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Tourism Impact on Water Quality in Swat during Winter and Summer Seasons

Rizwan Ali[1], Saeeda Yousaf[1], Taqweem Ul Haq[2], Anis Safir[1]*, Sidra[3]

[1]Department of Environmental Sciences, University of Peshawar, Khyber Pakhtunkhwa, Pakistan.
[2]State Key Laboratory, School of Environment, Beijing Normal University, China
[3]Department of Environmental Sciences, Government College and Women University Sialkot, Pakistan

*Corresponding author: anissafir2019@gmail.com

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Abstract: Tourism may be a source of income or it may pose harm to the environment. This study examines the effects of unplanned tourism on the degradation of essential resource like clean water. This study includes fieldwork and lab analysis to evaluate the consequences of tourism activities on water quality. Forty-eight samples were analyzed for physicochemical and microbiological characteristics collected from four sampling sites. During the busiest travel seasons, tourist destinations samples had greater amounts of Total Dissolved Solids (TDS), conductivity, chloride, and coliform bacteria than specimens from non-tourist and off-season locations. TDS varying from 87. 34 mg/l to 112. 29 mg/l to 223. 26 mg/l; conductivity ranged from 150. 32 µs/cm to 199 µs/cm, increasing to 307 µs/cm; and chloride varied from 5. 37 mg/l to 7. 1 mg/l, and reached up to 18. 89 mg/l. The range of fecal coliform bacteria was 1. 0 to 3. 6 (MPN/100ml), while the range of coliform bacteria was 1. 0 to 2. 8 (MPN/100ml) and up to 5. 1 (MPN/100ml). More than half (52%) of the hotels evaluated had inadequate waste management procedures, which led to waste being discharged into nearby rivers and streams. The industry needs environmentally responsible strategies, as suggested by the 76% of travelers who support sustainable tourism practices. The findings demonstrate a direct correlation between rising tourism and deteriorating water quality.

Keywords: Tourism, water quality, physicochemical, microbiological analysis, mitigations.

Introduction

Tourism-related problems and issues are causing increasing concern. The creation, construction, and operation of tourism infrastructure as a whole have direct and indirect environmental implications (Martinis et al., 2011). After knowing that tourism sector has both positive and negative impacts, researchers and stakeholders have demonstrated a significant interest in investigating the impacts of tourism (Ko and Stewart, 2002). High concentration of tourists' involvement due to attracting spots in different areas is important factor from economic point of view but on the other hand waste disposal at these tourists' spots is a serious problem (Saqib et al., 2019). Tourism has grown rapidly in recent years and at the same time the water quality has been deteriorated sharply (Grobler et al., 2017). Biological contaminants from nearby sources such as hotels, bathrooms, underground damaged sewerage pipes, seepage/percolation from drainage systems, and inadequate performance of waste water treatment plants typically cause pollution, which leads to serious disease and even death (Khan et al., 2018). For promoting tourism in an area that has water tourism activities, it is very necessary to control pollution of water sources either they need for drinking water or non-drinkable purpose. The impact of human mass tourism on touristic rivers is important to investigate as a reference for limiting water pollution, enhancing tourism service quality, and preserving sustainable development (Yu et al., 2021). Either the ecosystem or revenue streams may be threatened by tourism. It is widely recognized for having a major impact on both national and local revenue growth. Natural eco-systems and their preservation have been further impacted by the expansion and diversity of tourism (Saqib et al., 2019).

Pakistan is among the nations that may draw tourists from all over the world because of its diverse terrain and exceptional landscapes, which include towering mountains, breathtaking lakes, streams, seashore domains, arid regions, and a variety of cultures. Khalid et al. (2018) carried out a second parallel investigation in which they evaluated the physicochemical and microbiological parameters related to the pollution of the district Vehari's drinking water.

