European Water 58: 217-221, 2017.

A comparative study of water quality in a highly frequented seacoast in Albania

E. Hamzaraj*, P. Lazo, A. Paparisto and R. Bami
Faculty of Natural Sciences, University of Tirana, Tirana, Albania
* *e-mail: etleva.hamzaraj@fshn.edu.al*

Abstract: The control and monitoring of environment is done not only to guarantee healthy ecosystems but also to put in evidence if they present any risk for humans. The new demographic changes in our country, especially in seacost regions, have increased the interes concerning their negative effects from environmental point of view in these areas. The objective of this study was to evaluate dynamics of water quality in a highly frequented seacoast in Albania in a ten years period. For this reason, a bacteriological and chemical study was carried out from July 2015 to June 2016 on seacoast of Durrës, and the data collected were compared with those of a similar study during 2005 and 2006. Seawater samples were taken monthly from six stations evenly distributed on this coast line. Total coliforms, faecal coliforms and intestinal enterococci were estimated using MPN method, while chemical parameters like pH, ammonia, phosphate, nitrite and nitrate where estimated using standard methods. Our data show that after ten years, in general, bacterial indicators were increased, but at least in one station, where a new system of waste water pipes is built, bacterial parameters are decreased. High concentrations of faecal bacteria were associated with high concentration of nitrite and nitrate. The results of this study indicate that there is no improvement in the quality of seawater in Durres, and there is still much work to be done in order that water in this area becomes safe for bathing.

Key words: water quality, faecal coliforms, intestinal enterococci, MPN method

1. INTRODUCTION

Human activity exerts a significant impact on coastal ecosystems. The pressures exerted are diverse and result from many activities such as coastal engineering, sediment dredging, pollution, fishing, aquaculture, urban development, maritime transport, tourism, oil extraction, transport, agricultural and industrial activities, etc. Sewage and untreated industrial effluents are being discharged from decades into the sea which leads to increase in pollution level (Chrost, 1990).

Contamination of water is a serious environmental problem as it adversely affects the human health and the biodiversity in the aquatic ecosystem. Among many pollutants, faecal waste presents the most acute risk to human health. Faecal waste generally harbors enteric pathogens in addition to agents that cause skin, eye, ear, and respiratory illnesses. Enteric pathogens are typically responsible for waterborne diseases (Stewart et. al., 2008; Halpern et al., 2007, 2008).

Current guidelines in the three water-related areas (drinking water, wastewater and recreational water) assess quality, in microbiological terms, by measuring indicator organisms. Faecal coliforms and intestinal enterococci are widely used for assessment of water pollution and possible water quality deterioration in fresh water sources (Foden, 2008). Coliforms are Gram-negative, no spore-forming, oxidase-negative, rod-shaped facultative anaerobic bacteria that ferment lactose (with β-galactosidase) to acid and gas within 24 - 48h at 36 ±2 °C. Not specific indicators of faecal pollution. Thermotolerant coliforms are coliforms that produce acid and gas from lactose at 44.5±0.2°C within 24±2h, also known as faecal coliforms due to their role as faecal indicators. *Escherichia coli* is part of thermophilic coliforms that produce indole from tryptophan, but also defined now as coliforms able to produce β-glucuronidase (although taxonomically up to 10% of environmental *E. coli* may not). This is the most appropriate group of coliforms to indicate faecal pollution from warm-blooded animals (Karaboze, 2003). Intestinal enterococci are Gram-positive, catalase-negative cocci from selective media (e.g. azide dextrose broth or m Enterococcus agar) that

grow on bile aesculin agar and at 45 °C, belonging to the genera *Enterococcus* and *Streptococcus* possessing the Lancefield group D antigen. The presence of these bacteria in water could be from human origin or animal origin (Prescott, 2002, Nogales, 2007).

We focused our study in seacost line of Durrës as one of the most frequented areas during summertime. Swimming in seawater with faecal contamination increases the possibility of getting a disease like gastro-intestinal ones, or different infections. For this reason estimation of microbiological water quality is very important for public health (Borrego, 1991). Normally beaches where swimming is allowed should be tested for water quality before the swimming season begins, to get a baseline of contamination due to natural wildlife or run-off and each week thereafter until the area closes (UNEP, 1990).

The objective of this study was to monitor the quality of seawater in Durrës coastline and to compare it with a similar study done ten years ago.

