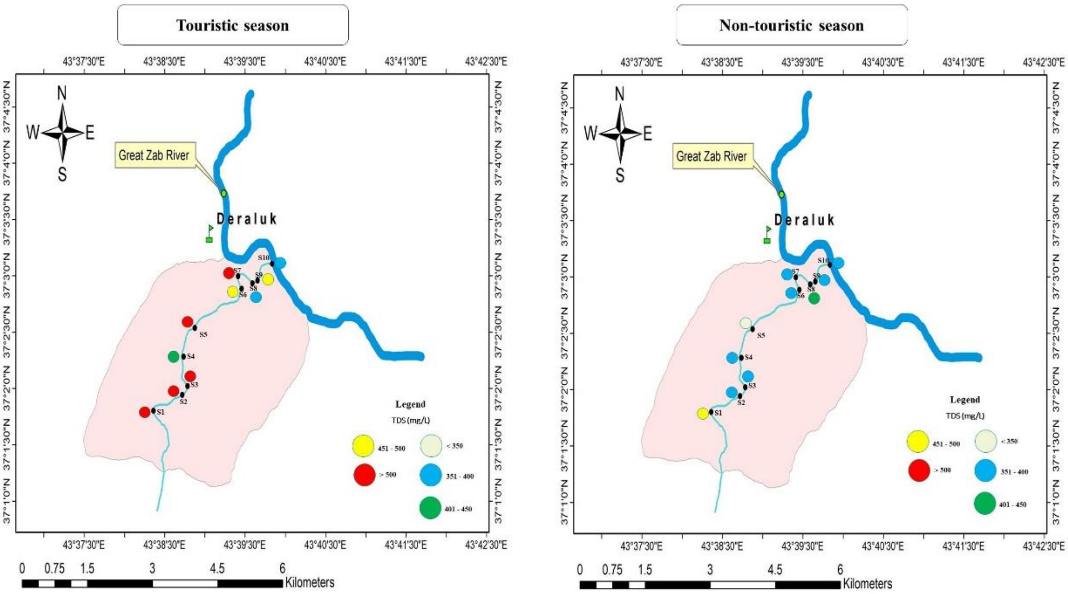

Figure 4.2. The spatial distribution of TDS in the study area.

Temperature (T)

The overall vitality of water particles is measured by temperature. It's one of the foremost basic shapes of water quality. The chemistry of water and the parts of marine species are all influenced by temperature. According to (Water Resources Control Board, 2010), temperature influences the:

- The sum of oxygen that can be ingested in water.
- The rate at which green growth and other marine plants photosynthesis.
- The metabolic rates of animals.
- The organism is sensitive to radioactive wastes, pathogens, diseases, and the timing of marine animals' reproduction, migration, and aesthetics.

The values of temperature in the study area ranged between 17.5 to 20.7 °C during the non-touristic period and 18.9 to 21.9 °C during a touristic period (Table 4.1 and 4.2), this means that this water is cold and comfortable for touristic purposes, especially for tourists of southern Iraq due to warm climate. The spatial distribution of temperature for the study area is available in Figure 4.3.

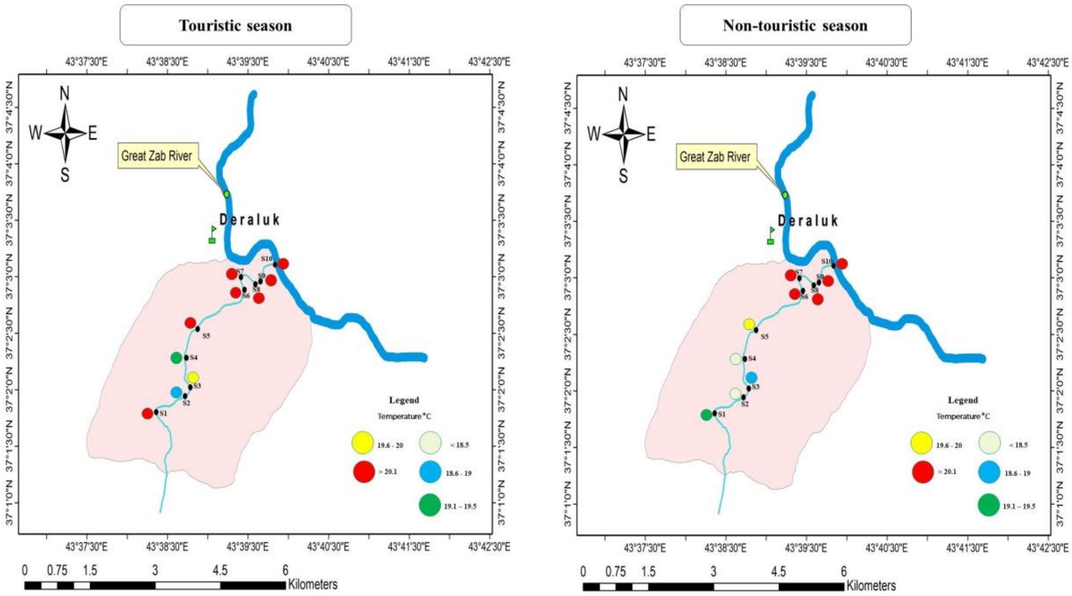

Figure 4.3. The spatial distribution of Temperature in the study area.

Turbidity (TU)

Turbidity is an essential physical characteristic for water quality, indicating suspended particulates in water and producing a water body's muddy or turbid appearance (Tiwari et al., 2014). The quantity of dissolved particles in the water is measured by turbidity. Algae suspended sediment and organic matter particles will turbinate water by clouding it. Turbidity measures water clarity; the more suspended particles in the water, the murkier it appears, and hence the turbidity value would be higher (Mohammed and Bamarni, 2019).

Turbidity values at Sherana river non-touristic period ranged from 0.1 to 0.5 NTU with an average of 0.28 NTU (Nephelometric Turbidity Unit). They ranged from 0.1 to 1.5 NTU with an average of 0.64 NTU during the touristic season (Table 4.1 and 4.2). According to the drinking water standard by WHO (2008), the maximum permissible level of turbidity is 5 NTU. There are no water samples that exceeded the permissible limit. This could mainly be due to the clarity of water and several springs flowing to the river between the first and last water sampling locations.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+})

Calcium is the most common water parameter. It reaches the freshwater system through the weathering of rocks, mainly limestone, seepage, leaching, and runoff from the soil (Day E.H., 1963). Water hardness is mainly made up of calcium. According to (Potelon et al., 1993), calcium is a widely distributed metal in nature, especially in carbonates in limestone rocks (CaCO3). In nearly all-natural waters, it can be used.

The concentration of calcium ion in the study area water ranged from 55 to 142 mg/L with an average 87 mg/L non-touristic period. Also, it ranged between 38 to 124 mg/L with an average of 79 mg/L during tourism season. This indicates that all water samples are above the Iraqi standard value of 50 mg/L (MOE, 1998). Only two water samples have values lower than the mentioned limit (S2 and S4) during the touristic season (Table 4.2). The spatial distribution of calcium in the study area is shown in Figure 4.4.

After calcium, magnesium is the second most essential ingredient of water. Ferromagnesian minerals (olivine, augite, diopside biotite, hornblende) in igneous and metamorphic rocks, as well as magnesium carbonate (dolomite) in sedimentary rocks, are the main sources of magnesium in natural water (Singh et al., 2012). While the main sources of Ca and Mg in water bodies are the geochemistry of rock forms, the basin's long-term agricultural operations can also increase the concentration of both ions directly or indirectly (Mohammed, 2010).

The magnesium concentration level of water samples ranged from 49 to 91.5 mg/L with an average of 71 mg/L in the non-touristic season. However, magnesium values ranged from 39 to 73 mg/L with an average of 53 mg/L during tourism season. The spatial distribution of magnesium is given in Figure 4.5.

The value of calcium and magnesium ions in all analyzed water samples is within the limit of the WHO standard of 200 mg/L (WHO, 2008). But in most of the water samples exceed the Iraqi standard value of 50 mg/L (MOE, 1998). Thus, the calcium and magnesium values show a decline during the tourist season Table 4.2.

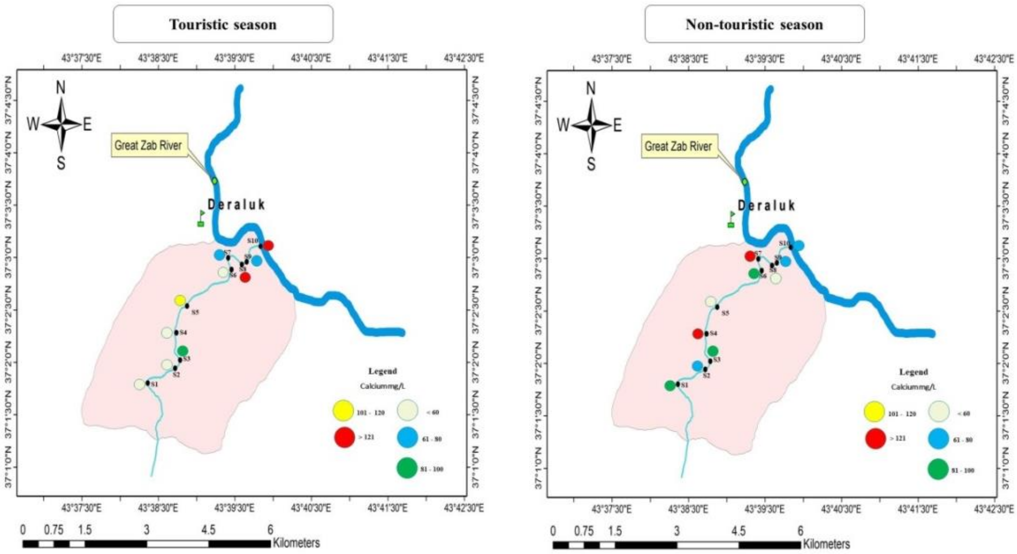

Figure 4.4. The spatial distribution of Calcium in the study area.

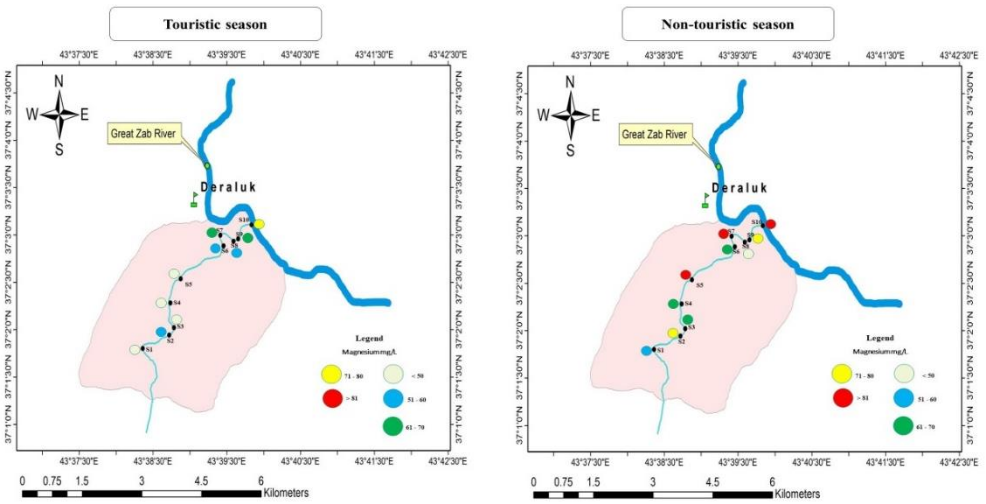

Figure 4.5. The spatial distribution of Magnesium in the study area

Chloride (Cl^-)

Chloride is an anion that occ;urs naturally in all sources of water. Chloride in natural water may come from a variety of places, including soil, urban or industrial sewage, and animal wastes (Girija et al., 2017). It is often used as a chemical exposure measure for sewage contaminants. Normal sources of chloride in water resources include sewage and agricultural effluents, de-icing salt in urban runoff, and saline infiltration. Depending on the alkalinity of the water, high chloride concentrations accelerate metal corrosion in the delivery system. The leaching of chloride-containing minerals (such as apatite), inland salinity, and the drainage of rural, commercial, and household waste water are all possible sources of chloride in natural water bodies (Abbasi, 1998).

This study water samples' chloride concentration ranges from 39 to 80 mg/L with ;an average of 59 mg/L in a non-touristic period while varies from 10 to 35 mg/L with an average of 23.3 mg/L during the tourism season. These values are acceptable by WHO standards value of 250 mg/L. As shown in the spatial distribution of chloride Figure 4.6.