Individuals throughout the globe utilize the valley as a vacation spot due to its exceptional natural beauty, which includes rough mountains, rivers, snowfall, dense forests, unique physiographic features, and historical elements (Ahmad et al., 2022). The number of visitors to Swat Valley has increased significantly in recent years, the most popular tourist destinations are Kalam, Malamjabba, Miandam Valley Madyan and Bahrai (Erwin, 2024). A vast

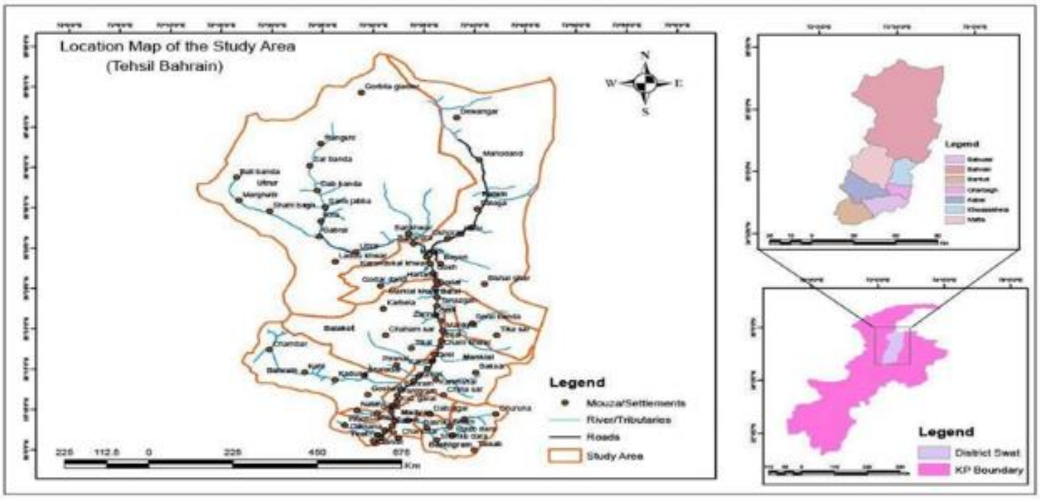

Fig. 1 Study areas map

amount of data is available, people focus only on the information that is relevant and useful for their upcoming conversations (Ahmad et al., 2022).

Apart from their immediate effects on the regional biota, water, and air quality, tourism-related activities can also have indirect consequences on manufacturing, production, and the transportation of materials (Abbas et al., 2011). Parks and conserved areas may be adversely affected by the introduction of waste and pollution, directly or indirectly by disturbing wildlife (Jassef et al., 2020). Among these initiatives, the World Conservation Union's (IUCN) work is among the most well-known. Globally, the number of international NGOs, academics, governments, and other protected area-related projects have increased dramatically with the growth of the population, thus tourism is growing at a rapid pace. People go to natural places to spend their leisure time and appreciate the aesthetic splendor of natural resources. Due to an increase in the number of tourists and a lack of awareness among hosts and tourists, there may be negative environmental consequences; nevertheless, if this sector is managed well, it will provide many direct and indirect benefits. In light of the above literature, the current research study is designed with the goal of determining the direct and indirect environmental impacts of tourism on water quality at Kalam district Swat.

Materials and Methods

Study Area

The Kalam valley in District Swat is the site of this investigation (Fig 1). The steep location of Kalam draws a lot of visitors. It is among the most popular tourist attractions in Pakistan. It is situated in Tehsil Bahrain of Swat, alongside the River Swat, 99 km away from Mingora. The 6,800-feet-tall Kalam Valley is located in the northern parts of Pakistan. Situated around 350 miles away from Islamabad, it shares borders with the Bahrain and Mankiyal valleys to the south, Utror and Gabral valleys to the west, Ghizar and Chitral districts to the north, and the Indus Kohistan to the east (Ali et al., 2023). Beside the conifer forest, there are beautiful lakes, waterfalls, and verdant grasslands. Not only it is the meeting point of the Ushu and Utror rivers, but its lower parts are also referred to as the River Swat. In Kalam and the surrounding areas, highest temperature is seldom greater than 20°C. The excessive snowfall during winter exacerbates the challenges faced by residents, impacting their daily lives (Sanaullah et al., 2020). The Kalam Valley has numerous sources of potable water, including rivers, wells, and springs. In this context, N=47 (72.3%) local community members stated that their primary source of water for drinking is the spring, whereas N=18 (27.7%) members said they consume river water. Increasing number of tourists and population density are contributing to river water contamination in the area.

