Proper assessment of coastal water quality for recreational purposes contributes towards human health and tourism promotion

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ABSTRACT: The aim of this research is to verify the health conditions of seawater and beach sand in the beaches of Albanian Adriatic coast during the period of summer 2023. *Escherichia coli* and *Enterococci* parameters were evaluated. Their densities were determined by the Filter Membrane Method (ISO 7899-1 for *Enterococci* and ISO 9308-3 for *E. coli*) and estimated by the colony-forming unit (CFU) using, in that order, selective terrain ECD and TTC agar. The recent tourism development of Albania requires serious monitoring and assessment of the coastal water and sand since that is directly connected to human health and national economy.

KEYWORDS: coastal beaches, quality, management, microbiological pollution, human health.

1.   INTRODUCTION

Following Albanian strategy for tourism development (MoTE, 2019), the coastal tourism category includes coastal tourism and maritime tourism. The first refers to activities that take place on the seafront or that proximity to the seafront is the basis of their organization, such as swimming, beach baths and other related recreational activities, while the second refers to activities taking place at sea, including tourist cruising (yachting, sailing, cruising), yacht ports with all related services and activities, and sea sports. The beach, the sea and the sun has been the main product for years, accounting for the largest share of total tourism products. This type of tourism in Albania has an emphasized seasonal character, and as a result most of the coastal accommodation facilities face seasonal difficulties of operation. Meanwhile, for maritime tourism, the infrastructure is currently lacking and this segment (yachting, sailing, and cruising) is still in its beginnings, but the potential for development is enormous and very important for Albania's economy and elite tourism. Further on the statistical data for the year 2023, show a record number of 10 million tourists that mostly were using the coastal beaches. This required serious monitoring and assessment of the coastal water and sand since that is directly connected to human health and national economy.
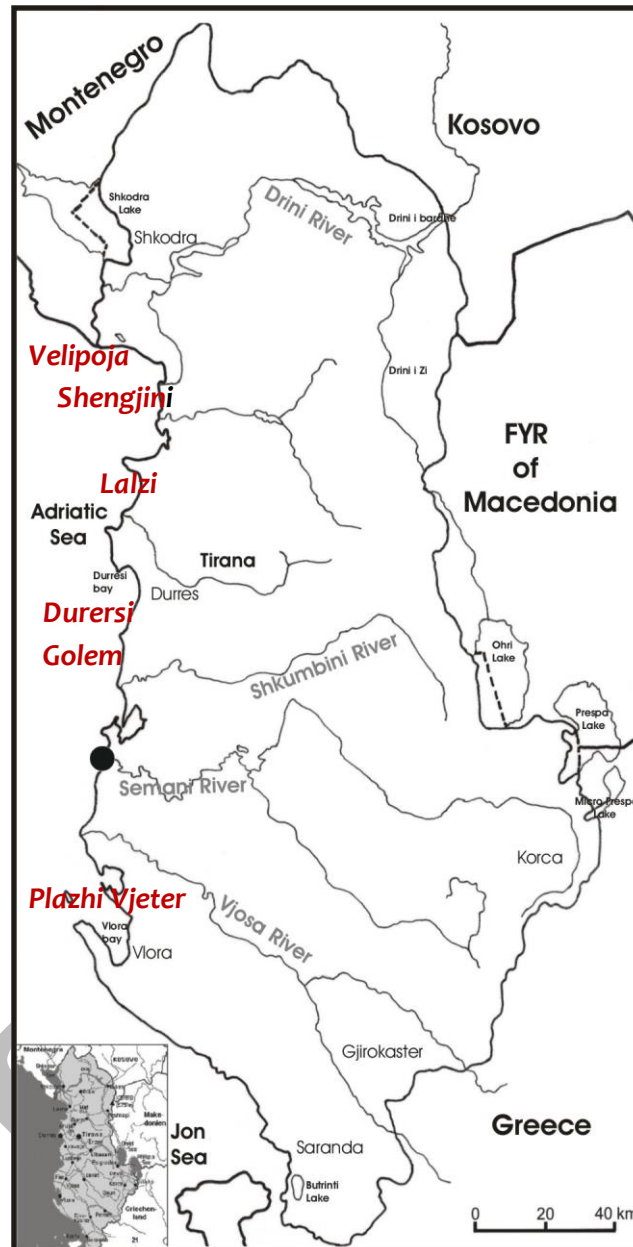
Figure 1. Six different beach areas considered for microbiological quality of water and sand in Albanian Adriatic coast