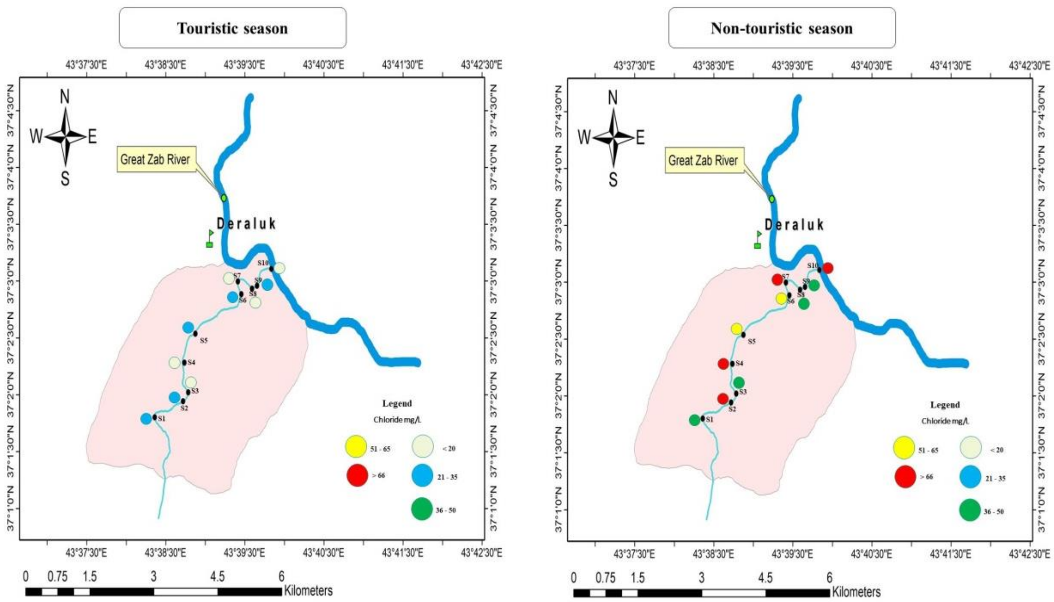

Figure 4.6. The spatial distribution of Chloride in the study area.

Sodium (Na^+)

Sodium is an essential naturally occurring cation with a concentration in fresh water smaller than calcium and magnesium. Among the other cations, Na+ is the most abundant ion in water. This is due to the weathering of silicates and the dissolving of soil salts held due to evaporation and human activities (N. Subba Rao et al., 2012) and agricultural operations and inadequate drainage conditions.

The value of sodium is ranged from 19 to 64 mg/L with an average of 36 mg/L in the non-touristic period. In comparison, it went from 18 to 64 mg/L with an average of 45.8 mg/L during the touristic period at the accepted level of sodium is 200 mg/L by (WHO 2008). Figure 4.7 illustrates the spatial distribution of sodium in the Sherana area.

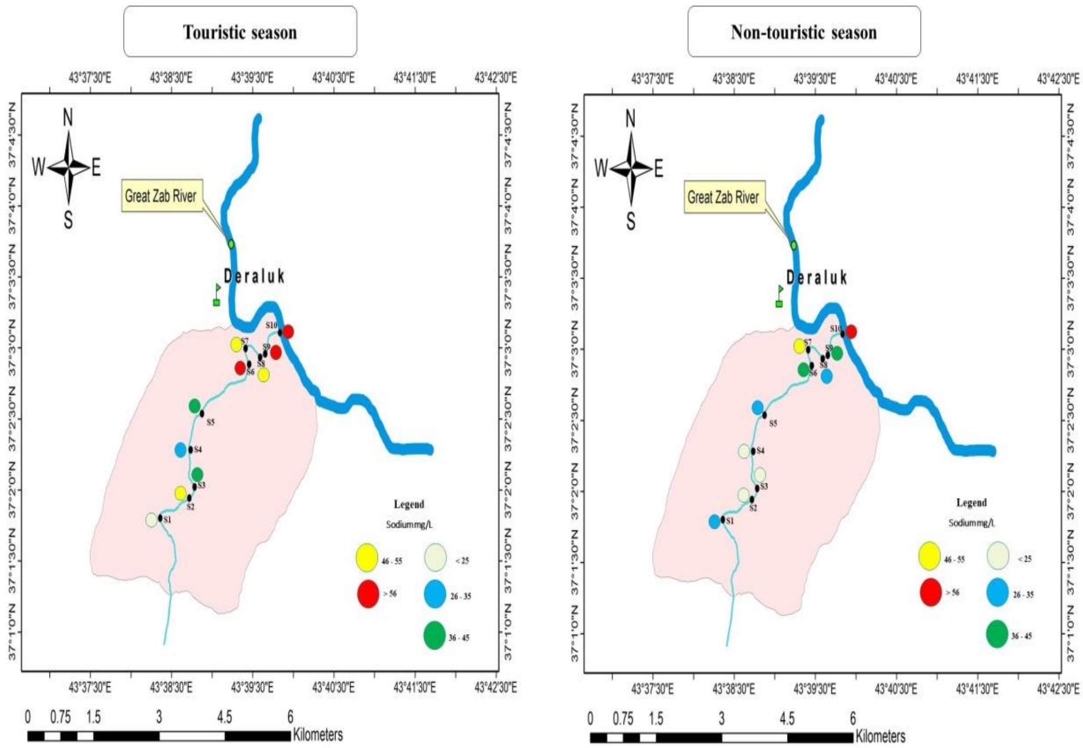

Figure 4.7. The spatial distribution of Sodium in the study area.

The concentration level of all mentioned water parameters besides nitrate, nitrogen, and phosphorus is illustrated in (Table 4.1 and 4.2).

4.1.2. Heavy metals

The “heavy metals” is a broad phrase that has been defined in the literature, and it refers to a wide range of contaminants found in soils and water bodies Duffus, 2002). Heavy metal toxicity has been established due to their bio accumulative propensity in biotic systems. They can get into the environment via mining, industrial discharge, and residential applications and then end up in surrounding bodies of water (Ravindra et al., 2014). The analytical results of the heavy metals are illustrated in Table 4.4, 4.5, and 4.6.

Table 4.4. Heavy metals analyses of water samples during Non-tourism period.

Parameters	Sample ID									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
As (mg/L)	0.005	0.003	0.004	0.001	0.001	0.005	0.001	0.001	0.002	0.001
Ba (mg/L)	2.14	1.45	2.141	1.508	1.253	1.221	2.11	2.17	1.947	1.471
Cr (mg/L)	0.001	0.001	0.002	0.004	0.001	0.003	0.008	0.001	0.005	0.004
Cd (mg/L)	0.001	0.001	0.005	0.125	0.001	0.015	0.089	0.005	0.008	0.024
Pb (mg/L)	0.054	0.061	0.005	0.005	0.004	0.017	0.004	0.002	0.001	0.014
Fe (mg/L)	0.017	0.024	0.021	0.034	0.027	0.031	0.037	0.041	0.056	0.019
Cu (mg/L)	0.245	0.178	0.264	0.144	0.193	0.029	0.394	0.145	0.086	0.247
Zn (mg/L)	0.008	0.014	0.024	0.017	0.124	0.025	0.044	0.016	0.009	0.027
Ag (mg/L)	0.005	0.001	0.004	0.001	0.001	0.001	0.002	0.001	0.001	0.001
Sr (mg/L)	0.001	0	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001
Mn(mg/L)	0.125	0.024	0.144	0.178	0.123	0.146	0.085	0.076	0.062	0.028
Ni (mg/L)	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se (mg/L)	0.001	0.001	0.002	0.001	0.003	0.001	0.001	0.002	0.004	0.001

Table 4.5. Heavy metals analyses of water samples during tourism season

Parameters	**Sample ID**									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
As (mg/L)	0.001	0.001	0.005	0.001	0.003	0.001	0.005	0.001	0.002	0.004
Ba (mg/L)	2.2	1.4	1.2	1.2	1	1.8	2.4	1.4	1.5	0.8
Cr (mg/L)	0.001	0.002	0.008	0.001	0.004	0.001	0.005	0.001	0.006	0.007
Cd (mg/L)	0.001	0.001	0.001	0.002	0.001	0.005	0.005	0.002	0.001	0.001
Pb (mg/L)	0.034	0.021	0.081	0.004	0.044	0.009	0.051	0.001	0.001	0.028
Fe (mg/L)	0.037	0.034	0.017	0.022	0.031	0.028	0.026	0.021	0.001	0.005
Cu (mg/L)	0.11	0.18	0.15	0.19	0.13	0.24	0.17	0.24	0.12	0.27
Zn (mg/L)	0.008	0.014	0.024	0.017	0.124	0.025	0.044	0.016	0.009	0.027
Ag (mg/L)	0.001	0.001	0.003	0.001	0.003	0.001	0.004	0.001	0.001	0.003
Sr (mg/L)	0.001	0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mn(mg/L)	0.021	0.066	0.039	0.028	0.034	0.022	0.011	0.021	0.02	0.024
Ni (mg/L)	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se (mg/L)	0.001	0.001	0.002	0.005	0.005	0.001	0.001	0.005	0.001	0.005

Table 4.6. Minimum, maximum, average and standard deviation of Heavy metals water parameters and comparing with WHO standards

Parameters	Non-touristic period				Tourism Season				WHO standards
	Min.	Max.	Average	SD	Min.	Max.	Average	SD	
Mn (mg/L)	0.024	0.178	0.0991	0.0521	0.011	0.066	0.0286	0.0152	0.4
Cu (mg/L)	0.029	0.394	0.1925	0.1023	0.11	0.27	0.18	0.0551	2
Pb (mg/L)	0.001	0.061	0.0167	0.022	0.001	0.081	0.0274	0.0259	0.01
As (mg/L)	0.001	0.005	0.0024	0.0017	0.001	0.005	0.0024	0.0017	0.01
Ba (mg/L)	1.221	2.17	1.7411	0.3947	0.8	2.4	1.49	0.5087	0.7
Cd (mg/L)	0.001	0.125	0.0274	0.0434	0.001	0.005	0.002	0.0016	0.003
Fe (mg/L)	0.017	0.056	0.0307	0.0118	0.001	0.037	0.0222	0.0118	1
Zn (mg/L)	0.008	0.124	0.0308	0.0343	0.008	0.124	0.0308	0.0343	4
Cr (mg/L)	0.001	0.008	0.003	0.0023	0.001	0.008	0.0036	0.0027	0.05
Ag (mg/L)	0.001	0.005	0,0018	0.0014	0.001	0.004	0.0019	0.0011	0.1
Ni (mg/L)	0.001	0.002	0.0011	0.0003	0.001	0.002	0.0011	0.0003	0.07
Se (mg/L)	0.001	0.004	0.0017	0.001	0.001	0.005	0.0027	0.002	0.04
Sr (mg/L)	0	0.003	0.0011	0.0007	0	0.001	0.0009	0.0003	-

Manganese (Mn)

Manganese is one of the foremost accessible metals within the Earth's hull, and it is commonly found in conjunction with press. It is basically utilized within the generation of press and steel amalgams and an oxidant for washing, dying, and sanitization (as potassium permanganate) and as a component in different things. Mn is found actually in different surface and groundwater sources, especially in anaerobic or low-oxidation situations, and is the foremost basic source of drinking water. Mn may be a common follow metal within the environment; it may be a little portion of most rocks and is additionally found in soils due to weathering and ethereal statement (Keen and Zidenberg Cherr, 1994).

According to Canada Health (2016), an Mn concentration of 0.01 to 0.02 mg/l is a suitable limit for preventing water discoloration. According to several reports on drinking water, public concerns of discolored water and staining in washing arise at Mn levels above 0.02 mg/L, according to several reports on drinking water (Sly et al., 1990; Casale et al., 2002; Kohl and Medlar, 2006; Mohammed, 2019). While the World Health Organization recommends a limit of 0.4 mg/L for Mn (WHO, 2011), most countries have set a lower limit, owing to aesthetic and infrastructure concerns. For example, the European Committee (EC) and the Environmental Protection Agency (EPA) have designated Mn as an indicator at a concentration of 0.05 mg/L in drinking water (EC, 1998; EPA, 2007).

The concentration value of manganese of this study water samples ranges from 0.024 to 0.178 mg/L with an average of 0.099 mg/L in the non-touristic period, while ranges from 0.011 to 0.066 with an average of 0.028 mg/L during tourism season. There is no water sample exceed the WHO standard, but the European Committee limit for Mn drinking water of 0.05 mg/L was exceeded in 8 water samples in non-touristic period (Table 4.4) and one water sample (S2) during tourism season (Table 4.5), as shown in Figure 4.8.

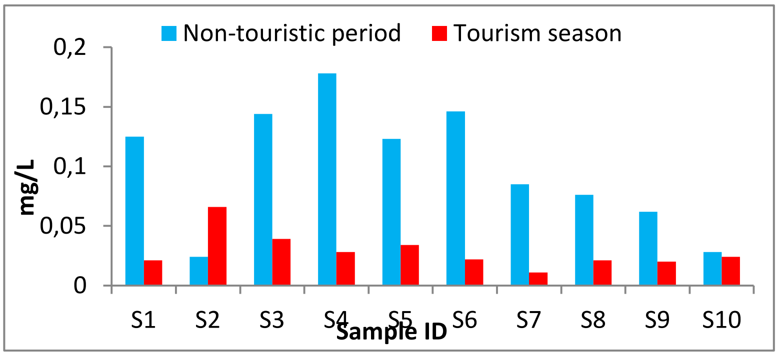

Figure 4.8. The concentration value of manganese in the study area.