Water Samples Collection and Analysis

For the purpose of determining quality of water in the study area, overall total of 48 samples were collected from tourist and to non-tourist sites. Tourist sites include Kalam (K) and Ushu (U) villages where majority of hotels are located and non-tourist sites are Matiltan (M) and Bafer (B).

Kalam is a seasonal spot. The main season starts in June-August when almost all other areas are under the hot spell of summer. The 1st sampling was carried out in June-July from four sampling points including two tourists and two non-tourist's sites.

Table 1. Water quality parameters and methods used for analysis.

Serial#	Parameters	Analysis method
1	TDS	TDS Meter
2	Turbidity	Electronic turbidity meter
3	Electrical conductivity	Conductivity meter
4	PH	PH meter
5	Total Hardness	EDTA Titration method
6	Alkalinity	Acid base titration
7	Phosphate	Visible spectrophotometer
8	Sulfate	Visible spectrophotometer
9	Sodium	Flame photometer
10	Potassium	Flame photometer
11	Magnesium	Complex metric Titration
12	Calcium	Complex metric Titration

Three samples were collected from each point, one from the pollution source caused by tourism, another from the area before the pollution source and third from the area beyond the pollution source. The sampling was again carried out from the same four sites at the end of the season from both tourist and non-tourist sites. Water was analyzed for physio-chemical parameters like turbidity, electrical conductivity, sulphate, pH total hardness, TDS, total alkalinity, sodium, potassium, magnesium, calcium and microbial parameters like total coliform and fecal coliform (Table 1). The water samples, for physio-chemical analysis, were collected in 1.5-liter polystyrene bottles. The bottles were carefully cleansed and rinsed three times with sample water before collecting the samples. For bacteriological analysis, water samples were collected in clean bottles (200 ml) to avoid contamination throughout the collection process.

Results and Discussion

Physio-chemical and biological studies were carried out within specific area to determine the quality of the water in winter as well as in summer seasons at both tourist and non-tourist locations, respectively. To find out how tourism affects water quality, samples were analyzed using physio-chemical and biological methods at both tourist and non-tourist locations during the summer and winter seasons. (Tables 2-5).

Physio-chemical Analysis of Tourist and Non-Tourist Sites

Total hardness: Water samples from tourist areas Kalam and Usho) displayed increased overall hardness compared to non-tourist locations of Bafer and Matiltan. During the summer, Kalam had the highest readings (198.5–207.40 mg/L), whereas Usho recorded 157.58–187.66 mg/L. Winter levels fell to 141.40–150.47 mg/L in Kalam and 103.71–115.56 mg/L in Usho. The measurements at non-tourist locations were more uniform, Matiltan showed 135.13–157.10 mg/L in the summer and 117.72–141.21 mg/L in the winter; Bafer varied from 168.23 to 200.55 mg/L in the summer and 133.11 to 167.17 mg/L as well. Every measurement was significantly below the WHO norm (500 mg/L) and below the acceptable aesthetic level (200 mg/L), indicating safe drinking water.

Total dissolved solids (TDS): The highest TDS levels were found in the summer, especially at popular tourist destinations like Kalam and Usho, where they reached 223.26 mg/L and 219.16 mg/L, respectively. On the other hand, winter readings drastically decreased; for example, Usho only recorded 98.14 mg/L. TDS levels at non-tourist locations, such as Matiltan and Bafer were consistently lower and more steady during both seasons and in January, Matiltan recorded as low as 44.23 mg/L. All measurements showed satisfactory water quality, being considerably below the WHO standard of 500 mg/L. TDS levels at tourist destinations rise seasonally, which is consistent with research conducted by Kakar and Khalil (2017).