Based on similar studies in the Mediterranean (Anfuso et al., 2013; Botero et al., 2021; Bolívar-Anillo et al, 2022) beach sand analysis has resulted in the presence of fungi, total coliforms, coliforms faeces, *Escheriscia coli*, *Staphylocoques* and *Pseudomonas* in sand. Fungal species identified in order of importance are: Penicillium spp. Aspergillus, Cladosporium, Fusarium, Rhodoturula, Alternaria spp. Mucor, *Candida zeylanoïdes*, Phialophora spp., *Cryptococcus albidus*, Rhizopus spp., Scopulariopsis spp., Chrysosporium spp., Geotrichum spp., Acremonium spp., Rhizomucor spp., *Saccharomyces cerevisiae*, *Candida albicans*. Among these taxa, some species are highly pathogenic to humans and represent a real risk to public health. In recent years, there has been a growing interest of researchers in the world, mainly focused on marine mushrooms (Fujioka et al., 2015; Sánchez Moreno et al., 2019; Shah et al., 2019), due to their considerable utility in agri-food and health on the one hand, as well as their great harmful effects on the other hand, producing toxic substances, as they cause digestive dysfunctions in the affected persons.

2. MATERIAL AND METHODS

The assessment of the quality of coastal bathing waters was carried out based on 57 sampling stations during the period May-September 2023 (Figure 1). A sampling series was taken at the beginning of the bathing tourist season, in the month of May 2023; from a sampling series during the bathing tourist season, in the months of June, July and August 2023, while a sampling series was carried out after the bathing tourist season, in September 2023. The number of samples is the same as for coastal bathing waters and sand, sampling was carried out in the same coordinates, in total 57 water samples, 57 sand samples were taken every month.

Based on the work method, the following indicators were evaluated during the study: (i) Bacteriological indicators: *Enterococcus* intestinal (IE) and *Escherichia coli* (E.coli) in water and sand; (ii) Bacteriological indicators in drinking water: *Escherichia coli* (E. coli); (iii) Chemical indicators measured in water (in situ): temperature and pH; (iv) The degree of exposure of the population to the microbiological pollution of the beaches and (v) Parameters related to the visual aspect; anthropogenic pollution; water color; meteorological situation and type of beach.

3. RESULTS AND DISCUSSIONS

During the study period for the year 2023, 12 monitoring stations (respectively 7 and 5) were monitored on the beach of Velipoja and Shengjin and a total of 60 samples were analyzed.

Assessment of the quality of coastal bathing waters: A total of 60 samples were analyzed, which were assessed for the presence of *Escerischia coli* microorganisms (expressed no/100 ml of water) and *Enterococci* (expressed no/100 ml of water), were measured on site: water temperature (at 0C) and pH (in pH units). The presence of the microorganism E. coli was found with Min 5 CFU/100ml of water; Max 420 CFU/100 ml of water; Average value was 91.4 and Standard Deviation 87. Presence of *Enterococci* with Min 3 CFU/100 ml of water; Max 280 CFU/100 ml of water; Average 71.4 and Standard Deviation 62.4. For the parameters measured in situ, the Min temperature was found to be 19^0C; Max 29.5^0C; Mean 25.7 and Standard Deviation 3.4 and pH has a Min 7 pH units; Max 7.5 pH units; Average 7.4 and Standard Deviation 0.2.
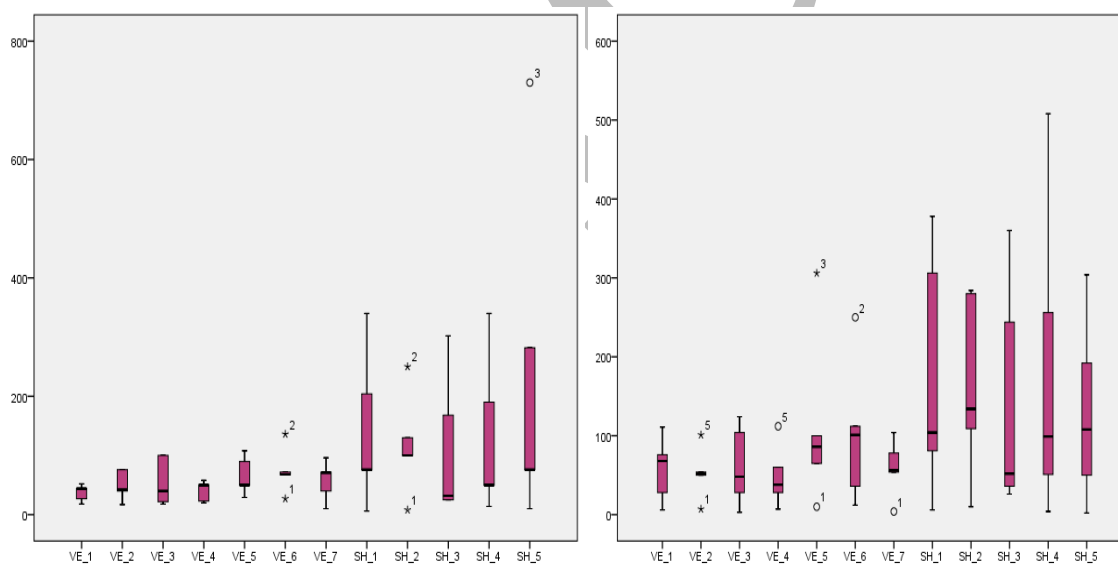