Copper (Cu)

Copper is an essential trace element needed by biological processes to activate certain enzymes during photosynthesis. Still, it can be harmful to the human body at higher concentrations. Copper dust absorption at high levels irritates the nose, eyes, and mouth, as well as causing nausea and diarrhea (Ravindra et al., 2014). Copper amounts of drinking water vary greatly, with corrosion in internal copper piping being the most common cause. Copper levels in treated water often rise during delivery, especially in systems with an acid pH or high-carbonate waters with an alkaline pH. In developing countries, the leading causes of copper toxicity are food and water (WHO, 2011).

The concentration of Cu in water samples ranges from 0.029 to 0.394 mg/L with an average of 0.192 in the non-touristic period and 0.11 to 0.27 with an average of 0.18 during tourism season as both levels are smaller than the maximum permissible level of 2 mg/L for drinking water set by WHO (2008) as shown in Table 4.6. The concentration of copper is shown in Figure 4.9.

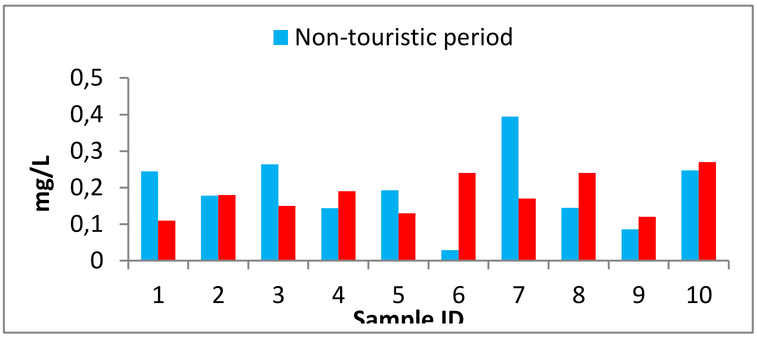

Figure 4.9 the concentration value of copper in the study area.

Lead (Pb)

Lead is a potentially volatile substance that can only be present in trace amounts. When plumbing components containing lead deteriorate, lead can enter the water, especially when the water has high acidity or low mineral content, corrodes pipes and fixtures. Lead pipes, faucets, and fixtures are the most prevalent lead water sources (EPA, 2007). Lead is toxic to the nervous system, and it builds up in the kidneys, skeleton, and reproductive system. Lead poisoning can cause irreversible brain damage, and unborn babies are more vulnerable than adults (Jennings et al., 1996; Mohammed, 2019). Lead is rarely found in drinking water due to natural dissolution; however, it is found mainly due to corrosive water effects on domestic plumbing systems with lead in tubing, solder, fittings, or utility connections residences.

The minimum concentrations level of lead 0.001 mg/L and a maximum of 0.06 mg/L an average of 0.0167 in the non-touristic period and the value of a lead is ranged from 0.001 to 0.081 mg/L with an average of 0.0274 mg/L during the touristic season. It is seen that 4 water samples have lead concentration above the WHO standard of 0.01mg/L (WHO, 2008) in non-touristic period (Table 4.4), while the 6 water samples exceed WHO standard during tourism season as shown in Table 4.5 and Figure 4.10. The heightened levels of lead in the research area's groundwater and springs might be due to agricultural run-off including phosphatic fertilizers, as well as excessive pesticide use on grape plantations (Abdul Jameel et al., 2012; Assubaie, 2015).

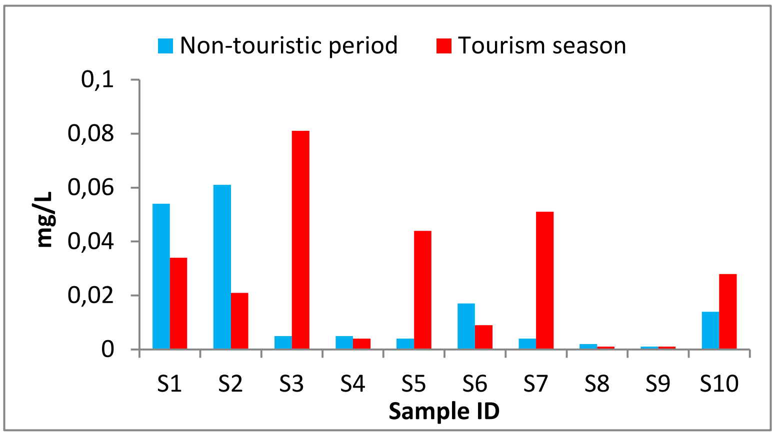

Figure 4.10. The concentration value of Lead in the study area

Arsenic (As)

Arsenic is present naturally in the earth's crust layers all over the world. Arsenic concentrations in specific locations can be greater than the recommended dosage, posing serious health risks to humans and livestock. Natural weathering of rocks and anthropogenic practices, such as mining and smelting operations, chemical use, and coal combustion, both contribute to its presence in the setting (Ravindra et al., 2014). Natural weathering of rocks and anthropogenic activity, such as mining and smelting operations, pesticide usage, and coal combustion, contribute to its presence in the environment (Ravindra et al., 2014). Arsine is the most toxic source of arsenic, followed by arsenites, arsenates, and organic arsenic compounds (WHO, 2011).

The concentration of arsenic obtained from the groundwater samples ranges from 0.001 to 0.005 mg/L with an average concentration of 0.0024 mg/L during both sampling time Table 4.4 and 4.5. According to (WHO, 2011) the maximum permissible limit of As in drinking water is 0.01 mg/L. There is no water sample above the WHO standard, as shown in ;Figure 4.11.

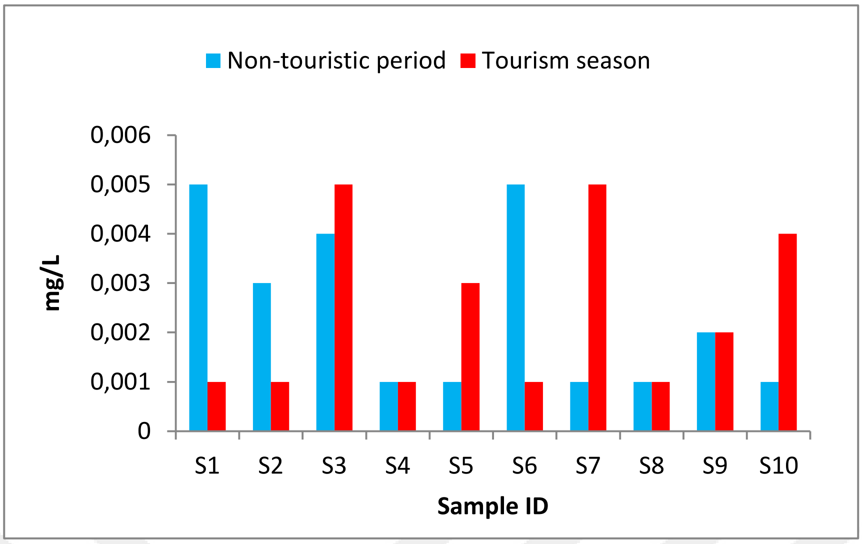

Figure 4.11. The concentration value of Arsenic in the study area.

Barium (Ba)

Barium is most commonly found in sedimentary and igneous rocks, most barium in water comes from natural sources. Because the concentration of barium in water is higher, however, water represents a significant share of overall intake (WHO, 2011). Barium is not an essential nutrient for humans. Barium acetate, barium chloride, barium hydroxide, barium nitrate, and barium sulfide are readily soluble in water and can have significant health consequences. Barium carbonate does not dissolve in water, but it can dissolve in an acidic environment in the intestine, posing a health risk. It can raise blood pressure, induce gastrointestinal issues, muscular weakness, and impact the neurologic and circulatory systems. (Hardi et al., 2019).

The concentrations of Barium ion were detected in groundwater samples and varied from 1.221 to 2.17 mg/l with an average of 1.741 mg/L in non-touristic time, where the value of barium during tourism season ranged between 0.8 to 2.4 mg/L with an average of 1.49 mg/L (Table 4.6). The maximum permissible limit of barium is 0.7 mg/L for drinking purposes set by WHO (2004). All water samples in both sampling periods are above permissible level, as shown in Figure 4.12.

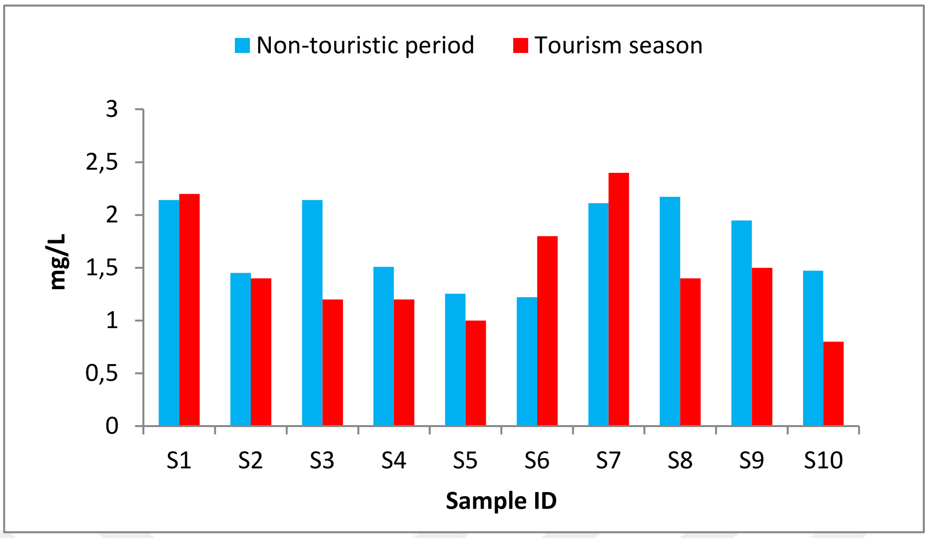

Figure 4.12. The concentration value of Barium in the study area.

Cadmium (Cd)

Cd is a non-essential trace element that is found in abundance in nature. Cd concentrations in soils and groundwater can be elevated by geogenic and anthropogenic causes (Kubier et al., 2019). Cadmium compounds are often used in battery construction. Cadmium is emitted into the atmosphere by drainage, and pesticide runoff and local air pollution cause diffuse pollution. Impurities in the zinc of galvanized pipes and solders, as well as some metal fittings, can contaminate drinking water. Cadmium poisoning in natural water causes kidney failure, bone deterioration, liver damage, and blood poisoning (Ravindra et al., 2014). The World Health Organization (2011) suggested Cd content in drinking water of less than 0.003 mg/L.

The minimum, maximum and average value of cadmium in the non-touristic period are 0.001, 0.125 and 0.0274 mg/L, the findings found that 5 of the water sample exceeds the WHO limit value of 0.003 mg/L , especially (S4) (Table 4.4). During tourism season the value of cadmium concentration of groundwater varied from 0.001 to 0.005 mg/L with an average of 0.002 mg/L, at this time only 2 water samples are above the permissible limit (Table 4.5). As shown in Figure 4.13.

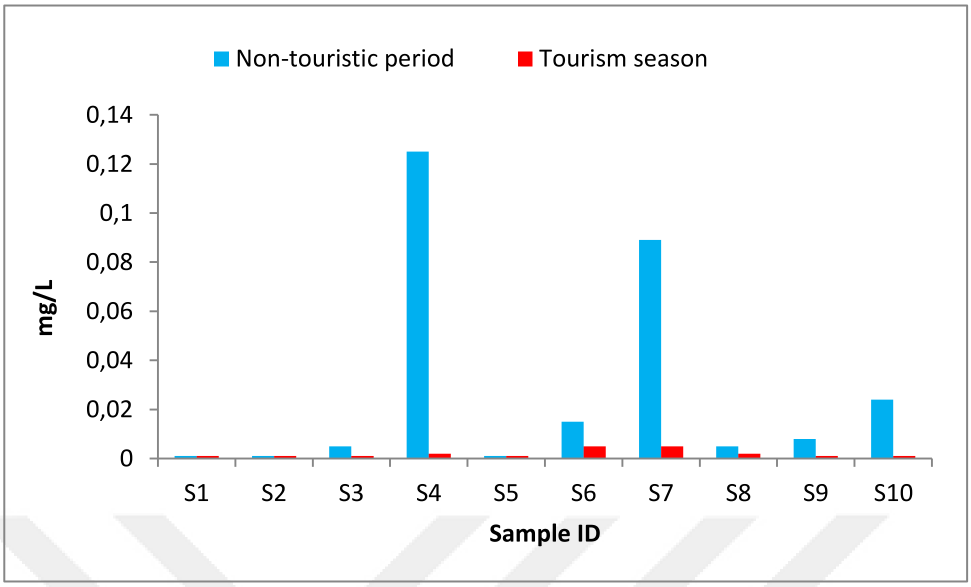

Figure 4.13. The concentration value of Cadmium in the study area.

