Preliminary water-sampling to assess the level of biological pollutants from five rivers in Albania.

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Introduction

During a 3-year monitoring programme[1] of sea turtles that forage in Drini Bay, northern Albania, it was noted that all the beaches in this 30-km bay were heavily polluted with anthropogenic waste, particularly plastics (White *et al*. 2010a). In 2009 quadrat surveys of visible waste were conducted at eleven different sites around the bay, so as to pinpoint the worst affected areas; the outflow of River Ishmi and the adjacent beaches of Godull and Cape Rodoni were the most heavily polluted (White *et al*. 2010a). It was clear that the debris, which was mostly manufactured plastic items, did not originate in the very impoverished area of Godull, but was most likely to have been transported there by the four rivers that enter Drini Bay: Ishmi, Mati, Drini and Bunës. Water-sampling was not conducted in 2009, as there were no analytical facilities available, however, it was assumed that other pollutants (biological and chemical) were also likely to be present; because there was a foul odour at the mouth of Ishmi and a discoloured plume of water that extended from the outflow almost one kilometre out to sea.

The present study was undertaken in collaboration with the Department of Microbiology, Tirana University, and we analysed water samples that were collected from five different rivers. High levels of faecal coliform bacteria and heterotrophic bacteria were present in all samples, and, although this is only the first step, it extends our knowledge of the levels of anthropogenic pollutants that have an impact upon Albania's coastal zone. Four of the sampled rivers ultimately discharge into Drini Bay; which is now known to be a critical-habitat for sea turtles in the Mediterranean (White, Boura & Venizelos 2010). The fifth river, Gjanica, joins Semani River, which enters the sea to the north of Vlore; sea turtles have been confirmed from this habitat too (White pers. obs.).

Materials and Methods

1) Sampling technique:

Faecal coliform bacteria samples should be collected and transported in an insulated-container to the laboratory, usually on the sampling day. The faecal coliform samples need to be tested within 48 hours from the time the first sample in the field was taken. Water was collected by hand, using sterilised containers, from five rivers (Fig. 1):

[1] Mediterranean Association to Save the Sea Turtles (2008-2010)

Lumi Mati: Sampling point **(Latitude: N41°.41.015 Longitude: E019°.40.230)** was the south bank of the river; just to the west of the autostrada bridge, and adjacent to a large gravel-extraction facility. Water flow was fast, and the banks and water were very clean. [Sampled at 09:45, 22/10/2010; water temperature = 13.0°C]

Lumi Gjanica: Sampling point **(Latitude: N40°.43.618 Longitude: E019°.33.760)** was in Fier, near to a bunker on the eastern bank of the river, just to the north of the small foot-bridge at the northern end of the market (not the larger bridge with stalls on it by the Orthodox Church). Water flow was fast, there was garbage everywhere, some of which was thrown into the water; and rats were observed on both banks and swimming in the river. Sewage effluent is discharged directly into the river from nearby houses and hotels.
[Sampled at 13:30, 21/10/2010; water temperature = 17.0°C]

Lumi Gjola: Sampling point **(Latitude: N41°.28.029 Longitude: E019°.41.535)** was just off the road from Kruje to Vore; there is a small right-hand turn-off (signposted to 'Ishem') about 500 metres after Nord Park Kompleks; the sample was collected beneath the small bridge there. Water flow was medium, there was substantial garbage, including in the trees (from the previously high water levels); rats were present on both banks; and garbage was thrown from the bridge as the sample was being taken.
[Sampled at 17:10, 21/10/2010; water temperature = 16.5°C]

Lumi Tirana: Sampling point **(Latitude: N41°.23.906 Longitude: E019°.42.264)** was under the autostrada bridge on the way from Rinas Airport to Tirana; the site is a short distance after Epoka University and can be accessed from either side of the road. Lorries drive down a small track and dump waste directly into the river beneath the road bridge. Water flow was fast and garbage was widespread on the banks and in the water.
[Sampled at 10:45, 22/10/2010; water temperature = 14.5°C]