Figure 2: (left) Boxplot for distribution of microbiological data (E. coli) according to monitoring points and (right) Boxplot for distribution of microbiological data (Enterococci) according to monitoring points

Assessment of sand quality:

A total of 60 samples were analyzed and evaluated for the presence of microorganisms E. coli (expressed as CFU/gr of sand) and *Enterococci* (expressed as CFU/gr of sand). The presence of both microorganisms was found in all the samples analyzed. The highest values were found in the month of June 2023 (Figures 1, 2 - distribution of microbiological data from *E. coli* and *Enterococci* by month including the Median and the presence of outliers) and at the first monitoring point (Ex Cabins) in Shengjin beach (Figures 2). In 48% of the analyzed samples, they were positive for the presence of mold.

Similarities in results is reflecting consisting data with other different countries (including Mediterranean countries), where the possibilities of impacts on beach users from microorganisms in water have received considerable attention (Bici et al. 2022; Bolívar-Anillo et al., 2023), while there are relatively few related studies with microbial contaminants in beach sand (Sánchez Moreno et al., 2019). From a recreational point of view, sandy beaches are the busiest, as they represent a space of relaxation and entertainment (Bunghez, C.L. 2016; Anfuso et al., 2018; Botero et al., 2022). Following high attendance, a possible microbiological contamination of the sand may be a source of pathogen transmission.

Referring to the guidelines for the quality of recreational waters according to the WHO (WHO, 2021) as well as the European Directive on bathing waters (Sabino et al., 2011), the classification of beach sand for the presence of the microorganism E. coli resulted in 48 sand samples (80 %) above the reference value of 25 CFU/1g of sand. *Enterococci* in 32 sand samples (48%) above the reference value of 60 CFU/1g sand. The graphic presentation of this categorization is shown below by means of a Scatter Chart (Figure 3).
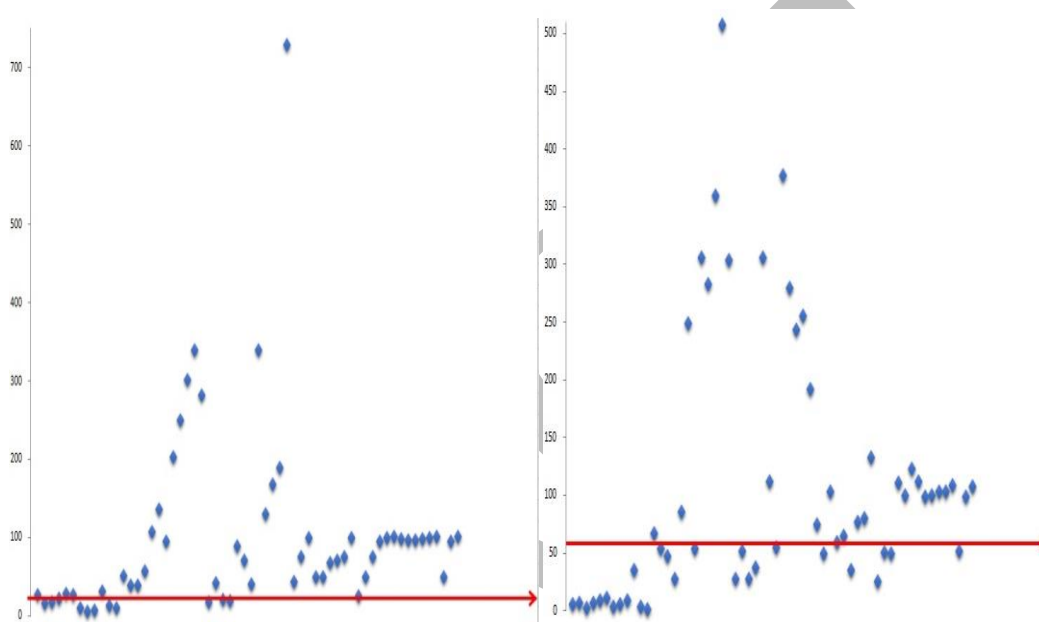