The minimum, maximum and average concentrations of Iron (Fe), Zinc (Zn), Chromium (Cr), Silver (Ag), Nickel (Ni), Selenium (Se), and Strontium (Sr) in the groundwater samples during two different times are available in the table 4.6. The WHO guideline maximum for Fe, Zn, Ag, Ni and Se were measured as 1 mg/L, 4 mg/L, 0.05 mg/L, 0.1 mg/L, 0.07 mg/L and 0.04 mg/L, respectively. Sr was nondetermined in the study. Therefore, these investigated metals were found under the limits. As shown in (Table 4.4, 4.5, and 4.6).

4.2. Number of Visitors

This research study intends to assess the importance of ecotourism activities in the Duhok governorate, especially in Sherana valley. The globally growing field of ecotourism bodes well for North of Iraq, especially in the natural and cultural areas in the Duhok governorate. From the data in Figure 4.14, there is a clear trend for increasing tourists in the Duhok governorate from 2016 to 2019. The tourist population in 2020 during the covid-19 pandemic period was observed lower than in 2019 but even more than in 2018. (Figure 4.15) is quite revealing in several ways. First, the average number of visitors was calculated from 2016–2020 monthly. The maximum number of visitors have peaked during the summer periods for June, July, August, and September with 24567, 28218, 36717 32651, respectively. Secondly, when comparing the average values of the population between summer and winter (from November to February), 3.4 times lower number of tourists was found in winter seasons. These differences in the number of tourists between the seasons can be explained in part by the landscape structure and climate of the Duhok governorate. In fact, during the summer, the weather is very hot, with an average summer temperature of more than 40°C. Consequently, the tourists search for the clement and merciful micro-climate near a stream, spring, and waterfall on the mountains of Duhok governorate. However, in winter, the climate in these mountainside areas is very cold, it is often covered by snow, and thus the roads are inaccessible and impracticable.

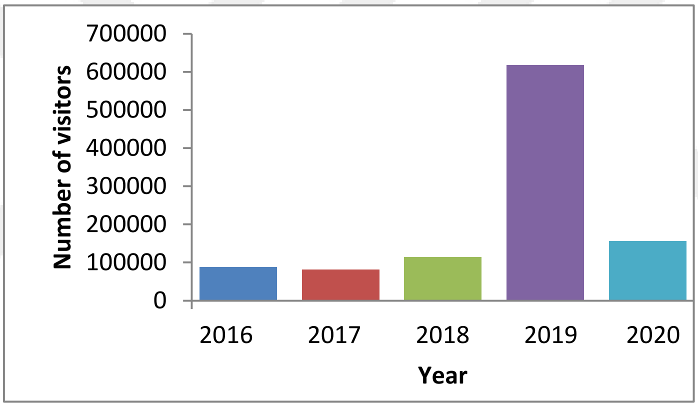

Figure 4.14. Total number of visitors in Duhok governorate from 2016 to 2020.

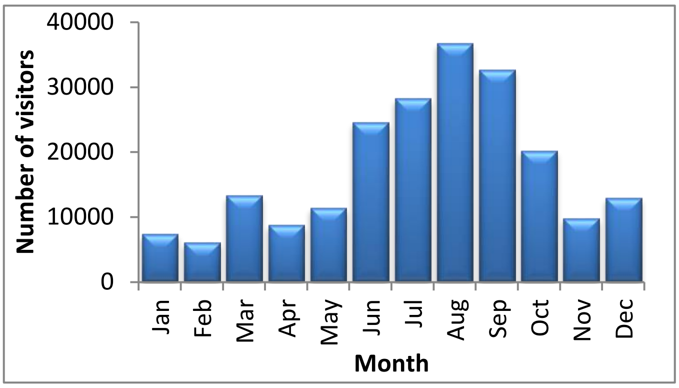

Figure 4.15. Average monthly number of visitors in Duhok governorate from 2016 to 2020.

Figure 4.16 that shows the total number of visitors in Sherana valley from 2016 to 2020, in 2016 only about 7000 tourists visit the valley because it is considered one of the protected area and only the rural people visit this site, after creating road and touristic services this number has been increased approximately 11 times more visitors in 2017 and approximately 26 times more than 2016 and 2018. Since 2017, foreign and South Iraqi tourists have been visiting this site during the summer season. In 2019, these sites were prepared by the authority and stakeholders to receive more visitors and create a strong marketing and advertising process, which increased to 420000 visitors. After that, the authority planned to increase this number to more than 700000 visitors, but due to the COV19 pandemic and announcement of curfew by the government, only 87000 tourists have been visited.

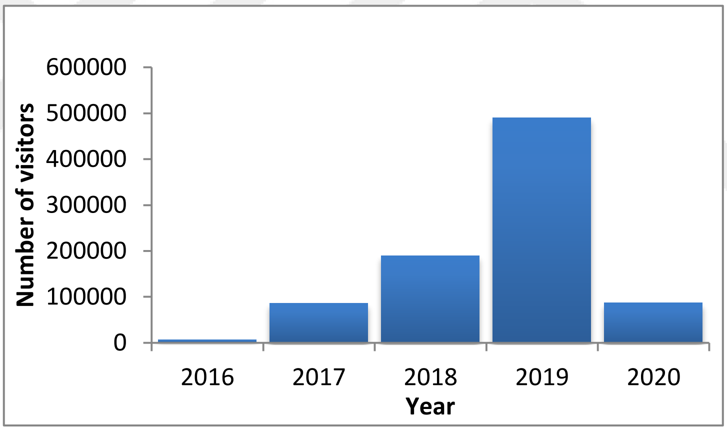

Figure 4.16. Total numbers of visitors in Sherana valley from 2016 to 2020.

The total number of (Domestic, Southern Iraq, and Foreign) visitors from 2016 – 2020 shown in Figure 4.17, the most striking result to emerge from the data is that most tourists are Iraqi citizens from Southern Iraq. By way of illustration, from 2016 - 2020, around 75% of the tourists were from Southern Iraq and foreign while only 25% are local people. This finding has important implications for developing and encouraging ecotourism activities. However, further studies on the current topic should investigate the key role that ecotourism plays in the country's global economy and development.

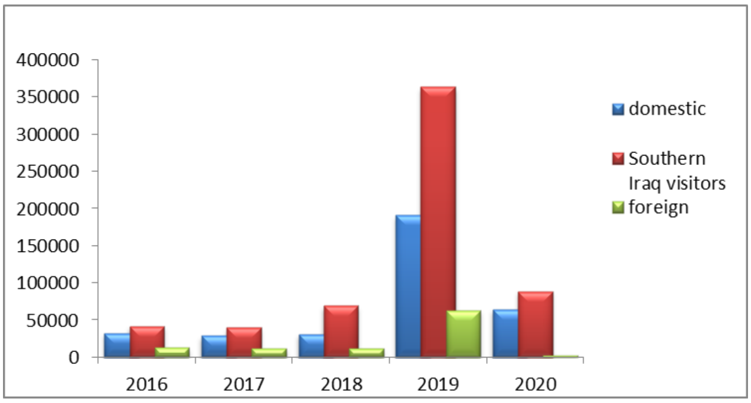

Figure 4.17. Total number of domestic southern and foreign tourists in Duhok.

4.3. Carrying Capacity

Problems that arise due to a lack of ecotourism management based on the CC of the ecosystem, such as pollution, waste, and areas that are not correctly assigned. Furthermore, it is a situation in which the number of travelers exceeds the carrying capacity, which is feared to reduce the consistency of the travel experience/satisfaction. There are no tourist satisfaction limitations in ecotourism management, but there are environmental limits, such as area and visit time (Sari et al., 2018). As a result, it's important to understand the environment's CC when participating in ecotourism events.

4.3.1. Physical carrying capacity (PCC) calculation

In 2019 maximum number of visits was recorded in all resorts of Sherana River, as in Figure4.16. The area of each resort on the Sherana River was calculated, Avasheen resort was found a bigger surface area than the other three resorts (Table 4.7). PCC was computed considering the area required per tourist is 8 m2 /person (Bera et al., 2015; Rodella et al., 2017; Zacarias et al., 2011). The rotation factor (R.F) for all resorts is equal to 3 visits/day according to equation (2), the estimated value of PCC was calculated according to equation (1), the number of visitors these resorts both daily and summer seasons from June to September (Table 4.7)

Table 4.7. PCC calculation of all resorts

#	Resorts Name	Area (m^2)	Au (m^2)	R.F	PC daily	PCC Seasonal
1	Sherana resort	3120	8	3	1170	142740
2	Avasheen resort	6930	8	3	2598	316956
3	Navdar resort	5760	8	3	2160	263520
4	Chinar resort	3345	8	3	1254	152988

The overall number of people at this site can never reach this range, showing the value of the rotation factor as a management measure for implementing ecotourism management strategies (Zacarias et al., 2011). This number is physically sufficient for visitors to feel comfortable and enjoy outdoor activities.

4.3.2. Real carrying capacity (RCC) calculation

The RCC was calculated using four correction factors, which are described in Table 4.8. The correction factors (Cf) were measured according to equation (4).

Rainfalls (Cf1), four months of the year, are of particular interest in climate change (Jan, Feb, Mar, and Dec); therefore, the limiting magnitude of this parameter is equal to 121 days, while the total magnitude is the total magnitude was total days of year 365 days. Calculated the correction factor for rainfall is given in (Table 4.8).

For wind speed (Cf2), the number of windy days during the summer season when the wind speed exceeds 5.5 m/s was calculated as the limiting magnitude of 8 days. Regarding the total magnitude is 122 total days of the summer season. The value of this parameter is calculated (Table 4.8).

Excessive sunshine (Cf3), during the summer season, the maximum temperature was recorded between 11:00 and 16:00 hour intervals. The limiting magnitude is determined as 122 days in 5 hours periods. Therefore 610 hours for the limiting magnitude was founded. Besides, the total magnitude was calculated during 12 hours for 365 days. According to equation 4, the value of Cf3 was estimated (Table 4.8).

Diversity of mammals (Cf4), the number of mammals in the tourism area has been measured after construction touristic resorts in the Sherana area compared to previous years, according to the results of interviews with the local community. Based on the Simpson diversity index, the value of this correction factor is equal to 0.8952. As shown in Table 4.9.

Table 4.8. Correction factors

Correction factors (Cf)	**Value**
Rainfall (Cf1)	0.6684
Wind speed (Cf2)	0.9345
Excessive sunshine (Cf3)	0.8607
Diversity of mammals (Cf4)	0.8952
Cftot	0.48127

Table 4.9. Mammals diversity according to Simpson index

#	**Species**		**N_i**	**n(n-1)**	**N(N-1)**	**ID**	**Corrective value**
	Common name	Scientific Name					
1	Brown Bear	*Ursus arctos*	24	552			
2	Wolf	*Canis lupus*	33	1056			
3	Wild boar	*Sus scrofa*	112	12432			
4	Wild goat	*Capra aegagrus*	37	1332			
5	Roe deer	*Capreolus capreolus armenius*	2	2			
6	Jackal	*canis aureus*	135	18090			
7	Striped hyena	*Hyaena hyaena*	3	6			
8	Fox	*Vulpes sp.*	40	1560			
9	Hare	*Lepus sp.*	60	3540			
10	Badger	*Meles canescens*	25	600			
11	Marten	*Martes sp.*	0	0			
12	Wild Cat	*Felis silvestris*	2	2			
13	Leopard	*Panthera pardus*	0	0			
14	Hedgehog	*Erinaceus europaeus*	55	2970			
15	Indian porcupine	*Hystrix indica*	58	3306			
16	Squirrel	*Sciurus (Tenes) anomalus*	99	9702			
17	Black squirrel	*Sciurus sp.*	4	12			
18	Lynx	*Lynx lynx*	4	12			
19	Fish otter	*Lutra sp.*	48	2256			
	Amount		741	57430	548340	0.1047	**0.895266**

The real carrying capacity (RCC) is determined by multiplying the PCC by the total corrective factors according to equation (3). The different values of RCC in all resorts are reported in Table 4.10. The estimated value of RCC at Sherana resort is (563 visitors/day, 68686 visitors/season), in Avasheen resort is (1250 visitors/day, 152500 visitors/season), while in Navdar resort is (1039 visitors/day, 126758 visitors/season), and in Chinar resort is (603 visitors/day, 73566 visitors/season). The RCC is lower than PCC. The use of RCC helps preserve a balance between tourism's environmental conditions and the number of tourists to the Sherana area. Meaning that while a certain number of tourists can fit into resorts, experience shows a different case. As the number of tourists grows, visitors perceive that the destination is losing quality. The capacity to restore the natural site is expensive, and the environmental condition gradually deteriorates its natural resources (Arangunen et al., 2008). According to Butler (1999), carrying capacity is a maximum of space use tourism until a major reduction in the quality of the base of tourist products or tourist experience.