Lumi Drini: Sampling point **(Latitude: N41°.45.832 Longitude: E019°.37.966)** was the south bank of the river; just to the west of the autostrada bridge near to Lezhe; actually on the small road to Ishull Lezhe & Vain Lagoon; there is a large red/yellow/blue building nearby. The sample was collected next to a 'kalemero' fish trap. Water flow was slow and there was very little waste in the water or on the banks.
[Sampled at 09:20, 22/10/2010; water temperature = 15.0°C]

Note: a planned sample from Lumi Ishmi (Godull) could not be collected as the area was inaccessible after heavy rain and extensive flooding.

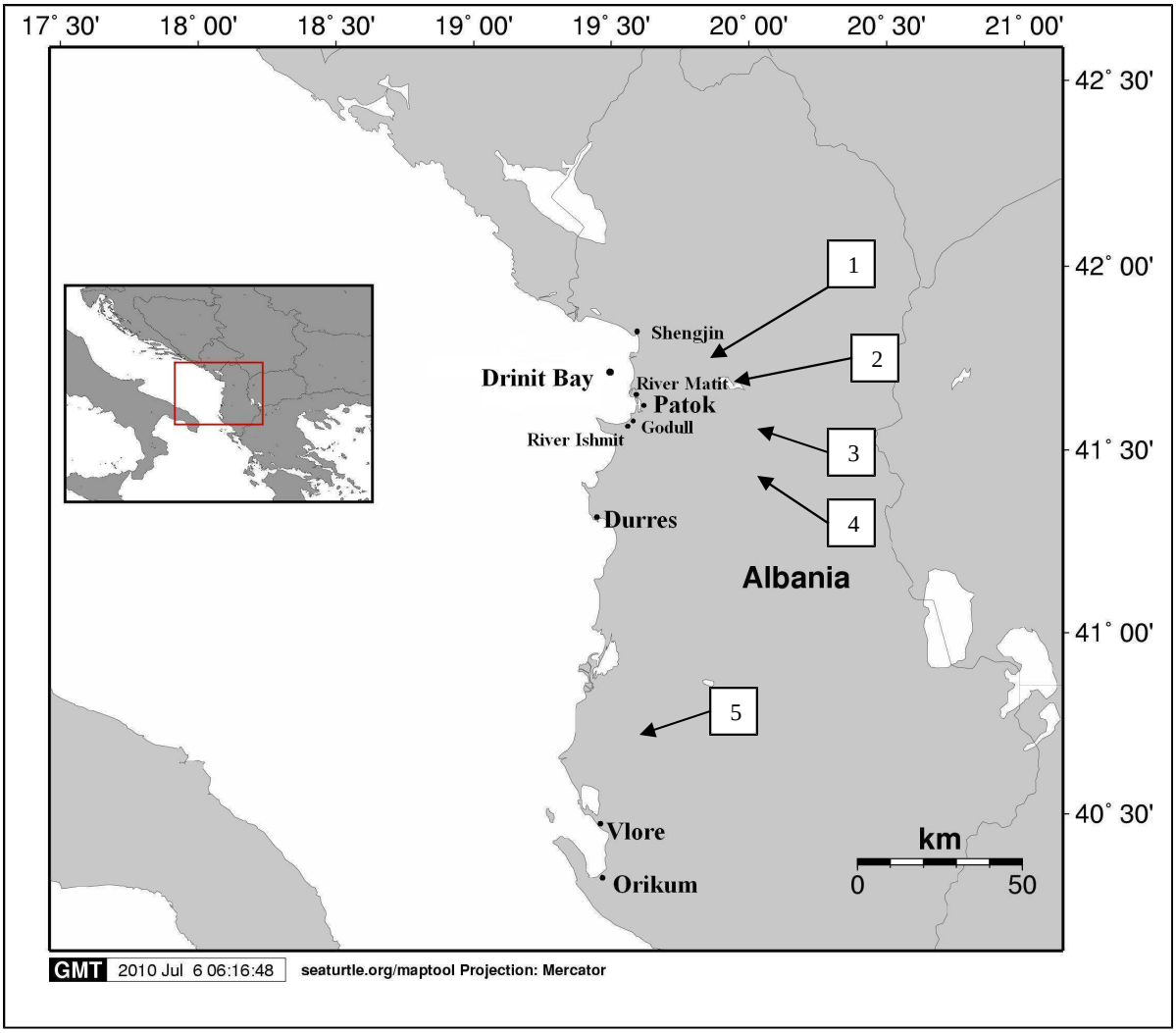

Figure 1. Map of northern Albania showing the approximate positions of water sampling points for five rivers: 1 Drini; 2 Mati; 3 Gjola; 4 Tirana; 5 Gjanica. (Map drawn with MapTool; a product of www.seaturtle.org)

2) Laboratory and Analytical techniques:

Faecal Coliform Bacteria Parameter and Total Coliform Bacteria

Faecal coliform bacteria are microscopic organisms that live in the intestines of all warmblooded animals, and in animal wastes or faeces eliminated from the intestinal tract. Faecal coliform bacteria may indicate the presence of disease-carrying organisms which live in the same environment as the faecal coliform bacteria. Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm-blooded and cold-blooded animals. They aid in the digestion

of food. A specific subgroup of this collection is the faecal coliform bacteria, the most common member being *Escherichia coli*. These organisms may be separated from the total coliform group by their ability to grow and use lactose sugar at elevated temperatures (44-45ºC) and are associated only with the faecal material of warm-blooded animals.

3) Tests, Media and incubation temperatures:

a) Faecal Coliforms: The MPN **(Most Probable Number)** test and the nutrient Media EC were used; the incubation was at 44.5ºC

b) Heterotroph Bacteria: The method was the Petri Dishes Plating; that used the YEA Nutrient Media; the incubation was at 37.0ºC