Chloride: The entire study locations had chloride concentrations that were substantially below the 250 mg/L WHO limit, meaning that there was no risk to the safety of water. Due to increased human activity, summer levels in tourist destinations like Usho and Kalam were somewhat higher (up to 18.89 mg/L) than winter levels. Both seasons had consistently low chloride levels at non-tourist locations like Matiltan and Bafar. These seasonal changes are consistent with the study by Matta et al. (2015), which reveals that chloride levels remain within safe limits despite being impacted by seasonality and tourism.

Sulphate: All sites' levels of sulphate and chloride remained significantly below WHO guidelines, indicating safe drinking water throughout the year. While winter values at non-tourist locations like Matiltan and Bafar stayed low (3.57–6.25 mg/L) and summer levels of chloride were slightly higher, particularly at tourist areas, reflecting seasonal and human impacts. Additionally, sulphate concentrations remained within safe limit, reaching a maximum of 119 mg/L. These patterns support earlier study conducted by Kumari et al. (2013), which found no detrimental effects of seasonality or tourism on water quality.

pH: There were no issues with acidity or alkalinity because the pH levels at every site stayed within the WHO-recommended range of 6.5 to 8.5. Seasonal decreases were noted, with winter pH falling to 6.18–6.37 in all tourist and non-tourist locations, whereas summer values were greater. Unlike other studies, Chauhan et al. (2016) found higher pH as a result of tourism or natural basicity and these data indicate a negligible impact of tourism on pH levels.

Sodium: There were no health risks because sodium levels at all locations stayed significantly below the WHO standard of 200 mg/L. While non-tourist locations like Matiltan had significantly lower sodium concentrations, particularly in winter (as low as 4.03 mg/L), tourist destinations like Usho and Kalam had greater concentrations (up to 30.25 mg/L). Bafar had somewhat greater levels (up to 28 mg/L), despite not being a tourist site. Seasonal differences were noted, with the majority of sites showing somewhat greater winter concentrations. All readings were within safe bounds, even if some were higher than the reference level of 14.7 mg/L.

Total alkalinity: Total alkalinity levels at all locations were considerably below the 200 mg/L WHO and NDWQS limit, indicating a strong buffering capacity and no health hazards. In comparison to non-tourist locations like Matiltan and Bafar, which stayed lower over both seasons, tourist destinations like Usho and Kalam displayed somewhat higher values (up to 53.14 mg/L). All measurements show that the water is suitable for human consumption, and seasonal changes were negligible. These results go counter to earlier claims of increased alkalinity during monsoon seasons (Chauhan et al., 2016).

Calcium: All sites maintained calcium levels within the 100 mg/L WHO acceptable range. Due to increased runoff and human activity, concentrations were greater in tourist regions, especially in the summer (up to 85.56 mg/L in Kalam). Conversely, non-tourist locations such as Matiltan and Bafar observed far lower amounts, particularly during the winter (down to 14.25 mg/L). At isolated locations, these seasonal variations are a result of natural fluctuations and little human influence. According to trends seen in earlier studies, all values support the safety of the water (Chauhan et al., 2016).

Magnesium: All sites had magnesium concentrations above the WHO standard of 50 mg/L, suggesting a high natural mineral content that is most likely the result of weathering carbonate rocks (Wilson et al., 2004). Moreover during the summer, visitor destinations like Kalam and Usho recorded up to 130.75 mg/L, while non-tourist destinations like Bafar and Matiltan displayed even higher levels (up to 151.87 mg/L). Despite its advantages, too much magnesium can alter the flavor and usability of water. The need for routine monitoring and perhaps therapy prior to ingestion is highlighted by the persistent elevation in all areas

Potassium: Potassium levels were significantly below the WHO standard of 20 mg/L, indicating that there was no risk to health. Tourist destinations such as Usho and Kalam had slightly higher concentrations (up to 4.8 mg/L), whilst non-tourist destinations such as Matiltan had the lowest amounts (0.48–1.73 mg/L). All results were found within permitted limits, and there was little seasonal change, indicating that the water was safe to drink throughout the study area.