Table 4.10. RCC calculations of all resorts

#	Resorts Name	PCC Daily	Total correction factors	RCC Daily	RCC Season
1	Sherana resort	1170	0.4812	563	68686
2	Ava sheen resort	2598		1250	152500
3	Navdar resort	2160		1039	126758
4	Chinar resort	1254		603	73566

4.3.3. Effective carrying capacity (ECC) calculation

ECC is the product of combining RCC with the management capacity of staff of the tourism area Management Capacity (MC). The management, staff, and authority of these projects are done by the Harike village, Sherana village, and Deraluk district. This is considered one of the benefits of nature-based tourism to the local peoples to improve the local community's livelihood (Abdullah et al., 2019). The MC of staff is determined by the ratio between the actual amounts of managing a team to the ideal amount of managing staff (Sari et al., 2018). Based on the interview results with the authority of all touristic projects of the Sherana area met 59 persons, where the required number of staff is 95 persons as described in Table 4.11, the value of MC is 0.621.

Furthermore, after the calculation of ECC according to equation (5), the estimated value of ECC in Sherana resort (349 visitor per day, 42578 visitors per season), in Avasheen resort (776 visitor per day, 94672 visitors per season), while in Navdar resort (645 visitors per day, 78690 visitors per season) and Chinar resort (374 visitors per day, 45628 visitors per season) as shown in Table 4.12, ECC all times is lower than RCC and PCC. These results should not be taken lightly, as Cifuentes (1992), Cifuentes et al. (1999), Arangunen et al.(2008), and Segrado Pavón et al. (2008) have proposed because perception can take several forms.

Table 4.11. Management capacity of staff (MC)

Position	Actual number of staff	Ideal number of staff	MC
Ticket officer	5	8	0.621
Parking	4	6	
Service(Cleaning locations)	20	40	
Activities supervisor	7	4	
Cafe and restaurants	7	14	
Security	8	12	
Accountant	4	7	
Managers	4	4	
Total	59	95	

Table 4.12. ECC calculations of all resorts

#	Resorts	RCC daily	MC	ECC daily	ECC season
1	Sherana resort	563	0.621	349	42578
2	Avasheen resort	1250		776	94672
3	Navdar resort	1039		645	78690
4	Chinar resort	603		374	45628

4.4 Vegetation Cover and Wildlife Diversity

4.4.1. Vegetation community structure in Sherana valley

The vegetation structure of Iraqi territories has been described on the site seeing observations by both Townsend & Guest (1966-1985). Recently, this vegetation structure has been reviewed by Ghazanfar & McDaniel (2016). However, far too little attention has been paid to the ecological plant community and landscape diversity. In this context, Youssef et al. (2019) have revised and thus re-described the main elements of vegetation community structure in North Iraq, an autonomous region. This new vegetation description has been constructed on botanical field surveys and an ecological plant diversity basis. This recent evidence suggests that the main categories of the vegetation community structure are described as follows; the steppe grassland community, cultivated communities and segetal plant community, thorn-cushion zone, alpine zone, and open forest formation including mountain rive rain forest, oak forests, and pine forests (Youssef et al. 2019). The vegetation cover structure in the Sherana valley site area is featured by its remarkable natural landscape diversity, such as the deep Sherana valley pass through by a river in Sherana with a lot of small beautiful waterfall crossed through the chains of Gara Mountain. Globally, it consists of an open oak formation with existing various herbaceous species densely on the ground (Youssef et al., 2019). Thus, according to Youssef et al. (2019), Sherana valley belongs to the Oak Forest formation's low and medium sub-zone. Quercus aegilops is the dominant tree species in this oak forest formation with a mixt of some other spars tree species like *Pistacia sp., Prunus sp., Crataegus sp.* and *Q. infectoria*. While during our biodiversity field surveys, we have observed the following plant diversity: among the tree species, we have found *Q. aegilops, Salix sp., Ulmus sp., Paliurus sp., Acer sp., Q. infectoria, Juglans sp., Pistacia sp., Ficus sp., Platanus sp.*) and among shrub species, we recorded *Juniperus sp., Rosa sp., Anagyris sp., and Prunus sp.*). Hence, all the natural attractions (vegetation cover, favorable climatic conditions, landscape diversity, and river canyon) cooperate to make great recreational attractions in the valley.

4.4.2. Wildlife diversity in Sherana valley

Habitat disturbance and deterioration due to an anthropogenic agent have become the main threats to wild animals' distribution worldwide (Bowyer et al., 2019). Land use for agriculture, road construction, deforestation, and illegal hunting are all major threats to wildlife species in northern Iraq, including endangered species like the Persian leopard Which is considered a cryptic and tough species to observe, and wild goat (Nature Iraq and Iraqi Ministry of Environment, 2011; Al-Sheikhly et al., 2020).

In Iraq, 93 different species of wild mammals have been identified, divided into eight orders, 28 families, and 65 genera (Wilson & Reeder 2005). Moreover, about 400 species of birds had identified when Nature Iraq launched its Key Biodiversity Areas (KBA) program, intending to identify sites in Iraq that are significant for their biological diversity (Al-Sheikhly et al., 2020). The IUCN evaluated 24 of the 93 species of mammals that have been reported in Iraq ”one species listed as extinct, one species as Critically Endangered, four species as Endangered, eight species as Vulnerable, seven species as Near Threatened, and three species as Data Deficient” (Omer at al. 2012; Al-Sheikhly & Nader 2013; Al-Sheikhly et al., 2014). Therefore, wild mammal conservation is critical, and it can be accomplished by gathering data on species diversity and distribution in different natural habitats. However, it is very hard to observe wild animals in some habitats because they are cryptic, prefer dense vegetation, occur in small numbers, keep a safe distance from humans, and are usually nocturnal (Debata and Swain, 2018). However, human activities such as resort construction and development have an impact on Sherana habitat and biodiversity.

This study focused on the species diversity in Sherane resort to investigate the effect of the tourists on species richness. Wild mammals' species were identified depending on the questionnaires filled out by indigenous rural people in Sherane Resort. The main reasons for wild mammal species identification are an insufficient time for field survey and direct observation, lack of database about the wildlife species and abundance in this district, political conflicts, mines, and the appropriate surveying tools and equipment unavailability. The number of species before and after the construction of the Sherane resort was gathered through interviews with indigenous rural people. According to the results, the number of wild mammals in the study area was 19 species and 840 individuals before the construction of the Sherane resort but was reduced to 17 species and 741 individuals after construction, as shown in Table (4.13).

The Simpson index of diversity has been used to determine the variety of wild mammal species in the Sherana area. The data has stated that resort construction impacts negatively on the species richness. The species of wild mammals have decreased from 0.924 to 0.895 before and after resort construction (2016 to 2020). As shown in figure 4.18, this is regarded as a short period of substantial decrease. Furthermore, the collected data revealed that two species have disappeared since the resort's construction; Martes foina may have disappeared because its activities are more significant in the summer than in any other season, and during this period, the Sherana area is full of tourists, who play the primary disturbance role for this species. The other one is Panthera Pardus. It is solitary and cryptic, avoiding human inhabitant areas. This touristic resort has affected the habitat of the Persian leopard.

Table 4.13. Number of individuals before and after resorts construction

#	Species		Number of individuals/ species	
	Common name	**Scientific Name**	**Before Sherana Resorts Construction**	**After Sherana Resorts Construction**
1	Brown Bear	*Ursus arctos*	31	24
2	Wolf	*Canis lupus*	58	33
3	Wild boar	*Sus scrofa*	81	112
4	Wild goat	*Capra aegagrus*	75	37
5	Roe deer	*Capreolus capreolus armenius*	18	2
6	Jakal	*canis aureus*	87	135
7	Striped hyena	*Hyaena hyaena*	15	3
8	Fox	*Vulpes sp.*	69	40
9	Hare	*Lepus sp.*	95	60
10	Badger	*Meles canescens*	30	25
11	Marten	*Martes foina*	16	0
12	Wild Cat	*Felis silvestris*	18	2
13	Leopard	*Panthera pardus*	5	0
14	Hedgehog	*Erinaceus europaeus*	52	55
15	Indian porcupine	*Hystrix indica*	43	58
16	Squirrel	*Sciurus (Tenes) anomalus*	93	99
17	Black squirrel	*Sciurus sp.*	13	4
18	lynx	*Lynx lynx*	8	4
19	Fish otter	*Lutra sp.*	33	48
Total			840	741

These studies indicate that most of the number of mammals species has reduced after touristic project construction. This decreasing reason in several wild animals is that some animals do not want to go around peoples or affaire from humans. Another reason is that many rural peoples target some wild animals for hunting purpose, especially Wild goat (Capra aegagrus) and Roe deer (Capreolus capreolus armenius), other reasons also like (tourism, forest clearance - timber-cutting, NTFP collection, livestock grazing, house construction, and fires) affecting in decreasing wild animals. The general number of individuals of all species decreased only in 6 species; Wild boar (*Sus scrofa*), Jakal (*Canis aureus*), Hedgehog (*Erinaceus europaeus*), Indian porcupine (*Hystrix indica*), Squirrel

(*Sciurus (Tenes) anomalus*), and fish otter (*Lutra sp.*) were increased from 81 to 112, 87 to 135, 52 to 55, 43 to 58, 93 to 99 and 33 to 48 individuals respectively as shown in table 4.13, this increase due to the anthropogenic wastes of tourists, all of the mentioned animals using this wastes for eating. However, there has been a significant change in species diversity attributed to mass tourism in the resort, particularly during the summer, habitat loss, road and building construction, riverbank, water pollution, and waste.

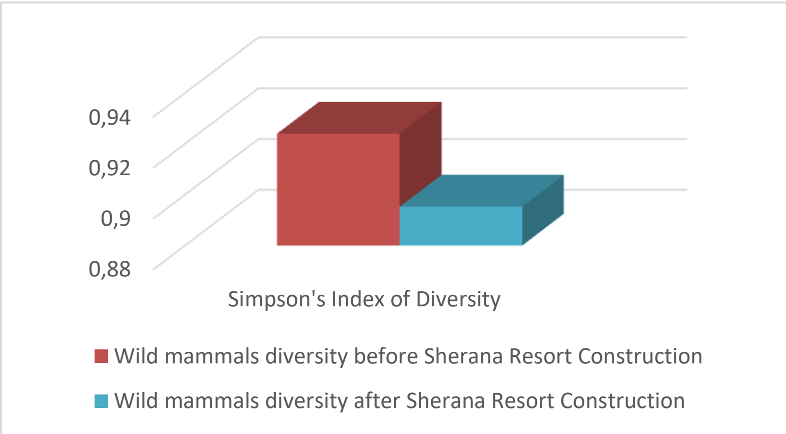

Figure 4.18. The impact of Sherana area resorts construction on wild mammals' diversity

5. CONCLUSION AND RECOMMENDATIONS

The study's results have a variety of major consequences for future practice. These results indicate that the Sherana area is one of the most beautiful and impressive aspects of nature-based tourism in Northern Iraq. In addition, there is a strong need to inform the rest of the world about the unique tourist sites and panoramas in this site, to improve the country's standing. Furthermore, more natural guides should be established to explore the beauty of tourist sites in northern Iraq. Essentially, these nature guides will offer a chance to teach local people of all ages about the value of environmental protection while also acting as a true gift to people in host destinations.

The water quality of Sherana valley according to results of 25 different physicochemical and heavy metals parameters examined in 10 water samples during two times (non-touristic period and tourism season), the nature of water are slightly basic or alkaline. The pH in two samples exceeds the permissible level, the TDS also in five water samples are above WHO standard during tourism season, most of calcium and magnesium samples exceeds the Iraqi standard but all of them within the WHO permissible level, Manganese in nine samples exceeds the European Committee limit, lead in 10 samples exceeded the WHO permissible limit, barium in all water samples are above WHO standard, barium in 7 water samples exceeds the WHO limit, another analyzed parameters are smaller than permissible limit.

Carrying capacity assessment is one of the most successful and popular ways to achieve a balance between tourism growth and environmental protection. The value of PCC in Sherana resort is 1170 visitors per day, Avasheen resort 2598 visitors per day, Navdar resort 2160 visitors per day, and in Chinar resort 1254 visitors per day. This means that is the maximum number of visitors can visit mentioned locations but at a certain time, the number of tourists never exceeds these numbers. But the permissible number of visitors obtained from the results for these locations RCC iks 563 visitors for Sherana resort, 1250 visitors for Avasheen resort, 1039 visitors for Navdar resort, and 603 visitors for Chinar resort these numbers are achieved after calculating the correction factors of Sherana area (Rainfall, wind speed, excessive sunshine, and mammal’s diversity). The actual or optimal number of visitors for study area ECC is 349 visitors for Sherana resort, 776 for Avasheen, 645 for Navdar, and 374 for Chinar resort. But these numbers cannot be accepted by the authors of these projects because all numbers are decreased 3 to 4 times than the daily visitor number.

