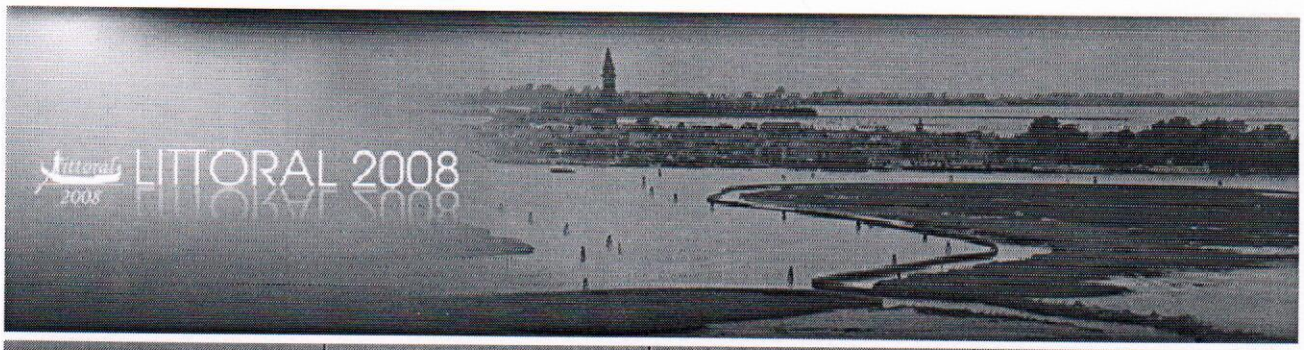


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MICROBIOLOGICAL COASTAL SITE QUALITY ASSESSMENT IN KONYAALTI AND LARA BEACHES, ANTALYA

Gonul TUGRUL ICEMER, Akdeniz University, Faculty of Engineering, Dept. of Environmental Engineering ANTALYA, TURKEY, gicemer@akdeniz.edu.tr
Aysegul TOPALOGLU, Akdeniz University, Faculty of Engineering, Dept. of Environmental Engineering ANTALYA, TURKEY, atopaloglu@akdeniz.edu.tr

Abstract

Illness occurrence risk has increased due to interaction between human that affects coastal site quality and contaminated areas, such as knee-deep sand, wave zone and dry sand. Most of the risk is caused by pathogen bacteria.In the present study, microbiological indicators that are *Escherichia coli* (EC), *Salmonella spp.* and Intestinal Enterococci (IE) are monitored for assessing microbiological coastal site quality of Antalya Bay. The beach sands showed a great difference of bacterial colonization in June and July. In stations E1 and E2, the highest and the lowest concentrations of EC were found both in the sea water and wave zones. All stations were evaluated using the European Community (EU) standards for EC and IE, and Turkey standards for recreational and bathing seawater. According to Directive 2006/7/EC of the European Parliament and the Council, all stations exhibited "excellent quality" and "good quality in high tourism season. Children of age group 1-5 yr, in particular, are exposed to considerable pathogen risk. In this reason, EC and intestinal enterococci should be analyzed both at wave zone and in sand, because these zones are areas of recreational activity for bathers and children.

Introduction

Coastal cities have the highest rates of growth than any other areas. It has been calculated that 320 million people shall be living in the world's megacities by 2010 [1]. Antalya is one of the most famous tourism destination which lies on the Turkish Mediterranean coast. The amount of tourists visiting Antalya is increasing every year because of the tourism activities. Coastal tourism and recreation activities are included ecotourism and recreational activities such as recreational boating, cruises, swimming, recreational fishing, snorkeling and diving.

In this reason, the coastal region of Antalya Bay has increased in population growth and development in the past twenty - five years. The Antalya Bay is 640 kilometers length and it has 1.789.295 (Turkish Statistical Institute) million populations. An estimated total 7.2 million tourist and about 3 million domestic tourist visits the public beach of Antalya, annually for a total economic benefit to the state over 5 US billion dollars. This increase causes microbiological pollution in the sea. Microbial pollution generated by these sources that can mostly reach the environment uncontrolled.