2. MATERIALS AND METHODS

We carried out a bacteriological and chemical study from July 2015 to June 2016 along the seacoast of Durres. Seawater samples were taken monthly from 6 stations evenly distributed: Aragosta (St. 1), Porti (St. 2), Ura e Dajlanit (St. 3), Hekurudha (St. 4), Shkembi i Kavajes (St. 5), Perroi i Agait (St. 6).

Total coliforms, faecal coliforms and faecal streptococci were measured using the most probable number (MPN) method, while chemical parameters like pH, ammonia, phosphate, nitrite and nitrate where measured using standard methods (APHA, 1998, Elmir, 2007). MPN for total coliforms and faecal coliforms was determined by fermentation test on lactose broth for preliminary test, and on brilliant green bile confirmatory test. The concentration of intestinal enterococci was determined using, also, MPN method but the media used were azide dextrose broth for preliminary test, and TTC agar for confirmatory test.

3. RESULTS AND DISCUSSION

As previously mentioned, the region under study was seacoast of Durrës as one of the most frequented beaches in Albania. The objective of our study was not only to monitor the quality of coastal water during a one year period, but also to compare it with the data obtained by a similar study done during 2005-2006.

Indicators of faecal pollution comprises the bacteria which are normally taken as indicators of the degree of purity of water. In our study we used three parameters for fecal contamination: concentration of total coliform bacteria, *E. coli* and *Streptococcus faecalis*. Mean values of bacteriological and chemical indicators in all sampling sites during the investigation period are presented in Table 1. The highest values of microbiological parameters registered are at: total coliforms concentration 2075 CFU/100ml at sampling station No. 5 (Shkëmbi i Kavajës), and *E. coli* 1187 CFU/100ml and intestinal enterococci 1147 CFU/100ml at sampling station No. 6, Përroi i Agait (Table 1). We think that these high values of microbial load in this area are due to many visitors that frequent this area especially during summertime and due to a channel that spill sewage into the sea. The minimum concentration of same parameters are registered at sampling station No. 2, Porti: total coliforms concentration 798 CFU/100ml, *E. coli* 532 CFU/100ml and intestinal enterococci 407 CFU/100ml. Comparison of the data obtained from both studies put in evidence the decrease of faecal indicator organisms concentration only in one sampling site that is "Porti" (Table 5). For the last years a new system of waste water pipes is built in Durres and this could be the reason why the bacterial load in this sampling site is decreased.

According to Directive 2006/7/EC of the European Parliament concerning the management of bathing water quality, the quality of coastal waters in the bay of Durrës during the period of investigation falls in the category "Poor". The 90th percentile for intestinal enterococci is 1015

CFU/100ml (which is higher than 185 CFU/100ml), while for *E. coli* is 1500 CFU/100ml (which is higher than 500 CFU/100ml). As mentioned above, a similar study was conducted in 2005-2006. By comparing the data it appears that there is an increase of 90th percentile values of *E. coli* concentration at each sampling site, except for the site "Porti" where impairment is significant (Table 3). However, even according to the study conducted in 2005-2006 coastal water quality was under the category "Poor", based on Directive 2006/7/EC. (The 90th percentile for intestinal enterococci was 742 CFU/100ml, while for *E. coli* was 1300 CFU/100ml). This means that in all these years although efforts were made to minimize the causes of pollution of the sea water, we are far from bathing coastal waters of good quality.

Table 1. Mean values of bacteriological and physico-chemical indicators in all sampling sites during the investigation period

	St. 1	**St. 2**	**St. 3**	**St. 4**	**St. 5**	**St. 6**
Coliform total	1493	798	1243	1360	2075	1447
E. coli	1047	532	1048	898	1063	1187
Intestinal enterococci	638	407	695	712	668	1147
Nitrites NO_2^- mg/l	0.011	0.017	0.031	0.067	0.061	0.075
Nitrates NO_3^{2-} mg/l	0.905	0.513	0.903	0.45	0.787	0.461
Phosphates PO_4^{3-} mg/l	1.81	1.285	1.325	1.185	1.37	2.23
Ammonia NH_3 mg/l	2.2	1.595	1.825	1.475	1.71	1.97
pH	6.8	7.4	7.5	7.2	7.45	7.43

Table 2. Directive 2006/7/EC of the European Parliament concerning the management of bathing water quality

	A	B	C	D	E
	Parameter	Excellent quality	Good quality	Sufficient	Reference methods of analysis
1	Intestinal enterococci (cfu/100 ml)	100 (*)	200 (*)	185 (**)	ISO 7899-1 or ISO 7899-2
2	Escherichia coli (cfu/100 ml)	250 (*)	500(*)	500 (**)	ISO 9308-3 or ISO 9308-1