The vegetation cover structure in the Sherana valley site area is featured by its remarkable natural landscape diversity, such as the deep Sherana valley pass through by a river in Sherana with a lot of small beautiful waterfall. Quercus aegilops is the dominant tree species in this oak forest formation with a mixt of some other spars tree species like Pistacia sp., Prunus sp., Crataegus sp. and Q. infectoria, and among shrub species Q. aegilops, Salix sp, Ulmus sp, Paliurus sp, Acer sp, Q. infectoria, Juglans sp, Pistacia sp, Ficus sp, Platanus sp) have founded, the Juniperus sp, Rosa sp, Anagyris sp, and Prunus sp also founded in some place. According to local people the number of wild mammals was reduced from 19 species, 840 individuals to 17 species, and 741 individuals after construction of touristic resorts in the study area, this indicate that these projects have the negative influence on wild animals activities, on the other hand there are no research and data focused on wildlife activities in the Sherana area.

The authors recommend to managers of all projects in the study area is to apply this research to keep the quality of the touristic project and the ecosystem of this location. And also suggest that this study must be complete in all touristic projects especially in the natural location in the north of Iraq because no research has been yet about tourism carrying capacity in Northern Iraq. Its aims to continue this reserch in the coming years, to protect the management system based on the nature.

This data can be used to highlight the importance of cooperation between academic researchers on the one hand, and managers and administrators on the other hand.

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(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

EXTENDED TURKISH SUMMARY

TURİZM TAŞIMA KAPASİTE DEĞERLENDİRMESİ VE DOĞA TURİZMİN SU KALİTESİ VE EKOSİSTEM ÜZERİNE ETKİLERİ, SHERANA VADİSİ ÖRNEĞİ

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ÖZ

Bu çalışma, birçok turistik cazibe merkezine sahip olan Kuzey Irak'taki Sherana vadisine gerçekleştirilmiştir. Bu vadide ki su kalitesini belirlemek için 10 farklı örneklem noktasından\ farklı zamanlarda alınan su örnekleri fizikokimyasal (pH, TDS, EC, T, bulanıklık, kalsiyum, magnezyum, klorür, sodyum, nitrat, azot ve fosfor) ve ağır metal (arsenik, Baryum, krom, kadmiyum, kurşun, demir, bakır, manganez, çinko, stronsiyum, gümüş, selenyum ve nikel) parametreleri analiz edilmiştir. Elde edilen bu veriler yerel halkın ve turistlerin doğayı korumadaki farkındalıklarını değerlendirilmek üzere irdelenmiştir. Bununla birlikte, yerel halkın ve turistlerin ekolojik okuryazarlıklarını bilimsel olarak ifade etmek için son beş yıldaki toplam turist sayısı ile yerüstü su kalitesi birlikte değerlendirilmiştir. Ayrıca, vadideki turizmin sürdürülebilir olması için turizm taşıma kapasitesi belirlenmiştir.

Çalışmanın su kalite bulguları göstermiştir ki bazı parametreler her iki sezonda da Dünya Sağlık Örgütü tarafından öngörülen standartların üzerindedir. Turist sayısındaki değişim irdelendiğinde, yaz sezonunda turist sayısında artış olduğu görülmüştür. Bu ziyaretçi artışının, yöre halkına ekonomik fayda sağlarken, vadinin ziyaretçi kapasitesinin üzerine çıktığı belirlenmiş ve tahmin edileceği gibi ekosisteme olumsuz etkisi tespit edilmiştir. Bu yüksek lisans çalışmasında, Sherana vadisinde sürdürülebilir turizmi sağlamayabilmek için gerekli fiziksel taşıma kapasitesi (PCC), gerçek taşıma kapasitesi (RCC) ve efektif taşıma kapasitesi (ECC) değerleri sırasıyla günlük olarak 1170-2598 ziyaretçi, 563-1250, 349-776 ziyaretçi olarak hesaplanmıştır.

Anahtar kelimeler: Doğa turizmi, Taşıma kapasitesi, Su kalitesi, Çevresel yönler, Sherana vadisi.

1. GİRİŞ

Turizm, binlerce yıl öncesine dayanan uzun bir geleneğe sahiptir. Dünya çapında 230 milyondan fazla kişiyi istihdam eden dünyanın en büyük sanayi sektörüdür (TIES, 2006). Bu gelişen turizm, birçok farklı türde aktiviteleri, çok uluslu zincirlerden oluşan veya aile tarafından işletilen şirketlere kadar her büyüklükteki oyuncuları içermektedir. Birleşmiş Milletler Çevre Programı'na göre (UNEP, 2010 ve 2011) turizmin doğal kaynakların tükenmesi, kirlilik ve fiziksel değişimlere neden olan etkileri ifade edilmiştir.

Doğa temelli turlar, turistlerin çevresel davranışlarını değiştirmede etkili bir araç olmuştur (Ballantyne ve Packer, 2011; Powell, Brownlee, Kellert ve Ham, 2012; Abdullah ve diğerleri, 2019). Doğa, doğal tarih ve doğanın korunmasına yönelik olumlu, ilk elden deneyimler yoluyla çevre farkındalıklarını, davranışlarını ve davranışsal niyetlerini geliştirebilirler (Ballantyne ve diğerleri, 2011; Powell ve Ham, 2008). İnsanların yeni şeyler öğrenmek ve yeni şeyler denemek için heyecanlandıkları bu tür etkinlikler, uzun vadeli öğrenmeyi hazırlamaya yardımcı olabilir (Falk ve diğerleri, 2012).

Su, yaşamın gerekli bir bileşenidir. Belki de tüm canlıların en önemli parçasıdır. Fabrikalardan, evlerden, yetiştirme çiftliklerinden ve diğer kaynaklardan gelen arıtılmamış atık su, deniz ekosistemlerine girerek habitat bozulmasına ve ötrofikasyona neden olur (Mutlu ve diğerleri, 2018; Kumar ve diğerleri, 2018; Belhouchet ve diğerleri, 2019). Kış turizmi, tarım turizmi ve vahşi yaşam turizmi gibi birçok turizm türü dolaylı olarak suya bağlıdır (Gössling ve diğerleri, 2010). Termal su etkinlikleri, su turizminin çifte neden ve faydalarının en eski ve en iyi örneği olarak kabul edilse de, ticari açıdan bakıldığında, genç müşteriler arasında ilgi eksikliği nedeniyle bu tür turizmin giderek azaldığını belirtmek gerekir (Fernández ve diğerleri, 2018).

Ziyaretçi cazibe merkezleri içinde, ziyaretçi varış bölgelerinin oluşturulmasında hazırlık aşaması yeterli olmaz. Talep ve memnuniyeti artırmak, turist ziyaretlerini artırmak; turizm büyümesi tipik olarak turistik cazibe merkezlerine ve hizmetlere öncelik verir. Biyofiziksel perspektiften bakıldığında, turistik cazibe merkezlerini koruma ve sürdürme girişimleri genellikle yönetim tarafından ihmal edilmektedir. Eko-turizmde taşıma kapasitesi konusu, çevresel zararla yakından bağlantılı olduğu için çok önemlidir (Fandeli ve diğerleri, 2009). Taşıma kapasitesi (CC) çalışmalarının temel amacı, operasyonlar için kullanılan ekosistemin korunmasını sürdürülebilir kalkınma yönetimi ile uyumlu hale getirmektir. Başka bir deyişle, bir sitenin çekiciliğini korumak için rekabetçi bir özellik olarak görülebilirler (Dias e Cordeiro ve diğerleri, 2013). DTÖ, 1981'de turist CC kavramını "fiziksel, ekonomik, sosyo-kültürel ekosistemi bozmadan veya ziyaretçi memnuniyetinde makul olmayan bir düşüşe neden olmadan aynı anda bir turistik yeri ziyaret edebilecek maksimum insan sayısı" olarak tanımladı. " (UNEP/MAP/PAP, 1997).

Ziyaretçi cazibe merkezleri içinde, ziyaretçi varış bölgelerinin oluşturulması, genellikle uygun hazırlığa göre ayarlanmaz. Özellikle başta tarihi ve doğal alanlar olmak üzere çok sayıda turizm alanı bulunan Kuzey Irak'da ki turizmin büyümesi, talep ve memnuniyeti artırmak için çalışmaktadır. Son yıllarda, özellikle yaz aylarında Irak'ın güneyindeki aşırı sıcak yaz iklimi nedeniyle Irak'ın kuzeyine çekilen Irak'ın orta ve güney bölgelerinden gelen turistler başta olmak üzere birçok turist bu yerleri ziyaret etmiştir. Irak'ın kuzeyi, güzel doğası, nehirleri, çeşitlilik zenginliği, tarihi yerleri ve yaz aylarında güzel havasıyla turistleri büyülemektedir. Ancak bu turistik aktiviteler çevreyi olumsuz etkileyebilir.

Bu nedenle bu çalışmanın temel amaçları aşağıdaki gibidir:

1) Çalışma alanının su kalitesi, bitki örtüsü ve yaban hayatı çeşitliliğinin belirlenmesi,

2) Turistik faaliyetlerin doğal parametreler (su kalitesi, bitki örtüsü ve yaban hayatı çeşitliliği) üzerindeki etkilerinin belirlenmesi,

3) Turistlerin su kalitesi üzerinde olabilecek olumsuz etkilerini en aza indirmek.

4) Doğaya dayalı turizm faaliyetleri ile yerel toplulukların ekonomisinin iyileştirilmesi,

5) Sherana vadisinin turizm taşıma kapasitesinin değerlendirilmesi,

6) Doğaya dayalı turizm faaliyetlerinin istatistiklerini ve son beş yıldaki turist sayısını irdeleme yapılmıştır.

2. MATERYAL VE YÖNTEMLER

2.1. Çalışma Alanı

Bu araştırma 2020 yılında Duhok Eyaleti, Sherana Vadisi'nde gerçekleştirilmiştir. Duhok; ili, Irak'ın kuzeybatısında yer almaktadır (K 36o 52” 03', E 42o 59” 34'). Duhok'ta görülecek çok sayıda tarihi ve turistik yer var. Duhok'ta henüz keşfedilmemiş ve eski uygarlıkların izlerini taşıyan çok sayıda yer var. Sherana vadisi, Duhok'un yaklaşık 92 kilometre kuzeydoğusunda yer almaktadır. Bu vadi, Amadya ilçesinin Deraluk kasabasındaki Harike ve Sherana adlı iki köyde yer almaktadır. Yerel halk etobur veya yırtıcı hayvanlar gördüğünü bildirmiştir. Vadi, son 10 yılda popüler bir turizm merkezi haline geldikten sonra sit alanı olarak belirlenmiş. Bu lokasyonun paydaşları yol ve turistik tesisleri geliştirdikten sonra, şimdi Kuzey Irak'ın Duhok ilinde en popüler yaz turizm merkezlerinden biri haline gelmiş ve son beş yıldır hükümet tarafından bir turizm alanı olarak kabul edildi. İklim çoğunlukla karasal ve Akdeniz'dir, ılıman, yağışlı kışlar ve ılık ve kuru yazlar.

Bu vadi, 5.675 km uzunluğunda, ancak sadece 4.25 km'lik turizm amaçlı kullanılan en güzel nehirlerden birine ve nehrin yanında yer alan dört turistik projeye (Sherana, Avasheen, Navdar ve Chinar) sahiptir. Bu vadi, dağlar, manzaralar ve muhteşem bir nehir dahil olmak üzere nefes kesici doğal güzelliği ile ünlüdür. Mavi suyu ve muhteşem manzarasıyla Sherana Vadisi, sosyal medyada "Kuzey Irak'ın cenneti" olarak anılmaktadır. Su çok soğuktur (yaz mevsiminde yaklaşık 18,5°C sıcaklıktan dolayı) ve kristal mavisi bir renge sahiptir. Vadide insanlar yüzme, yürüyüş, piknik vb. çeşitli turizm aktiviteleriyle olmaktadır.

2.2. Su Kalitesi Değerlendirmesi

Bu bölümde, nehrin farklı yerlerinden iki sezon olarak, 10 faklı numune noktasından su örnekleri toplanmıştır. Alınan ilk numune 9 Haziran 2020'de bu, Cov-19 salgını nedeniyle sokağa çıkma yasağının olduğu ve bu nedenle turistik olmayan bir dönem olarak kabul edilmiştir. Turistlerin geldiği ikinci örneklem 13 Eylül 2020’de, turizm sezonunu olması nedeniyle alınmıştır. Tüm numuneler (1 litre) cam şişe ile su yüzeyinin en az 25 cm altından alınıp ve 4°C civarındaki soğuk bir buzdolabında konup laboratuvara taşınmıştır. Sherana nehrinin su kalitesini hesaplamak ve turistik faaliyetlerin su kalitesi üzerindeki etkisini değerlendirmek için bu su örnekleri fizikokimyasal ve ağır metal parametreleri bakımından analiz edilmiştir.