Conductivity: Conductivity levels across all sites were significantly below the 800 µS/cm WHO standard, indicating acceptable ion concentrations. The summer conductivity in tourist destinations like Kalam and Usho was higher (up to 307 µS/cm), while the winter conductivity decreased seasonally (167–199 µS/cm). Reduced conductivity values in non-tourist locations, such as Matiltan and Bafar, indicated less anthropogenic influence and mineral richness. Every reading shows that the water is of good quality, fit for human consumption, and in ecological balance.

The variation in both the summer and winter seasons' water quality pollution indices in both tourist and non-tourist locations show that certain parameters experienced a slight increase during the summer months when a high number of tourists visited the sites. For example, total hardness changed from 147 to 187.66, TDS changed from 112.29 to 219.16, chloride changed from 7.1 to 18.89, pH changed from 6.37 to 6.91, and conductivity increased from 199 to 307. At similar locations, these were the indicators' maximum values for both seasons. All the parameters, though fall below the WHO's permissible level.

In a similar way, when comparing tourist sites to non-tourist sites, the former has higher parameter values than the latter. For example, TDS ranges from 193 to 223.26 in tourist locations and from 96.67 to 112 in non-tourist sites; similarly, chloride ranges from 9 to 18.89 in tourist sites and from 9 to 15.2 in non-tourist sites. Comparably, the pH ranges from 6.5 to 6.6 in non-tourist areas and from 6.7 to6.9 in tourist areas. The sodium ranges from 12.1 to 18.7 in non-tourist areas and from 23.6 to 30.25 in tourist areas and the calcium ranges from 6.69 to 15.57 in non-tourist areas. In addition, conductivity

Table 2. Chemical analysis of water (mg/l) during summer and winter in tourist sites.

	Summer Season						Winter Season					
	Usho			Kalam			Usho			Kalam		
Parameters	Source	Before Source	After Source	Source	Before Source	After Source	Source	Before Source	After Source	Source	Before Source	After Source
Total hardness	187. 66	157. 58	166. 17	198. 52	207. 40	213. 34	115. 56	103. 71	112. 59	150. 47	141. 40	147. 13
TDS	219. 16	168. 67	199. 05	179. 04	223. 26	193	98. 14	87. 34	92. 56	112. 29	101. 00	118
Chloride	18. 89	10. 82	11. 31	10. 72	8. 93	12. 5	6. 21	5. 31	5. 37	6. 44	6. 8	7. 1
Sulphate	11. 2	10. 6	12. 1	9. 27	9. 15	9. 02	9. 1	8. 2	10	8. 29	8. 31	8. 02
pH	6. 91	6. 51	6. 68	6. 81	6. 58	6. 77	6. 37	6. 23	6. 22	6. 37	6. 18	6. 23
Sodium	30. 25	25. 4	29. 2	21. 2	19. 8	23. 6	28. 6	24. 12	24. 3	17. 1	16. 7	18. 2
Total Alkalinity	53. 14	47. 23	34. 42	53. 14	37. 39	43. 29	47. 8	43. 8	41. 3	47. 6	42. 8	45. 05
Calcium	74. 39	52. 92	48. 65	85. 56	79. 63	82. 59	53. 33	38. 52	32. 59	40. 58	40. 53	34. 23
Magnesium	113. 28	104. 66	117. 52	112. 96	127. 77	130. 75	62. 23	65. 19	80. 00	109. 89	100. 87	112. 9
Potassium	4. 2	4. 7	4. 8	3. 5	3. 2	3. 9	3. 9	4. 1	4. 5	3. 1	3	3. 4
Conductivity	288. 1	276. 35	280	307	292	298	174	188	170	199	176	167

Table 3. Chemical analysis of water (mg/l) during summer and winter at non-tourist sites.