c) Total Coliform Bacteria: The MPN (Most Probable Number) test and the nutrient Media LB were used; with the MacConkey pour-plating method; the incubation was at 37.0ºC.

The measurement is expressed as: "the number of organisms per 100 mL (CFU/100ml)"

4) Reference Standards:

ISO 7899-1 was used and also EC Directive (2006/7/EC) *"concerning the management of bathing water quality"*

Table 1. Standard for faecal coliforms (*Standartet e koliformëve fekalë në lumenj për pëcaktimin e pastërtisë së ujit).* ISO 7899-1

Faecal coliforms	Very good quality	Good quality	Bad quality	Very bad quality
Cfu/100ml	250-500	500-1000	1000-2000	Mbi 2000

Table 2. Standard for total coliforms (*Standartet e Koliformëve totalë ne lumenj për përcaktimin e pastërtisë së ujit).* ISO 7899-1

Total coliform	Very good quality	Good quality	Bad quality	Very bad quality
Cfu/100ml	1250	2500	5000	10000

Results

Table 3. Bacterial counts are given for: Faecal Coliforms; Heterotroph Bacteria; and Total Coliforms; which were present in water samples obtained from five rivers: Mati, Gjanica, Gjola, Tirana and Drini. Results are expressed as CFU/100ml (the number of organisms per 100ml). Mati was the least-polluted; Tirana the most-polluted. The low number of Heterotrophs in Gjanica may be a consequence of other, unidentified, pollutants that limited their growth.

River	Faecal Coliforms CFU/100ml	Heterotroph Bacteria CFU/100ml	Total Coliforms CFU/100ml
Mati	**1.2×10^2**	**3.0×10^5**	**1.3×10^2**
Gjanica	**1.4×10^3**	**5.0×10^4**	**1.5×10^3**
Gjola	**5.2×10^3**	**2.7×10^5**	**5.5×10^3**
Tirana	**1.2×10^4**	**3.1×10^5**	**1.3×10^4**
Drini	**5.1×10^3**	**2.5×10^5**	**5.3×10^3**

Table 3 shows that River Mati was the least-polluted for both faecal coliforms and total coliforms. River Tirana is the most-polluted for both faecal coliforms and total coliforms. In terms of Heterotrophic bacteria the River Gjanica produced the lowest count; an order of magnitude lower than the rest; the counts from the other rivers were broadly similar.