2.3. Ziyaretçi Sayısı

2016'dan 2020'ye kadar son beş yılda Sherana vadisini ziyaret eden turist sayısı, Duhok Valiliği Turizm Genel Müdürlüğü İstatistik Dairesi'nden toplanmıştır. Bu aşamada Duhok Valiliği Turizm Genel Müdürlüğü İstatistik Bölümünden veriler temin edilmiştir.

2.4. Turizm Taşıma Kapasitesinin Veri Analizi

Bir turistik destinasyonun kapasitesi, turizmin çevre ve doğal alanlar üzerindeki etkisini değerlendirmede çok önemlidir. Çalışma alanının bakım kapasitesini değerlendirmek için Cifuentes yöntemi (1992 ve 1999) kullanıldı.

Bu sistem, alanın fiziksel, biyolojik ve yönetim koşullarına göre bir alanın alabileceği maksimum ziyaret sayısını üç seviyeyi dikkate alarak hesaplamayı amaçlar.

Fiziksel taşıma kapasitesi (PCC), belirli bir süre için belirli bir yere fiziksel olarak sığabilecek maksimum ziyaretçi sayısıdır (Zacarias ve diğerleri, 2011).

Gerçek taşıma kapasitesi (RCC), sitenin belirli özelliklerinden kaynaklanan düzeltme faktörlerinin PCC'ye eklenmesinden sonra belirli bir siteye yapılabilecek izin verilen ziyaretçi sayısıdır (Cifuentes ve diğerleri, 1999).

Bir sitenin RCC ve yönetim kapasitesi mevcudiyetine bağlı olarak barındırabileceği gerçek izin verilen ziyaretçi sayısı veya optimum ziyaretçi sayısı Etkin Taşıma Kapasitesi (ECC) olarak bilinir (Rodella ve diğerleri, 2017; Zacarias ve diğerleri, 2011).

2.5. Bitki Örtüsü ve Yaban Hayatı Çeşitliliği

Gezegende, bitki örtüsü önemli bir ortamdır. Dünyanın sistemi üzerinde çeşitli etkileri vardır. Bu hassas değişken üzerindeki herhangi bir etki, özellikle sıcaklık değiştiğinde araştırılmalıdır. Bitkiler, insanlar tarafından olumlu ya da olumsuz etkilenebilir (Marck Oduber vd., 2015). Bu nedenle, bu bölüm turistik faaliyetlerin doğal parametreler (bitki örtüsü ve yaban hayatı çeşitliliği) üzerindeki etkilerini belirlemeyi amaçlamaktadır. Çalışma alanının içindeki bitki örtüsüde (ağaçlar ve çalılar) tanımlanmıştır.

Vahşi yaşamla ilgili olarak kırsal bölge halkıyla, turistik proje öncesi ve Sherana Vadisi'nden sonra yaban hayatı biyolojik aktiviteleri ve çeşitliliğini değerlendirmek için kırsal bölge halkıyla görüşülmüştür.

3. SONUÇLAR VE TARTIŞMA

3.1. Su Kalitesi Analizleri

Sherana bölgesindeki doğal su üzerinde gerçekleştirilen çeşitli fizikokimyasal analizlerin bulguları. Bu araştırmada, turizmin su kalitesi üzerindeki etkilerini değerlendirebilmek için su kalitesinin tespiti için analizler yapılmıştır. Elde edilen bulgular WHO su kalitesi yönergelerine dayanarak yorumlanmıştır.

En önemli su kalitesi parametrelerinden biri pH'dır. Sudaki pH, suyun ne kadar asidik veya bazik (alkali) olduğu hakkında bilgi veriri. Bu çalışmadan alınan su örneklerinin pH değeri, turistik olmayan dönemde ortalama 8,2 (8 – 8,7) arasında değişmektedir ve bu aralık, turizm sezonunda ortalama 8 (7,2 – 8,7) değerinde tespit edilmiştir.

EC, suyun bir elektrik akımı taşıma kapasitesinin bir derecesi olabilir ve daha belirgin EC değerleri, yeraltı suyunun tuz konsantrasyonunu gösterir. Bu çalışmanın EC su numuneleri turistik olmayan dönemde 607-800 µS/cm ve ortalama 647,8 µS/cm aralığında ve turizm sezonunda ortalama 765.4 µS/cm ile 588-930 µS/cm aralığındadır. Aynı zamanda, numunelerin hiçbiri WHO (2008) tarafından belirlenen izin verilen maksimum

EC sınırını (1500 µS/cm) aşmadığı tespit edilmiştir. Bu çalışmanın su örneklerinin TDS'si turistik olmayan dönemde 346 ile 493 mg/L arasında değişmekte olup, ortalama değeri 391 mg/L, turizm dışı dönemde 372 ile 544 mg/L arasında ve ortalama 475 mg/L arasında değişmektedir. Turistik sezonda, içme suyu için kabul edilebilir TDS değeri 500 mg/L'dir (WHO, 2008). Turistik sezonda izin verilen değeri aşan beş su örneği tespit edilmiştir. Çalışma alanındaki sıcaklık değerlerinin turistik olmayan dönemde 17.5 ile 20.7 °C arasında, turistik bir dönemde ise 18.9 ile 21.9 °C arasında değişmesi, bu suyun özellikle güneyden gelen turistler için turistik amaçlı soğuk ve rahat olduğu anlamına gelmektedir. Sherana nehri turistik olmayan dönemdeki bulanıklık değerleri 0,1 ile 0,5 NTU (Nefelometrik Bulanıklık Birimi) arasında değişmekte olup, ortalama 0,28 NTU belirlenmiştir. Turistik sezonda ortalama 0,64 NTU ile 0,1 ile 1,5 NTU arasında değişmektedir. WHO'nun (2008) içme suyu standardına göre, izin verilen maksimum bulanıklık seviyesi 5 NTU olduğundan turizm sezonunda bile içme suyu standartlarını bulanıklık bakımından sağladığı görülmektedir.

Çalışma alanı suyundaki kalsiyum iyonu konsantrasyonu, ortalama 87 mg/L turistik olmayan süre ile 55 ila 142 mg/L arasında değişmektedir. Turizm sezonunda ise ortalama 79 mg/L ile 38 ile 124 mg/L arasında değiştiği belirlenmiştir. Bu veriler Irak standart değeri olan 50 mg/L'nin üzerindedir (MOE, 1998). Turistik sezonda sadece iki su numunesi belirtilen limitin (S2 ve S4) altında değerlere sahiptir. Su numunelerinin magnezyum konsantrasyonu seviyesi, turistik olmayan sezonda ortalama 71 mg/L olmak üzere 49 ila 91,5 mg/L arasında değişmiştir. Ancak turizm sezonunda magnezyum değerleri 39 ile 73 mg/L arasında değişmekle birlikte ortalama 53 mg/L olmuştur.

Bu çalışma su numunelerinin klorür konsantrasyonu, turistik olmayan bir dönemde ortalama 59 mg/L ile 39 ila 80 mg/L arasında değişirken, turizm sezonunda ortalama 23,3 mg/L ile 10 ila 35 mg/L arasında değişmektedir. Bu değerler, WHO standartlarına göre 250 mg/L değerinde kabul edilebilir. Sodyum değeri, turistik olmayan dönemde ortalama 36 mg/L olmak üzere 19 ile 64 mg/L arasında değişmektedir. Karşılaştırıldığında, kabul edilen sodyum seviyesi 200 mg/L'de (WHO 2008) turistik dönemde ortalama 45,8 mg/L ile 18'den 64 mg/L'ye çıkmıştır.

"Ağır metaller" literatürde tanımlanmış geniş bir deyimdir ve topraklarda ve su kütlelerinde bulunan çok çeşitli kirleticilere atıfta bulunur (Duffus, 2002). Biyotik sistemlerde biyobirikim eğilimleri nedeniyle ağır metal miktarları izlenmiştir.

Bu çalışma su numunelerinin manganez konsantrasyon değeri turistik olmayan dönemde 0.024 ile 0.178 mg/L arasında ortalama 0.099 mg/L arasında değişirken, turizm sezonunda 0.011 ile 0.066 arasında ortalama 0.028 mg/L arasında değişmektedir. WHO standardını aşan herhangi bir su örneği yoktur, ancak turistik olmayan dönemde 8 su örneğinde ve turizm sezonunda bir su örneğinde (S2) Avrupa Komitesi'nin 0.05 mg/L Mn içme suyu limiti aşılmıştır. Su örneklerinde Cu değeri, turistik olmayan dönemde ortalama 0,192 ile 0,029 ila 0,394 mg/L arasında, turizm sezonunda ise 0,11 ila 0,27 arasında değişmektedir, çünkü her iki seviye de izin verilen maksimum seviye olan 2'den daha küçüktür. WHO (2008) tarafından belirlenen içme suyu için 2 mg/L.

Turistik olmayan dönemde kurşunun minimum konsantrasyon seviyesi 0,001 mg/L ve maksimum 0,06 mg/L ortalama 0,0167 ve bir kurşunun değeri turistik sezonda ortalama 0,0274 mg/L ile 0,001 ila 0,081 mg/L aralığındadır. Turistik olmayan dönemde 4 su örneğinin WHO (2008) standardı olan 0.01 mg/L'nin üzerinde kurşun konsantrasyonuna sahip olduğu belirlenmiştir. Su numunelerinden elde edilen arsenik konsantrasyonu, her iki numune alma süresi boyunca ortalama 0,0024 mg/L konsantrasyonla 0,001 ila 0,005 mg/L aralığındadır. WHO (2011) göre içme suyunda arsenik için izin verilen maksimum limiti 0,01 mg/L'dir.

Baryum iyonu konsantrasyonları turizm sezonu boyunca baryum değerinin 0,8 ila 2,4 mg/L arasında değiştiği turistik olmayan zamanlarda ortalama 1,741 mg/L ile 1,221 ila 2,17 mg/l arasında değiştiği tespit edilmiştir. Baryumun izin verilen maksimum limiti, WHO (2004) tarafından içme amaçları için 0,7 mg/L'dir. Her iki numune alma periyodundaki tüm su numuneleri izin verilen seviyenin üzerindedir. Turistik olmayan dönemde minimum, maksimum ve ortalama kadmiyum değeri 0,001, 0,125 ve 0,0274 mg/L'dir, bulgular su örneğinin 5'inin WHO sınır değerini 0,003 mg/L, özellikle (S4) aştığını tespit etmiştir. Turizm sezonu boyunca, yeraltı suyunun kadmiyum konsantrasyonunun değeri, ortalama 0,002 mg/L ile 0,001 ila 0,005 mg/L arasında değişmiştir, şu anda sadece 2 su numunesi izin verilen sınırın üzerindedir.

Fe, Zn, Ag, Ni ve Se için WHO kılavuzu maksimum sırasıyla 1 mg/L, 4 mg/L, 0.05 mg/L, 0.1 mg/L, 0.07 mg/L ve 0.04 mg/L olarak ölçülmüştür.

3.2. Ziyaretçi Sayısı

Bu araştırma çalışması, Duhok vilayetinde, özellikle Sherana vadisinde ekoturizm faaliyetlerinin etkisini değerlendirmek amaçlanmıştır. Küresel olarak büyüyen ekoturizm alanı, özellikle Duhok vilayetindeki doğal ve kültürel alanlarda, Irak'ın kuzeyi için iyiye işaret ediyor. İçindeki verilerden, 2016'dan 2019'a kadar Duhok vilayetinde turist artışında açık bir eğilim var. Covid-19 pandemi döneminde 2020'deki turist nüfusu, 2019'dan daha düşük olmasına rağmen 2018'den daha fazla olduğu tespit edilmiştir. Ziyaretçi sayısı 2016 – 2020 arasında aylık olarak hesaplanmıştır. Maksimum ziyaretçi sayısı yaz dönemlerinde sırasıyla 24567, 28218, 36717 32651 ile Haziran, Temmuz, Ağustos ve Eylül aylarında zirve yapmıştır. Nüfusun yaz ve kış (Kasım-Şubat) arasındaki ortalama değerleri karşılaştırıldığında, kış mevsiminde turist sayısının 3.4 kat daha az olduğu tespit edilmiştir.