	Summer Season						Winter Season					
	Matiltan			Bafer			Matiltan			Bafer		
Parameters	Source	Before Source	After Source	Source	Before Source	After Source	Source	Before Source	After Source	Source	Before Source	After Source
Total hardness	157. 1	135. 13	147. 55	168. 23	183. 36	200. 55	117. 72	129. 49	141. 21	133. 11	144. 91	167. 17
TDS	96. 67	85. 32	94. 33	110	106. 34	112. 00	48	47. 3	44. 23	92. 61	97. 49	96. 71
Chloride	9. 89	11. 82	11. 31	15. 8	13. 45	15. 2	5. 36	4. 47	3. 57	4. 47	4. 47	6. 25
Sulphate	7. 05	7. 17	7. 18	8. 72	7. 04	7. 88	7. 08	6. 2	7. 23	6. 28	7. 3	7. 8
pH	6. 54	6. 69	6. 62	6. 59	6. 67	6. 64	6. 22	6. 13	6. 18	6. 37	6. 23	6. 25
Sodium	12. 1	11. 9	12. 2	18. 9	19. 4	18. 7	8. 98	5. 98	4. 03	22. 7	26. 00	28. 13
Total Alkalinity	24. 89	22. 27	23. 58	31. 44	27. 74	20. 74	21. 8	20. 6	22. 3	28. 2	23. 4	25
Calcium	35. 68	26. 69	28. 12	22. 13	31. 49	51. 57	14. 25	17. 19	19. 31	19. 23	22. 3	25. 52
Magnesium	121. 42	108. 44	119. 43	146. 1	151. 87	148. 98	103. 47	112. 3	121. 69	113. 88	122. 6	141. 65
Potassium	0. 5	0. 5	1. 73	2. 4	2. 5	2. 1	0. 48	0. 53	1. 28	2. 1	2. 4	2
Conductivity	150. 32	150. 33	149. 52	172. 49	165	177. 17	73. 15	67. 87	68. 65	99. 35	125. 01	131. 12

varies from 149 to 177 in non-tourist areas, and from 276 to307 in tourist areas. In tourist destinations, the range of calcium hardness values is 74.39 to 82.5 mg/l.

Bacteriological Analysis

Tourist Sites: Drinking water polluted by human activity or by the feces of other warm-blooded animals can contain coliform and fecal coliform bacteria (Geldreich et al., 1976). Water samples from tourist destinations were subjected to bacteriological pollution. The results showed that the range of coliform bacteria in Usho was 2.2 after the source, 5.1 in Usho before the source, and 3.6 (MPN/100ml) in Usho after the source. Similar variations in values were seen in the Kalam area and the range for the Kalam source was 3.6 (MPN/100 ml). The value reduced to 2.2 (MPN/100 ml) prior to the source and the identical value, 2.2 (MPN/100 ml), was measured subsequent to the source. The highest permissible concentration for drinking water, according to standards, is zero measurable level per 100 milliliters. In this instance, the coliform bacteria (MPN/100ml) in the sources from Kalam and Bafar showed high levels of 3.6 and 5.1, respectively. Comparably, the ratio of fecal coliform bacteria in the Usho source was 3.6, but the Usho after source had a ratio of 2.2. On the contrary, the MPN/100ml of the fecal coliform bacteria at the Kalam site was 3.6 (MPN/100ml), 2.2 before the source, and 2.2 (MPN/100ml) after the source. Table 4 shows that the permitted value of fecal coliform bacteria (MPN/100ml) is in accordance with guidelines for bacteriological analysis. Hussain et al. (2019) discovered that 35% of the community drinking water samples from Rawalpindi/Islamabad had bacterial contamination.

It is necessary to implement an appropriate routine monitoring system to guarantee that the community has a safe supply of drinking water and to avoid and reduce the likelihood of bacterial contamination. According to Jeon et al. (2019) incidence of coliforms or E coli was 34.5%. This finding was consistent with a study conducted in Lahore, where 42% (n=42) of 100 samples showed E. coli growth. According to a related study carried out in Peshawar by Khalid et al. (2018) 43% of the samples had E.coli contamination. (Table 4).

Table 4. Bacteriological analysis of water samples of tourists site.