Figure 3: The classification of sand quality (left) Escherichia coli and (right) Enterococci

To show the possible relationship between the microbiological pollution in the bathing water and in the sand, the statistical test of correlation was used. The Pearson Correlation coefficient between E. coli in bathing water and sand is 0.532, this indicates a positive linear relationship between the two variables. P-value of 0.000 (rounded) < 0.05 indicating that the correlation is highly statistically significant.

The Pearson Correlation coefficient between Enterococci in bathing water and sand is 0.619 with a positive linear relationship between the two variables. The P-value of 0.001 < 0.05 indicates that the correlation is statistically significant. Scatterplot was used to present the correlation between the two variables (Figure 4).
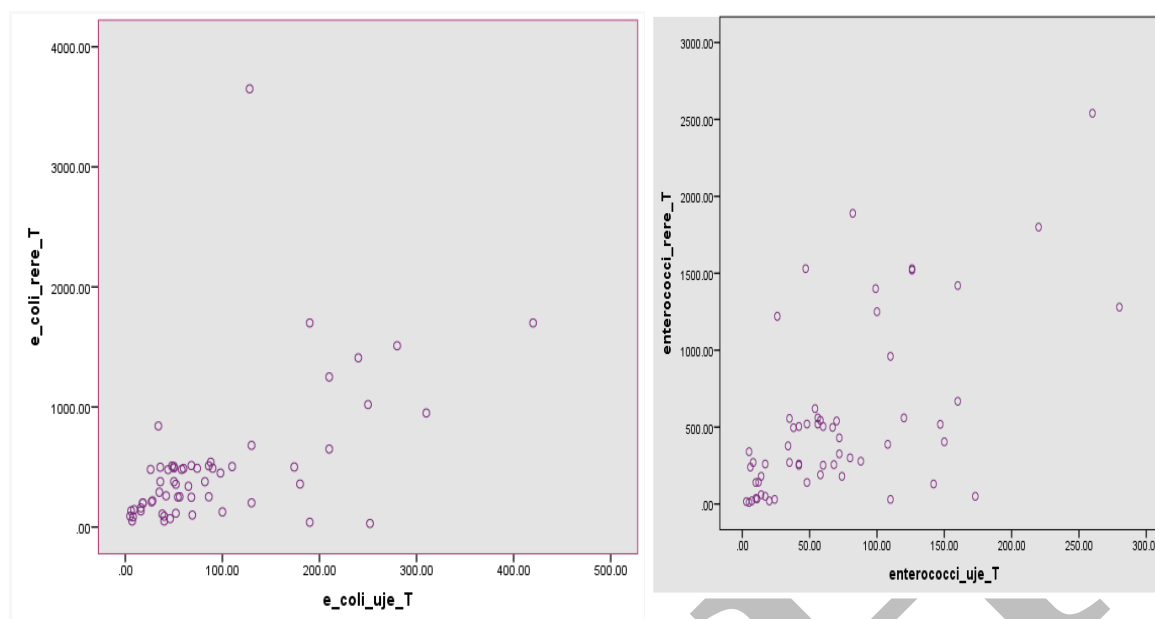
Figure 4: Correlation of E. coli in bathing water and sand. (left-E. coli and right-Enterococci)

4. CONCLUSSIONS

Microbiological pollution of bathing waters with the presence of E. coli and Enterococci microorganisms was found in all monitoring points, with the exception of only 2 (two) monitoring points on the beach of Lalzi Bay in May 2023. Higher microbiological pollution, was determined by the presence of the microorganism E. coli, which is associated with a high level of human fecal pollution.