Discussion

Environmental Impact:

The presence of faecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the faecal material of man or other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease-producing bacteria or viruses which can also exist in faecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis, hepatitis A; and Weil's Disease. The presence of faecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Faecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.

The least-polluted river is Mati: both the faecal coliform and the total coliform counts were in the 'very good' range. This finding is supported by the quadrat-sampling of plastics that was undertaken by White *et al*. (2010a), during which the two cleanest sites were immediately south of Mati outflow and at Ulcinj, Montenegro. One of the reasons for low levels of pollutants could be that Mati passes through areas with low population densities. Taken together these two studies (visible pollution and bacterial contamination) suggest that River Mati has the least impact on Drini Bay.

River Drini was 'very bad' for faecal coliforms and 'bad' for total coliforms. The river is used for waste-disposal, and plastics are commonly observed in the section at Lezhe; however, the water and river-banks are fairly clean.

Because River Ishmi could not be sampled at this time, although it was clearly the most-polluted site for debris in Drini Bay (White *et al*. 2010a), it is not possible immediately to confirm its exact impact in the coastal zone. However, River Ishmi is fed by both Tirana and Gjola rivers. The most-polluted river was Tirana: being 'very bad' for both faecal coliform and total coliform counts; by an order of magnitude above the other samples. Waste is dumped directly into this river, sometimes from lorries; including adjacent to the sampling-site. The river was seen to transport floating plastic items, which extended for more than a kilometre of the water's flow. A short distance downstream (2-3 km) this river enters the Lana river (which flows through Tirana City) to become Gjola; waste is also dumped directly into Gjola river. The faecal coliform and total coliform counts for Gjola are both 'very bad'; thus it seems likely that Ishmi will also have high coliform counts: whether from direct discharges or introduced from Tirana and Gjola rivers. Ishmi will be sampled at a later date.

Further south, near to Vlore, the River Gjanica passes through the town of Fier. During the winter months this river frequently overflows, flooding streets, houses, schools and the adjacent countryside. It was this river that initiated the present study. Results from Gjanica showed that the river was 'bad' for faecal coliforms, yet 'good' for total coliforms. However, the count of Heterotrophic bacteria was the lowest for any of the present samples; by an order of magnitude lower. This could be due to the presence of other, perhaps chemical (Miho *et al*. 2005), pollutants that were not assessed within the present study; these may have inhibited bacterial growth.

Public health concerns

The present findings raise several concerns regarding public health and safety. The first is that public bathing occurs in the Vlore sea areas and also at Drini Bay. Although Albania has not yet acceded to the European Union, it is a candidate Member and will have to implement EU legislation. The 'Bathing Waters' Directive (2006/7/EC) requires that members of the public at bathing areas are notified about the potential risks to their health from pollutants; this includes the presence of tarry residues, glass, plastics, rubber, or other waste (Article 9). The Directive also identifies impacts to transboundary waters (Article 10); the four rivers that enter Drini Bay are likely to have some impact on Montenegro, particularly at Plazh i Madh, just to the west of Bunës River.

The widespread distribution of waste, including food-stuffs is very likely to affect public health. Not only is there a foul smell from decaying food, but rats were very attracted to these areas. The worst example was at Fier (Gjanica), with three large rats being observed within ten minutes; one on either bank, the third swimming across the river. These animals are a known vector for Weil's Disease; and this river does overflow into a nearby school and business premises. A proper Environmental Impact Assessment (EIA) should be conducted during the winter months to quantify the true impacts here.