WHO [2], reported that recreational waters may contain a mixture of pathogenic and non-pathogenic microbes derived from sewage effluent, the public using the water, farming activities, and possibly wild life in addition to any indigenous microorganisms. Epidemiological studies have shown at higher risk children playing in the tidal or swash zone. Also, children may be at high risk because of the ingestion of water that may contain enteric pathogens. An increase in nutrient loading will increase microbiological densities in the water. In addition to the climatic conditions, another important fact is

that tropical or sub tropical regions have a much greater number of waterborne pathogens and infectious diseases. Sources of fecal bacteria in these beaches are suspected to be from sewage outfalls, combined sewer overflows, storm water discharges, river discharges, and bather shedding.

This paper reports the results of a monitoring program carried out on the Antalya bay for the assessment of *E. coli*, intestinal enterococci and *Salmonella* spp occurrence within marine water and sand, and in Konyaalti Beach and Lara Beach. In addition to, we were to evaluate that relation between health risks and microorganism levels in seawater body and sand or pebble.

Description of the area

In Antalya city, at the east and west of city waterfront, there are two beaches. In the east of city Lara Beach has a length about 5.5 km, and a continuous and sandy morphology. Also, Lara Beach area, seawater mixes with water that are coming from flows of sea outfall and river and/or stream, principally the Aksu and Duden Rivers that account for >70% of fresh water discharge into the Lara Beach. Antalya's five stars hotels which have great tourist capacity are situation on Lara Beach.

Konyaalti is situated beneath the old city of Antalya extending miles toward west with various kinds of beaches from sand to pebbles. The water is a little cooler compared to other beaches of Antalya because of an underground creek flowing to the sea. Konyaalti coast and shore band is an important pleasure resort where Turkish and foreign people may go swimming from within the city open to public. It is a 7 km long sand and shingle shore public beach 3 kilometers in the west of Antalya. It is the most crowded place of Antalya which accommodates some multiples of its own population during daytime in summer. Inside the beach there are cafes, restaurants, hotels and pensions. In Konyaalti Beach, there are 3 rivers and/or streams flowing and 1 deep sea outfall discharge. However, Bogacay, Arapsuyu I and Arapsuyu II streams are contributed significant to Konyaalti Beach area which is west of Antalya Bay.

Material and Methods

Samples are collected five different zones at same time. Shoreline microbiological water and sand quality are performed along the Lara and Konyaalti beaches. Sample area is divided two sections: Lara Beach, which is East Antalya and Konyaalti Beach, which is west Antalya (Fig. 1). We examined relationships colony forming unit between in the sea and on the coast. In addition to, we examined relationships bacterial counts and beach user density. Indicator bacteria analyses have been carried out on seawater samples which have been collected from Antalya coastline, on a fortnightly basis from June to August 2008. The samples were collected and analyzed at 6 stations in the study site. Samples were taken from 09:30 am to 11:30 am hours. Water samples were collected 30 cm below surface in inverted sterile bottles, and sediment samples were taken from a range of recreational coastal sites with sterile bags and subjected to manual shaking to separate micro organisms from sediment particles. Sand and pebble samples were collected on mediolittoral and subralittoral zone on the coast and then all of them kept in ice boxes in the dark before filtration. Water samples diluted 10 – 100 times with sterile 0.85% saline water before membrane filtration, sand and pebble samples to interfuse with water in an Erlenmeyer's balloon. Than water, sand mixture shaking with hand. All of the samples were taken during the official bathing season. *Salmonella spp.*(Bismuth Sulfite), Intestinal Enterococci (Azide), and *Escherichia coli* (ECD) determined by membrane filtration technique. After filtration, the membrane is placed on a selective and differential medium. ECD, incubated at 37°C ± 1°C for 18 - 24 hours, and Bismuth sulfite and Azide incubated at 36°C ± 2°C for 44 ± 4 hours. After

incubation, we counted bacteria which called CFU / 100 ml (Colony Forming Unit / 100 ml) [3].

Physical variables such as temperature, pH and total suspended solids were recorded at each sampling period. The number of swimmer was also recorded.