Parameters	Usho			Kalam			Method Number
	Source	Before Source	After Source	Source	Before source	After source	
Coliform bacteria (MPN/100ml)	5. 1	3. 6	2. 2	3. 6	2. 2	2. 2	9221 A-E
Fecal coliform bacteria (MPN/100ml)	3. 6	3. 6	2. 2	3. 6	2. 2	2. 2	9221 A-E
After Tourist Season							
Coliform bacteria (MPN/100ml)	3. 2	1	1. 5	3. 4	2. 1	1. 9	9221A-E
Fecal coliform bacteria (MPN/100ml)	1. 5	1. 0	1	2. 8	1. 2	1. 1	9221 A-E

Table.5. Bacteriological analysis of non-tourist sites during tourist and after tourist seasons.

Parameters	Matiltan			Bafer			Method Number
	Source	Before source	After Source	Source	Before source	After source	
Coliform bacteria (MPN/100ml)	2. 2	2. 2	2. 2	3. 6	2. 2	2. 2	9221 A-E
Fecal coliform bacteria (MPN/100ml)	1. 1	2. 2	2. 2	2. 2	2. 2	2. 2	9221 A-E
After tourist season							
Coliform bacteria (MPN/100ml)	1	1. 3	1. 3	2. 1	1	2. 1	9221 A-E
Fecal coliform bacteria (MPN/100ml)	0	1. 3	0	1. 2	0	1. 3	9221 A-E

Non-tourist Sites: Table 6 shows the findings of the bacteriological analysis of the Coliform bacteria at the non-tourist sites clearly showed that the type of the bacteria was the same in Matiltan before the source, 2.2 (MPN/100ml) in Matiltan, correspondingly, both prior to and following the source The Bafar origin had a range of 3.6 (MPN/100ml), however the concentrations in the Bafar area were changing; in the Bafar prior to the source the value had dropped to 2.2 (MPN/100ml), and in the Bafar subsequent to the source, a similar quantity of 2.2 (MPN/100ml) was found. The highest permissible level for drinking water, as per standards, is zero measurable concentration per 100 milliliters. Thus, no total coliforms or E. coli should be found in every 100 milliliters of drinking water tested in order to comply with the recommendation. However, in water samples from the Bafar and Matiltan sites, the range of coliform bacteria (MPN/100ml) was measured 2.2 (MPN/100ml) throughout the current study. This demonstrates a rise in bacteria in river water of study area. Comparably the fecal coliform bacteria ratio in Matiltan before the source was 1.1; however, this number changed to 2.2 in Matiltan after the source and Matiltan source, respectively. On the other hand the fecal coliform bacteria (MPN/100ml) at the Bafar site remained constant at 2.2 under all circumstances, including the Bafar source, Bafar both ahead of and behind the source.

Conclusion

According to this study, majority of the locals engaged in tourism earn significant revenue, because it is regarded as a productive activity for leisure and economic growth. The tourism sector is a major driver of the regional economy of Swat Kalam. In addition, tourist-related activities cause environmental deterioration because of insufficient oversight, planning, and knowledge among the public and tourism stakeholders. This study also evaluated the effects of tourism on water quality at popular tourist destinations during the summer and winter seasons. Moreover, 52% of the respondents indicated that there is no facility for garbage handling and disposal, indicating that trash management and disposal is a significant issue in the research area and could negatively impact the area's beautiful appeal. Since the Swat River is a source of drinking water, the majority of hotels directly release their waste into the river, polluting the water.

It is concluded that during summer high visitor numbers resulted in high concentration of the water contaminants. Furthermore, the residents indicated that tourism is growing their economies, but sustainable measures are necessary to protect this region from negative effects in the future.

Conflict of interest: None

References

Jassef, S., Getaneh, T., Bekele, F. (2020). Environmental determinants of diarrheal morbidity in under-five children, Keffa-Shekka Zone, Southwest Ethiopia. *Journal of Ethiopia*, **38**(1), 27-34.

Kakar, M. K., Khalil, S. (2017). The relation between tourism and employment in Pakistan. Master's Thesis report: Department of Applied Economics, University of Karachi, Pakistan.