Limitations of the present survey & future research

i) The sampled rivers were of slightly different temperatures: Gjanica was the warmest (17°C); Mati the coolest (13°C). Future laboratory studies can investigate if this has any great effect on these particular bacterial-counts.
ii) Chemical pollutants were not assessed, as we lacked analytical facilities for this work. Gjanica had the lowest count of Heterotrophs (an order of magnitude lower than the other samples). Could this be due to a high loading of chemicals in the water that limited their growth? Samples should be collected further upstream of a petro-chemical complex on Gjanica, so that the extent of industrial impacts can be identified.
iii) The most-polluted river was Tirana; sampled about 3 km upstream of its confluence with Lana River. Samples are now required from Lana itself, upstream and downstream of the Tirana confluence. These should show how much Tirana river-water is diluted by mixing with Lana. The next step will be to sample River Terkuza, which then joins these others (Tirana and Lana) at the Gjola section (Gjola results are reported here). We should then be able to determine whether Tirana river is a bigger contributor of pollutants, into what will become River Ishmi, than the Lana/Terkuza section. The reason that this is of interest is that waste is being actively dumped into Tirana river at the sampling point (near Epoka University on the airport road): lorries drive under the bridge and empty garbage straight into the river; this then flows down to Ishmi, and then into Drini Bay (our turtle foraging habitat). If Tirana river is the biggest contributor: then the way ahead is to find out which Municipality is responsible, and the Regional Environmental Agency (REA) who should oversee them; and where they are supposed to be dumping the waste under environmental permit. A case can then be made to the Ministry of Environment.
iv) The same approach can be used for sea areas north of Vlore. Gjanica was observed to be a considerable source of pollution (e.g. plastics and sewage); this is the responsibility of Fier Municipality and its REA. This river joins into Semani, which has already passed through Berat - as River Osumi - and another REA, so by sampling the pollutant-levels upstream and downstream of where Gjanica comes in at Mbrostar, the impacts can be correctly attributed to each river, and each municipality urged to take responsibility for its environment.

Unfortunately at present, Albania is undergoing nationwide infrastructural development; which means that funds for environmental concerns are minimal. Yet, the country seeks to improve the socio-economic status and well-being of its population, and would like to have international tourism; also its future is most likely to be within the European Union. By implementing effective waste-management schemes, cleaning up rivers, coastal-zones

and the surrounding countryside, it seems likely that Albania could achieve those aims within a few years. However, this will require direct action throughout the country.