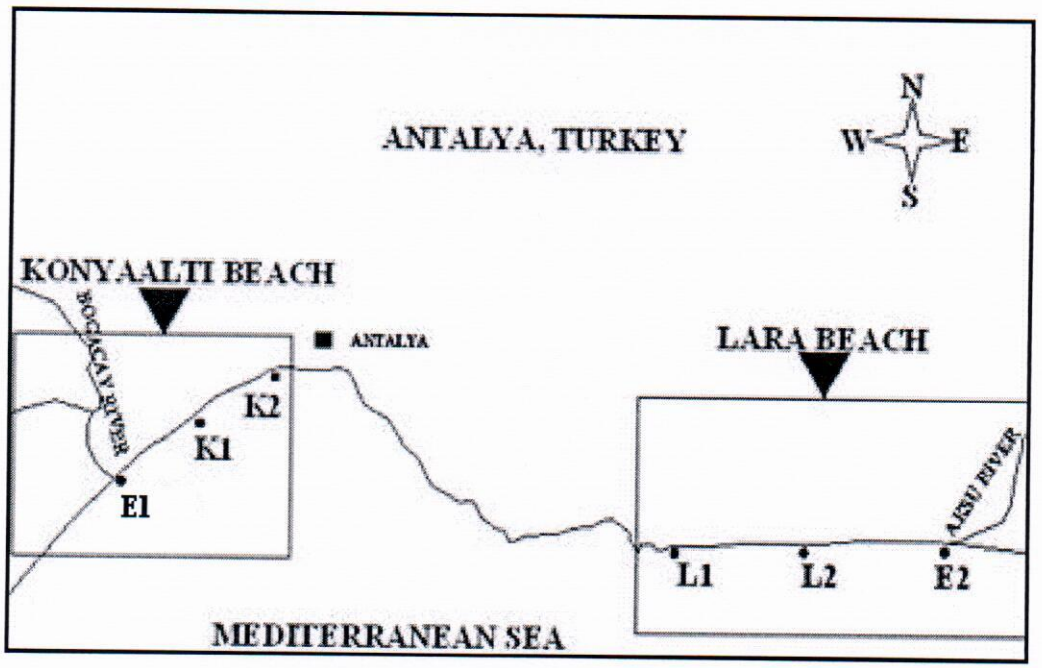


Fig.1.Study area and sampling site

Results and Discussion

Environmental variables and descriptive statistics of bacterial indicators in beaches of Antalya are shown in Table 1. *E. coli* and *Salmonella* concentrations in water were highest at E1, K1, L1 beaches. However, the highest mean found for *E. coli* was at beach E1 and the lowest L1, the highest mean found for enterococci was at beach E2 and the lowest K1 and *Salmonella spp.* concentrations were very high in K1 beach. The mean number of bathers present in water was 53 and the maximum number of bathers in the water at a sampling time was 225, ranging from 2 to 225 bathers in Konyaaliti and Lara Beaches. For all samples, the maximum temperature observed in beach water samples was 32 °C and the minimum was 21.5 °C.

In Konyaalti the mean of total suspended solids (TSS) in water was 520.4 ppm with a standard deviation of 21.5. In Lara the mean of total suspended solids (TSS) in water was 656.8 ppm with a standard deviation of 42.5. Total suspended solids concentrations were lower at Konyaalti Beach.

The highest of all values was obtained in Lara beach with a concentration of *E. coli* and enterococci of 71 and 67 CFU/100 ml, respectively. The mean pH obtained was 7.9- 7.8, mean temperature was 27.7- 28.0 °C, and the mean in Konyaaliti and Lara.

In Konyaalti most of the ranges of *E.coli* in water samples were from 4 to 360 CFU/ml, for enterococci levels change from 0 to 150 CFU/ml, and *Salmonella* levels change from 31 to 345 CFU/ml. In Lara most of the ranges of *E.coli* in water samples were from 15 to 160 CFU/ml, for enterococci levels change from 0 to 200 CFU/ml, and *Salmonella* levels change from 25 to 220 CFU/ml.