(*) Based upon a 95-percentile evaluation
(**) Based upon a 90-percentile evaluation

Table 3. 90th percentile values for E. coli in all sampling sites in two periods of investigation

	2005	**2015**
Aragosta	1100	1750
Porti	2400	930
Ura e Dajlanit	1240	1450
Hekurudha	1100	1100
Shk. i Kavajës	1100	1300
Përroi i Agait	1100	1750

Besides microbiological parameters we measured some chemical parameters that help determine water quality, such as nitrates, nitrites, phosphates, ammonia and pH. Correlation coefficients between the three microbiological indicators of water quality and chemical parameters measured during the study are presented in Table 4. From these data it appears that there is a strong positive correlation between *E. coli* and total coliform (r = 0.7) and between *E. coli* and intestinal Enterococci (r=0.78) (Aulicino, 1980).

These correlations suggest that there is one source of pollution. Our data show also that there is strong to medium positive correlation between faecal indicators and some nutrients as nitrite, phosphate and ammonia. This is an expected result because these affect directly microbial growth. The presented data confirm the known ecological phenomena consisting in the cooperation of biotic and abiotic factors of the environment influencing the life, dynamics and distribution of microorganisms in the waters.

Figure 1 shows clearly the growing trend of bacterial concentration in a ten years period, which confirms a deterioration in the quality of coastal seawater in bay of Durres.

Table 4. Pearson's correlation coefficient between different parameters

	Total coliforms	*E. coli*	Intestinal enterococci
Coliform total	1		
E. coli	0.7	1	
Intestinal enterococci	0.34	0.78	1
Nitrites NO_2^- mg/l	0.48	0.47	0.71
Nitrates NO_3^{2-} mg/l	0.35	0.34	-0.26
Phosphates PO_4^{3-} mg/l	0.17	0.59	0.76
Ammonia NH_3 mg/l	0.21	0.58	0.35
pH	-0.05	-0.06	0.17

Table 5. Mean values of microbial and chemical parameters measured during 2005-2006 and 2015-2016 in six sampling stations along the seacoast of Durrës

Parameters		St. 1	St. 2	St. 3	St. 4	St. 5	St. 6
Coliform faecal	2005-6	125	657	665	291	382	613
	2015-16	1047	531	1048	898	1063	1187
Coliform total	2005-6	521	997	451	610	690	325
	2015-16	1493	798	1243	1360	2075	1446
Ammonia	2005-6	0.36	0.46	0.42	0.37	0.43	0.51
	2015-16	2.2	1.39	1.83	1.48	1.71	1.97
Nitrite	2005-6	0.02	1.44	0.74	8.43	8.44	0.01
	2015-16	0.014	0.017	0.031	0.066	0.061	0.075
pH	2005-6	7.98	7.97	7.99	8	8	8.05
	2015-16	7.2	7.5	7.7	7.2	7.6	7.4

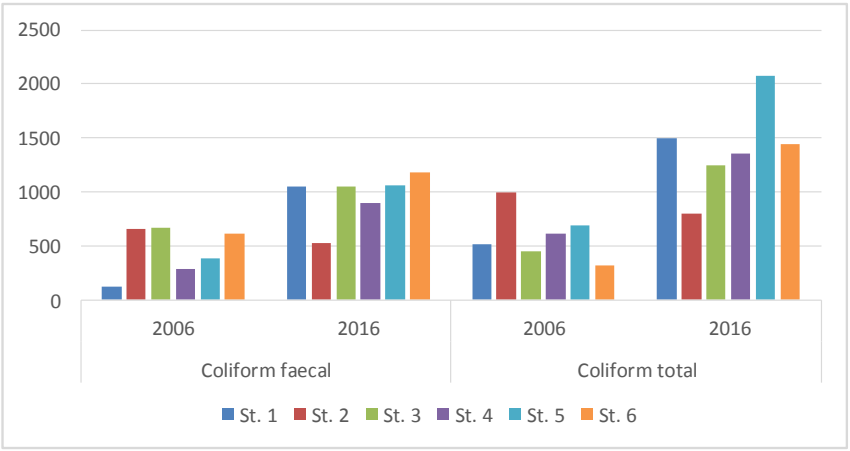

Figure 1. Dynamics of microbial indicators

Results, received during this study indicate that seawater along the seacoast of Durres is under high anthropogenic impact. Waste water from the settlements located in the watershed, especially on the shore, have distinct human impact to the water quality. It is more than evident that there is still much work to be done in order that water in this area become safe for bathing.

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