Faleminderit Shume

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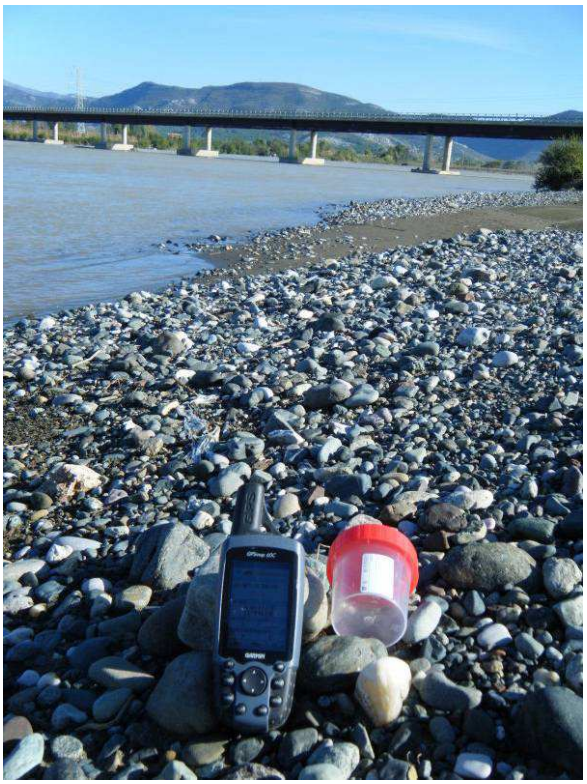
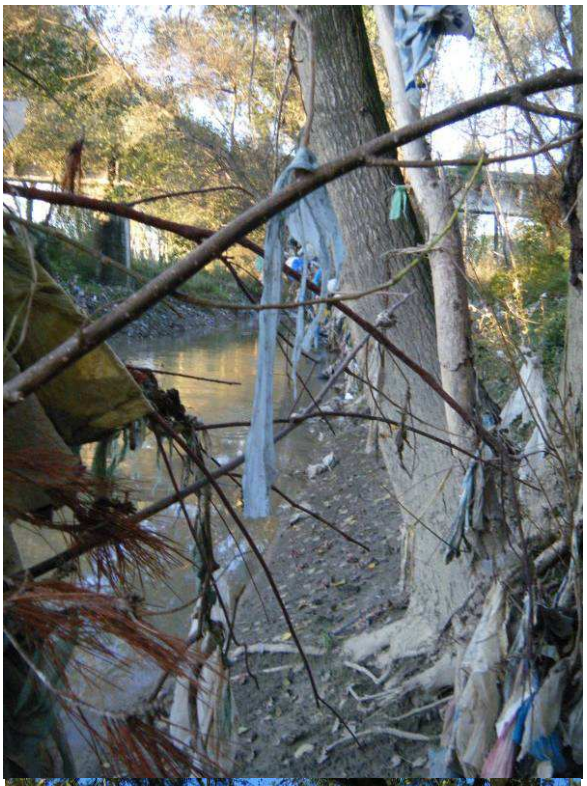
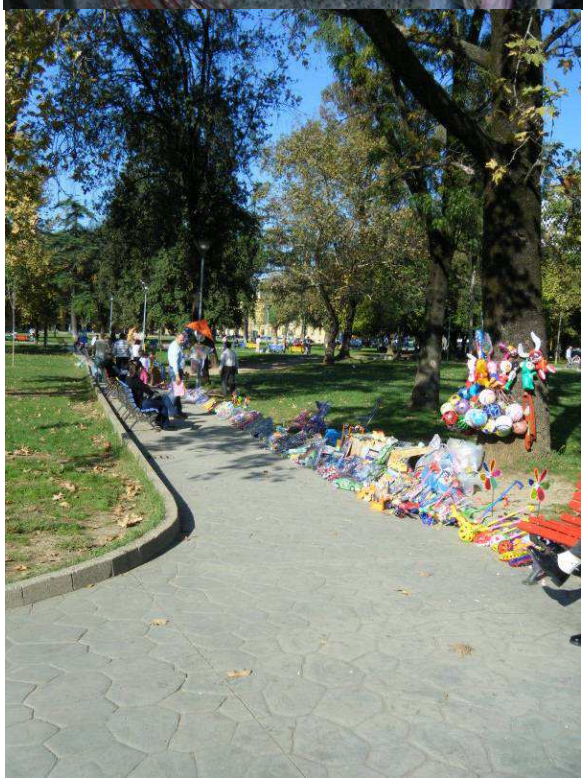
Top: River Drini sampling point. Bottom: Garbage from restaurants thrown into Patoku inner lagoon.



Top: Mati sampling point.

Bottom: Lana river in Tirana





Top: Gjola sampling point; plastic in the trees was from recent flooding

Bottom: 'Middle-man' for plastic consumer goods; many of these end up in the coastal zone

Tirana river sampling-point is beneath the autostrada bridge; lorries dump garbage directly into this river, which later joins Ishmi & enters Drini Bay

Top: Fier market & River Gjanica; garbage is thrown directly into the river.
Bottom: collecting water sample from Gjanica

Top: Fixing locations with GPS.
Bottom: waste near Gjanica sampling point

Top: Berat Castle, UNESCO World Heritage Site; garbage is thrown over the walls … & ends up in the River Osumi (below), which later joins with Gjanica and enters the Adriatic Sea just north of Vlore