*Table 1.Means of **E.** coli, enterococci Salmonella and environmental variations from beaches in Konyaalti and Lara.*

Konyaalti Beach	N*	*E. coli* (X± S.D)		Enterococci (X± S.D)		*Salmonella* (X± S.D)	
		seawater	sand	seawater	sand	seawater	sand
E1	7	104±77	18±35	47±44	98±62	80±38	12±12
K1	7	82±108	16±42	41±50	46±46	123±111	06±06
K2	7	102±120	06±15	27±12	57±51	153±82	46±117
Overall means	21	96±99	13±31	38±38	67±56	119±84	21±67
Environmental Characteristics	*Number of bathers*	*pH*		*Temperature*		*TSS*	
X± SD**	54±51		7.9±0.3		27±2		520±21
Lara Beach	N	*E. coli* (X± S.D)		Enterococci (X± S.D)		*Salmonella* (X± S.D)	
		seawater	sand	seawater	sand	seawater	sand
E2	6	93±46	99±77	80±64	62±29	76±45	40±46
L1	6	69±38	37±41	78±73	50±51	107±55	72±104
L2	6	53±29	64±85	45±33	39±37	129±64	90±35
Overall means	18	72±40	66±71	68±58	50±39	104±56	67±68
Environmental Characteristics	*Number of bathers*	*pH*		*Temperature*		*TSS*	
X± SD	30±26		7.8±0.2		28±2		656±42

N*: Number of samples
X± SD**:Mean± Standard Deviation

Table 2. The comparison of microbiological bathing and recreational water quality in EU and Turkey [4] [5].

	EU Guidelines		***Turkey Guidelines***			
Indicator microbes	Limit values	Accepted %test result higher than limit values	Limit values	Accepted %test result higher than limit values	Accepted limit values than 2015 year	Accepted %test result higher than limit values
Total Coliform (CFU/100ml)	-	-	500	20%	1000	5%
Escherichia coli (CFU/100ml)	100	(%20)* (%5)	100	20%	100	5%
Intestinal Enterococci	100	(%10)	100			
Salmonella /L	-	0	0			
Enterovirüs PFU /10 L	-	0	0			

(*) Based upon a 95 percentile evaluation (arithmetic mean of $\log_{10}$ values-μ)
(**)Based upon a 90 percentile evaluation (upper 90-percentile=antilog (μ+1.282 σ)

Table 3. Bathing water profile and classification [4]

Parameter	Excellent	Good	Adequate
Intestinal enterococci (CFU/100 ml)	100 (*)	200 (*)	185 (**)
Escherichia coli (CFU/100 ml)	250 (*)	500 (*)	500 (**)

(*) Based upon a 95 percentile evaluation (arithmetic mean of $\log_{10}$ values-μ)
(**)Based upon a 90 percentile evaluation (upper 90-percentile=antilog (μ+1.282 σ)

To prevent illness in swimmers, bacterial concentrations of samples must be compared with water quality standards (Table 2). Turkey and EU have promulgated standards for recreational and bathing waters. These standards are; a arithmetic mean of 95% total samples should not exceed for Intestinal enterococci 200 cfu/ml, for *E. coli* 250 cfu/ml in excellent quality (Table 3). Results of the percentage of samples that exceeded standards are shown in Table 4.

Table 4. Percentage of all samples exceeding Konyaalti and Lara Beaches EU and Turkey Bathing recreational water Quality standards.

Beach	No	*Escherichia coli*	Intestinal enterococci	*Salmonella* spp.
Konyaalti	E1	0	14%	100%
	K1	14%	0	100%
	K2	14%	14%	100%
Lara	E2	0	17%	100%
	L1	0	0	100%
	L2	0	33%	100%

In this study, *E.coli* concentrations in %14 of the samples in K1 and K2 points exceed limits of the directives of both EU and Turkey. Instestinal Enterecocci concentrations in %14 of the samples in E1 and K2 (konyaalti) and %17 and %33 of the samples in E2 and L2 (Lara) exceed limits, respectively. *Salmonella spp.* concentration exceeds the limits, owing to the requirements of the directives.