At all monitoring points for sand quality assessment, microbiological contamination was found with the presence of two microorganisms, E. coli and Enterococci. Higher microbiological contamination was found by the presence of Enterococci microorganism, which is related to a potential fecal contamination from animals. The high presence of these microorganisms can increase the risk of public health infections.

A direct positive correlation was found between samples with high microbiological contamination and samples positive for the presence of mold (54% of the analyzed samples were positive for the presence of mold).

Referring to the guidelines for the quality of recreational waters according to WHO, 2021 and the European Directive on bathing waters, 79.6% of the analyzed samples resulted above the reference value for E. coli and 51.2% for Enterococci. The highest microbiological pollution of the sand was found in the beach of Kavaja and Vlora.

From the processing of the data, a statistically significant relationship between microbiological contamination by E. coli and Enterococci in water and in sand has resulted. A negative correlation between these two variables has resulted only in the Lalzi Bay beach.There is a statistically significant relationship between the microbiological contamination by E. coli and Enterococci in the sand, as well as the health effects on the frequenters of these beaches.

REFERENCES

1. Anfuso, G., Bolivar-Anillo, H.J., Sanchez, H., Villate Daza, D.A., Lopez Daza, O.L. (2018). Coastal Tourism Importance and Beach Users' Preferences: The "Big Fives" Criterions and Related Management Aspects. J. Tour. Hosp., 7, 7–8.
2. Bici, E., Shumka, S., Kokali, A. (2022). Introducing an integrated evaluation index for recreational beaches in Albania aiming at Improvement of Assessment and Integrated Approach. Proceedings of the 4th Advanced Engineering Symposium http://aed.mersin.edu.tr/
3. Bolívar-Anillo, H.J., Soto-Varela, Z.E., Sánchez Moreno, H., Villate Daza, D.A., Rosado-Porto, D., Vega Benites, S. Pichón González, C., Anfuso, G. A. (2023). PreliMinary Approximation to Microbiological Beach Sand Quality along the Coast of the Department of Atlántico (Caribbean Sea of Colombia): Influence of the Magdalena River. Water, 15, 48. https://doi.org/10.3390/w15010048

4. Botero, C.M., Tamayo, D., Zielinski, S., Anfuso, G. (2021). Qualitative and quantitative beach cleanliness assessment to support marine litter management in tropical destinations. Water, 13, 3455

5. Fujioka, R.S., Solo-Gabriele, H.M., Byappanahalli, M.N., Kirs, M.U.S. (2015). Recreational water quality criteria: A vision for the future. Int. J. Environ. Res. Public Health, 12, 7752–7776.

6. MoTE (2019). National strategy for sustainable tourism development 2019 – 2023 for Albania. Tirana, pp. 29

7. Sabino, R., Veríssimo, C., Cunha, M.A., Wergikoski, B., Ferreira, F, C., Rodrigues, R. 2011: Pathogenic fungi: an unacknowledged risk at coastal resorts? New insights on microbiological sand quality in Portugal. Mar Pollut Bull., 62(7): 1506–11.

8. Sánchez Moreno, H., Bolívar-Anillo, H.J., Soto-Varela, Z.E., Aranguren, Y., Gonzaléz, C.P., Villate Daza, D.A., Anfuso, G. (2019). Microbiological water quality and sources of contaMination along the coast of the Department of Atlántico (Caribbean Sea of Colombia) - PreliMinary results. Mar. Pollut. Bull., 142, 303–308.

9. Shah, A.H., Abdelzaher, A.M., Phillips, M.; Hernandez, R., Solo-Gabriele, H.M., Kish, J., Scorzetti, G., Fell, J.W., Diaz, M.R., Scott, T.M. (2019). Indicator microbes correlate with pathogenic bacteria, yeasts and helMinthes in sand at a subtropical recreational beach site. J. Appl. Microbiol. 110, 1571–1583.