Khan, K., Lu, Y., Saeed, M. A., Bilal, H., Sher, H., Khan, H., Liang, R. (2018). Prevalent fecal contamination in drinking water resources and potential health risks in Swat, *Pakistan. Journal of Environmental Sciences*, **72**, 1-12.

Martinis, A., Halvatzaras, D., Kabassi, K. (2011). Promotion of eco-tourism using the practice of Wikipedia: The case-study of environmental and cultural paths in Zakynthos. In Book of Abstracts. International Conference on Organic Agriculture and Agro-Eco Tourism.

Ko, D. W., Stewart, W. P. (2002). A structural equation model of residents' attitudes for tourism development. *Tourism Management*, **23**(5), 521-530.

Saqib, N., Yaqub, A., Amin, G., Khan, I., Ajab, H., Zeb, I., Ahmad, D. (2019). The impact of tourism on local communities and their environment in Gilgit Baltistan, Pakistan: A local community perspective. Environmental & Socio-economic Studies, **7**(3), 24-37.

Grobler, J. J., Mearns, K. F. (2017). Applying water quality as a management tool for the wildlife lodge industry in South Africa and Botswana. BEST EN Think Tank XVII: Innovation and Progress in Sustainable Tourism, **18**, 12

Yu, J. H., Lin, H. H., Lo, Y. C., Tseng, K. C., Hsu, C. H. (2021). Research on sustainable development evaluation of reservoir water source area in Island Area. Water, **13**, 1130.

Khalid, S., Shahid, M., Natasha, Bibi, I., Sarwar, T., Shah, A. H., Niazi, N. K. (2018). A review of environmental contamination and health risk assessment of wastewater use for crop irrigation with a focus on low and high-income countries. International Journal of Environmental Research and Public Health, **15**(5), 895-931.

Ahmad, A., Ali, A., Mannan, A. (2022). Mountain Forests and their Significance. Mountain Studies: Understanding and Managing Mountains for People and Nature,

Erwin, E., Herwan, H. (2024). Value-based communication strategies and tourism growth: Effectiveness-vam model. Jurnal Ekonomi, **13**(3), 1584-1599.

Ali, S., Qurashi, R. U., Munazir, M., Shah, S. A., Hussain, W., Bussmann, R. W. (2023). Patterns of wild edible plants consumption of District Swat, Pakistan: Emphasizing the importance of plants in uplifting the quality of life of local residents.

Sanaullah, Rabbi, F., Ali, S., Khan, Z., Zamin, M. (2020). Visitors' willingness to pay for conservation of the biodiversity and tourism in Kalam valley of Khyber Pakhtunkhwa, Pakistan.

Matta, G., Kumar, A., Srivastava, S., Singh, V., & Dhingra, G. K. (2015). Impact assessment on water quality of Ganga canal system in Himalayan region. International Journal of Scientific & Engineering Research, **6**(5), 1524-1531.

Kumari, M., Mudgal, L.K. Singh, A.K. (2013). Comparative studies of physio-chemical parameters of two reservoirs of Narmada River, MP, India. Current World Environment, **8**, 473-478.

Chauhan, P., Rana, D., Bisht, A., Sharma, U. (2016). Tourism impact on physio-chemical parameters of Mansarlake, Jammu & Kashmir. Journal of Global Sciences, **5**(1), 3604-3610.

Wilson, M. J. (2004). Weathering of the primary rock-forming minerals: Processes, products and rates. *Clay Minerals*, **39**(3), 233-266.

Geldreich, E. E., Litsky, W. (1976). Fecal coliform and fecal streptococcus density relationships in waste discharges and receiving waters. *Critical Reviews in Environmental Control*, **6**(4), 349–369.

Hussain, W., Ahmed, U., Zaman, G., Jamil, B., Khursheed, U., Mirza, I. A. (2019). Bacteriological examination of drinking water in Rawalpindi and Islamabad area. Pakistan Journal of Pathology, **30**(4), 101-104.