Studies seawater and beach sand have demonstrated that sand may concentrate *E. coli* and that *E. coli* can survive in the beach environment. We found higher levels of *E.coli* in sand than in the sea water and *E. coli* survived in this sand for an extended time. Since *E. coli* concentrations in water may have been suspended from surviving cells in the sand, *E. coli* is not a good indicator of recent fecal contamination in subtropical waters. If *E. coli* survives in sand, enteric pathogens may also survive; causing gastrointestinal symptoms or illness beach bathers.

According to the Noble [6], one possible explanation for the consistently higher rate of *E.coli* standard failures is that *E.coli* survive longer in the marine environment than T.C or F.C. Hanes and Fragala [7] found that *E.coli* survival in marine water was 0,8 d while enterococci 2,4 d. Total coliforms, thermo tolerant coliforms and *E.coli* are the most common indicators of fecal contamination in recreational waters, because they are present in high concentration in the large intestine of warm blooded animals. Recreational water illnesses that are spread by swallowing, breathing or having contact with contaminated water from sea. Recreational water illnesses can cause a wide variety of symptoms, including gastrointestinal, skin, ear, respiratory, eye, neurologic and wound infections.

A positive correlation between fecal coliform counts and percent impervious surface and watershed population was observed in coastal areas of Antalya Bay [8] Wildlife, sewage effluents, failing, from septic systems and run off animal feedlots and agricultural lands are important sources of total and fecal coliform in surface water [9] [10]. Several investigators have reported that FC levels vary with seasonal changes in rainfall [11], tidal effect [12] and river discharge [13] [14] [15].