2016 yılında korunan alanlardan biri olarak kabul edildiğinden vadiyi sadece yaklaşık 7000 turist ziyaret etmişken, yol ve turistik hizmetler oluşturulduktan sonra bu sayı 2017'de yaklaşık 11 kat, 2016 ve 2018'e göre yaklaşık 26 kat artmıştır. 2017'den bu yana yabancı ve Güney Iraklı turistler yaz sezonunda bu siteyi ziyaret ettikleri belirlenmiştir. 2019 yılında bu siteler otorite ve paydaşlar tarafından daha fazla ziyaretçi almak ve güçlü bir pazarlama ve reklam süreci oluşturmak için hazırlanmış ve 420.000 ziyaretçiye ulaşmıştır. Bundan sonra, otorite bu sayıyı 700.000'den fazla ziyaretçiye çıkarmayı planladı, ancak COV19 salgını ve hükümetin sokağa çıkma yasağı ilan etmesi nedeniyle sadece 87.000 turist ziyaret edildi.

2016 – 2020 yılları arasında toplam ziyaretçi (yerli, Güney Irak'lı ve yabancıların) sayısı, verilerden çıkan en çarpıcı sonuç, turistlerin çoğunun Güney Irak'tan gelen Irak vatandaşı olmasıdır. Örnek olarak, 2016 - 2020 yılları arasında turistlerin yaklaşık %75'i Güney Irak'tan ve yabancı iken, sadece %25'i yerel halktır.

3.3. Taşıma Kapasitesi

PCC, turist başına düşen alan 8 m^2/kişi olarak hesaplanmıştır (Bera vd., 2015; Rodella; vd., 2017; Zacarias vd., 2011). Tüm tatil köyleri için rotasyon faktörü (RF), denklem (2)'ye göre 3 ziyaret/gün'e eşittir, PCC'nin tahmini değeri denklem (1)'e göre hesaplanmıştır, bu tatil yerlerinin Haziran ayından itibaren hem günlük hem de yaz mevsimi ziyaretçi sayısı Eylül'e.

Gerçek taşıma kapasitesi (RCC), PCC'nin denklem (3)'e göre toplam düzeltici faktörlerle çarpılmasıyla belirlenir. Sherana beldesindeki tahmini RCC değeri (563 ziyaretçi/gün, 68686 ziyaretçi/sezon), Avasheen beldesinde (1250 ziyaretçi/gün, 152500 ziyaretçi/sezon), Navdar beldesinde ise (1039 ziyaretçi/gün, 126758 ziyaretçi) /sezon) ve Chinar tatil beldesinde (603 ziyaretçi/gün, 73566 ziyaretçi/sezon). RCC, PCC'den daha düşüktür.

ECC, RCC'yi turizm alanı Yönetim Kapasitesi (MC) personelinin yönetim kapasitesi ile birleştirmenin ürünüdür. Ayrıca, denklem (5)'e göre ECC'nin hesaplanmasından sonra, Sherana beldesinde (günde 349 ziyaretçi, sezonda 42578 ziyaretçi), Avasheen beldesinde (günde 776 ziyaretçi, sezonda 94672 ziyaretçi) tahmini ECC değeri; Navdar beldesinde (günde 645 ziyaretçi, sezonda 78690 ziyaretçi) ve Chinar beldesinde (günde 374 ziyaretçi, sezon başına 45628 ziyaretçi), ECC her zaman RCC ve PCC'den daha düşüktür. Cifuentes (1992), Cifuentes et al. (1999), Arangunen ve diğerleri (2008), ve Segrado Pavón ve diğerleri. (2008), algının çeşitli biçimler alabileceğini öne sürmüşlerdir.

3.4. Bitki Örtüsü ve Yaban Hayatı Çeşitliliği

Sherana vadisi sit alanındaki bitki örtüsü yapısı, Gara Dağı'nın zincirlerinden geçen çok sayıda küçük güzel şelale ile Sherana'da bir nehirden geçen derin Sherana vadisi gibi olağanüstü doğal peyzaj çeşitliliği ile öne çıkmaktadır. Küresel olarak, zeminde yoğun olarak bulunan çeşitli otsu türler ile açık bir meşe oluşumundan oluşur (Youssef ve diğerleri, 2019). Böylece, Youssef et al. (2019), Sherana vadisi, Meşe Ormanı formasyonunun düşük ve orta alt bölgesine aittir. *Quercus aegilops, Pistacia sp., Prunus sp., Crataegus sp.* gibi diğer bazı spar ağaç türlerinin bir karışımı ile bu meşe ormanı oluşumunda baskın ağaç türüdür. Biyoçeşitlilik saha araştırmalarımız sırasında, ağaç türleri arasında *Q. aegilops, Salix sp., Ulmus sp., Paliurus sp., Acer sp., Q. infectoria, Juglans sp., Pistacia sp., Ficus sp., Platanus sp.* bitki çeşitliliğini gözlemlendi) ve çalı türleri arasında *Juniperus sp., Rosa sp., Anagyris sp.* ve *Prunus sp.*) kaydettik. Bu nedenle, tüm doğal özellikler (bitki örtüsü, elverişli iklim koşulları, peyzaj çeşitliliği ve nehir kanyonu) vadide büyük rekreasyonel çekicilikler oluşturmak için işbirliği yapmaktadır.

Bu çalışma, turistlerin tür zenginliği üzerindeki etkisini araştırmak için Sherane beldesindeki tür çeşitliliğine odaklanmıştır. Sherane Resort'taki yerli kırsal halk tarafından doldurulan anketlere bağlı olarak vahşi memelilerin türleri tespit edildi. Yabani memeli türlerinin tanımlanmasının başlıca nedenleri, arazi araştırması ve doğrudan gözlem için zamanın yetersiz olması, bu ilçedeki yaban hayatı türleri ve bolluğu hakkında veri tabanının olmaması, siyasi çatışmalar, mayınlar ve uygun ölçme araç ve gereçlerinin bulunmamasıdır. Sherane beldesinin inşasından önceki ve sonraki türlerin sayısı, yerli kırsal halkla yapılan görüşmeler yoluyla toplandı. Elde edilen sonuçlara göre, çalışma alanındaki vahşi memeli sayısı Sherane beldesinin inşaatı öncesinde 19 tür ve 840 birey iken, inşaat sonrasında 17 tür ve 741 bireye düşürülmüştür. Simpson çeşitlilik indeksi, Sherana bölgesindeki yabani memeli türlerinin çeşitliliğini belirlemek için kullanılmıştır. Veriler, tatil köyü inşaatının tür zenginliğini olumsuz etkilediğini belirtti. Yabani memeli türleri, tatil köyü inşaatından önce (2016 yılı) ve sonra (2020 yılı) 0,924'ten 0,895'e düşmüştür.

4. SONUÇ VE ÖNERİLER

Çalışmanın sonuçlarının gelecekteki uygulamalar için önemli sonuçlar elde edilmiştir. Bu sonuçlar, turizm sesozunu dışı ve turizm sezonu olarak alınan her iki periyod için 10 su örneği incelenmiştir. Her bir örnek 25 farklı fizikokimyasal ve ağır metal parametresinin sonuçlarına göre Sherana vadisinin su kalitesi değerlendirilmiştir. Genel olarak vadideki nehir suyunun hafif bazik olduğu belirlenmiştir. Turizm sezonu boyunca nehirin farklı beş noktasından alınan su numunelerinde elde edilen TDS verileri WHO standardının üzerinde olduğu tespit edilmiştir. Su numunlerindeki kalsiyum ve magnezyum değerleri bazıları Irak standardını aşmasına rapmen WHO da izin verilen seviye içinde olduğu tespit edilmiştir. Manganez değeri dokuz numunede Avrupa Komitesi limit değerinin üstünde tespit edilmiştir. Kurşun değeri ise 10 numunede, WHOda izin verilen limiti aşmıştır. Tüm su numunelerindeki baryum değeri ise WHO standardının üzerinde tespit edilmiştir. Analiz edilen diğer parametreler ise izin verilen limit değerinden küçük olarak temsil edilmiştir.

Taşıma kapasitesi değerlendirmesi, turizmin büyümesi ve çevrenin korunması arasında bir denge kurmanın en başarılı ve popüler yollarından biridir. Ancak bölgedeki turizimciler, günlük ziyaretçi sayısının artmasını isterken, veriler ekosistemin korunması ve ekotourizmin sürdürülebilirliği için ziyaretçilerin sayısının 3 ila 4 kat azalması gerektiğini göstermiştir. Turizm taşıma kapasitesi hakkında gelecekte yapılması önerilen benzer araştırmalarda, bu çalışmanın öncülük edeceğine ve literatüre katkı sağlayacağına inanmaktayım. Örneğin, Kuzey Irak'ta taşıma kapasitesi ve bunun etkileri hakkında araştırmalar yapılmamıştır. Bu veriler, bir yanda akademik araştırmacılar, diğer yanda yöneticiler ve idareciler arasındaki iş birliğinin önemini de vurgulamıştır. Örneğin ekoturizimle Kuzey Iraktaki ekonominin gelişmesi sağlanırken, doğal güzelliklerin korunması için bölgeye özgü yönetim sisteminin belirlenmesi ve gerekli rehberlik hizmetlerinin bu yönetim sistemine göre yapılması, ekoturizimin sürdürülebiliğine katkı sağlayacaktır.

APPENDIX

App 1 row data, Precipitation ratio of Study area from 2015 - 2020 by (mm)

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
2015	127	65	111	61.5	29.5	0.5	0	0	25.5	119.5	76.5	143.5	759.5
2016	300.5	169.5	167	57	25	9.5	0	0	0	21	33	164	946.5
2017	100	45	152	132	67	0	0	0	0	6	143	54.5	699.5
2018	165.5	191.5	81	98	123	0	0	0	0	137	233	406	1435
2019	205.5	132	507.5	198	48	0	0	0	0	49	28	220	1388
2020	192	180	379	131	25.5	6	0	0	0	4	62	68	1047.5
Avarage	181.75	130.5	232.9167	112.9167	53	2.666667	0	0	4.25	56.08333	95.91667	176	

App 2 row data, number of visitors in Duhok governorate from 2016-2020

	2016			**2017**			**2018**			**2019**			**2020**			
Month	Domestic	S.irq	Foreign	Domestic	s.iraq	Foreign	domestic	s.iraq	foreign	domestic	s.iraq	foreign	domestic	s.iraq	foreign	avarage
Jan	1877	2894	740	2361	2164	1202	1915	1672	886	5398	10827	2348	2494	0	0	2452
Feb	1842	1925	1070	1752	1756	811	1502	2414	804	3987	9238	1971	1049	0	0	2008
Mar	2947	2783	1234	2624	1860	994	2282	2863	1141	16865	25467	5272	0	0	0	4422
Apr	2127	2088	1119	2353	2112	1311	2361	3602	855	3658	18875	3245	0	0	0	2914
May	2024	2169	1269	2605	2606	1156	1602	1888	792	8765	27543	4672	0	0	0	3806
Jun	1504	2075	925	2512	4696	885	3107	6976	1077	30534	51656	8909	7979	0	0	8189
Jul	3540	5381	894	3102	8742	1054	3377	12779	987	29834	53014	8749	9638	0	0	9406
Aug	3391	7835	1024	2952	8650	1038	5642	14681	974	37903	58265	11094	10095	19412	632	12239
Sep	4541	7200	1194	3719	5420	913	2799	11343	920	20831	58842	8209	11361	24983	982	10884
Oct	2514	2819	1190	1698	724	684	2743	5553	872	13672	21213	3856	11241	31301	870	6730
Nov	2618	2789	1324	1596	806	731	1810	3050	1898	9046	11356	1791	3891	5929	236	3258
Dec	3802	2320	1402	1861	889	1643	2557	3036	859	10864	17657	3212	6961	7056	367	4299
Total	32727	42278	13385	29135	40425	12422	31697	69857	12065	191357	363953	63328	64709	88681	3087	
Grand total	88390			81982			113619			618638			156477			

APP 3 Wildlife Diversity Assessment Questionnaire

NO: Location: Date:
Name: Address: Age:

Evidence:
1.Sighting 2.Tracks 3.Vocalization 4.Dung 5.Nests
6.Scrapes/Claw Marks 7.Feeding Signs 8.Other: (Wallows - Bathing Pools - Mud Smears - Antler/Horn marks).

Human/Habitat Impact:
1. Tourism 2. Hunting Activities 3. Forest clearance - Timber-cutting 4.NTFP collection
5. Livestock grazing 6. House construction 7.Fires 8.Other

Date	Species	No. of Individuals		Evidence	Human/Habitat Impact
		before Sherana Resort Construction	After Sherana Resort Construction		

Other Notes :

CURRICULUM VITAE

He Started the school in the Zozik Primary School, from 1998 to 2004 (Duhok, Iraq), Hejar Mokriyani Intermediate School, from 2005 to 2008, (Duhok, Iraq) and Malta Secondary School, from 2008 to 2010 (Duhok, Iraq). In 2011 acepted in University of Duhok/ College of Agriculture / Forestry Department,and achieved B.Sc in Forestry Science, Duhok (Iraq), and Rank 3rd out of 43 Students in my B.Sc. Graduation session, overall School of Forestry level. After that, Started Postgraduate study at the Department of Environmental Engineering, Institute of Natural Applied Sciences at Van Yuzuncu Yil University in Turkey on February 2019.

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