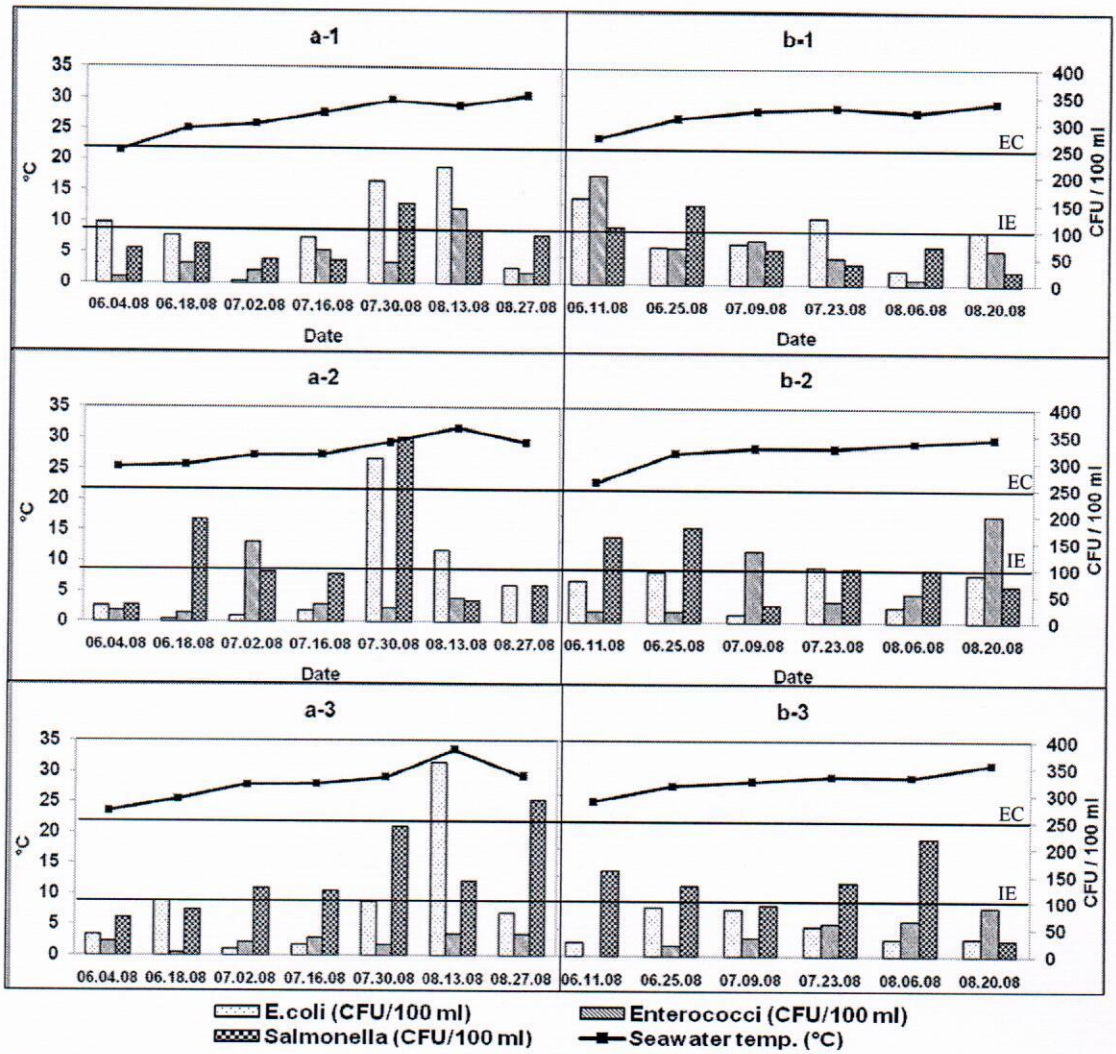


Fig 2. Microbiological and temperature parameters in seawater knee deep all of locations. E1 (a-1), K1 (a-2) and K2 (a-3) represent the relationships between E.coli, Intestinal enterococci, Salmonella and temperature in Konyaaltı. E2 (b-1), L1 (a-2) and L2 (a-3) represent the relationships between E.coli, Intestinal enterococci, Salmonella and temperature in Lara. (*EC: Excellent Quality for *E. coli* categorization in EU and Turkey standards **IE: Excellent Quality for Intestinal enterococci categorization in EU and Turkey standards)

According to the EU directive, E1, K1, K2, E2 and L1 are categorized as excellent and L2 is categorized as good for intestinal enterecocci parameter. All sample points are categorized as excellent for *E.coli*. As shown in figure 2, all indicator concentrations except *Salmonella spp.* are under the limits. It can be examined that microorganism concentration are increasing by depending on water temperature. The highest *E.coli* concentration is determined in K2 at August 13th, the highest enterecocci concentration is determined in E2 at June 11th, and in L1 at August 20th. The highest *salmonella spp.* concentration is determined in K1 at July 30th.

Different beach properties such as beach length and shore width etc. are very important for recreation activities in coastal site. In coastal sites, pathogens included bacterial, protozoan and metazoans communities are surviving for longer periods in sea sands. Recreational activities are done 1,5 meter depth in the sea which is called wet beach or supralittoral zone . Environment and microbial conditions are very important on sediment and sediment – water interface. However, microorganisms' level is in

the sediment 100 – 1000 times more then water body. All of these processes in supralittoral zone affect to children who are 1 – 5 years old. According to the research of survival microorganism, sediment contents and physical situation can satisfy suitable media for microorganism [16]. Peres-Rosas et al.,[17] that an in-situ study on *E. coli* survival in coral reefs, showed survival rates of up to 96 hours. *E. coli* survive in the marine environment than TC and FC. Hanes and Fragala [18] found that *E. coli* survive in marine water was 0.8d while EC survival was 2.4 d.

CONCLUSIONS

- An acceptable percent of samples were over the standards of EU and Turkey bathing water quality for the protection of swimmer's health.
- Indicators can survive outside the GI intestinal tract. Observation and personal communication of epidemiogical study showed that there is a lower risk of respiratory and skin symptoms in swimmers when compared to non-swimmers in Antalya's beaches.
- According to the EU directive, E1, K1, K2, E2 and L1 are categorized as excellent and L2 is categorized as good for intestinal enterecocci parameter.
- EC and intestinal enterococci should be analyzed both at wave zone and in sand, because these zones are areas of recreational activity for bathers and children.

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