

Madeira 2010 – Aftermath of flashfloods and mudslides on bathing water quality indicators and on sand microbial levels

Romão D¹, Abreu R², Calado G³, Freitas F³, Rodrigues P³, Ferreira C⁴, Campos A⁴, Temtem R⁴, MC Freitas⁵, C Andrade⁵, Prada S², Figueira C², Brandão J^{1*}

Abstract

Recent and past studies indicate that infectious disease outbreaks often take place after extreme weather events, as microbes, vectors and reservoir animal hosts are able to exploit the disrupted environmental conditions (1). Beaches, due to their proximity to oceans and cities, are often setting of such events affecting microbial communities, both in sand and bathing water (1 and 2).

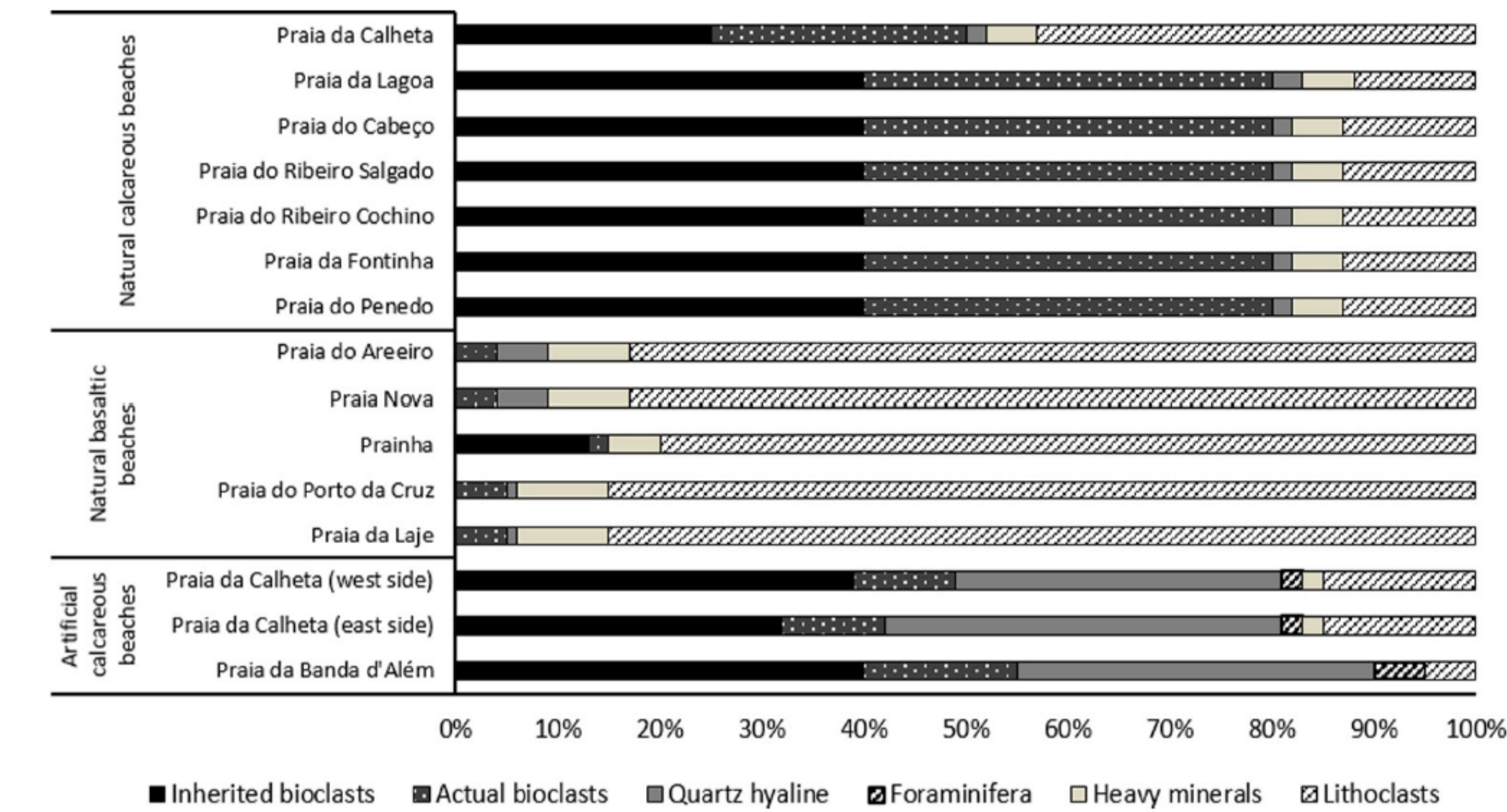
On 20th of February 2010, a series of storms, caused by an active cold front combined with Atlantic low-pressure and temperature differences of the sea surface across the Atlantic Ocean with unusually warm waters from West Africa, affected several countries, such as Portugal, Spain, Morocco and the Canary Islands, causing flooding, rain and strong winds. Madeira, an island with different types of beaches within a small coastline was severely affected. Between 6 a.m. and 11 a.m., 108 mm of rain were recorded at Funchal weather station and 165 mm at Pico do Areeiro (1818m of altitude).

The entire February's month average rainfall in Funchal is 88.0 mm. The South of the island was severely affected by flashfloods, originating mudslides that tore down everything along the way. The degree of devastation was highly substantial and costly, both in lives and economically. The areas affected the most were Funchal, Ribeira Brava, Câmara de Lobos and Santa Cruz.

The impact of this event in microbiological communities caused a notorious peak of *Enterococcus* spp., *E. coli* and sporulating fungi, both in sand and water until September of the same year. Bathing water and sand quality monitoring months later revealed thus that both water and sand profiles were profoundly altered for months to follow.

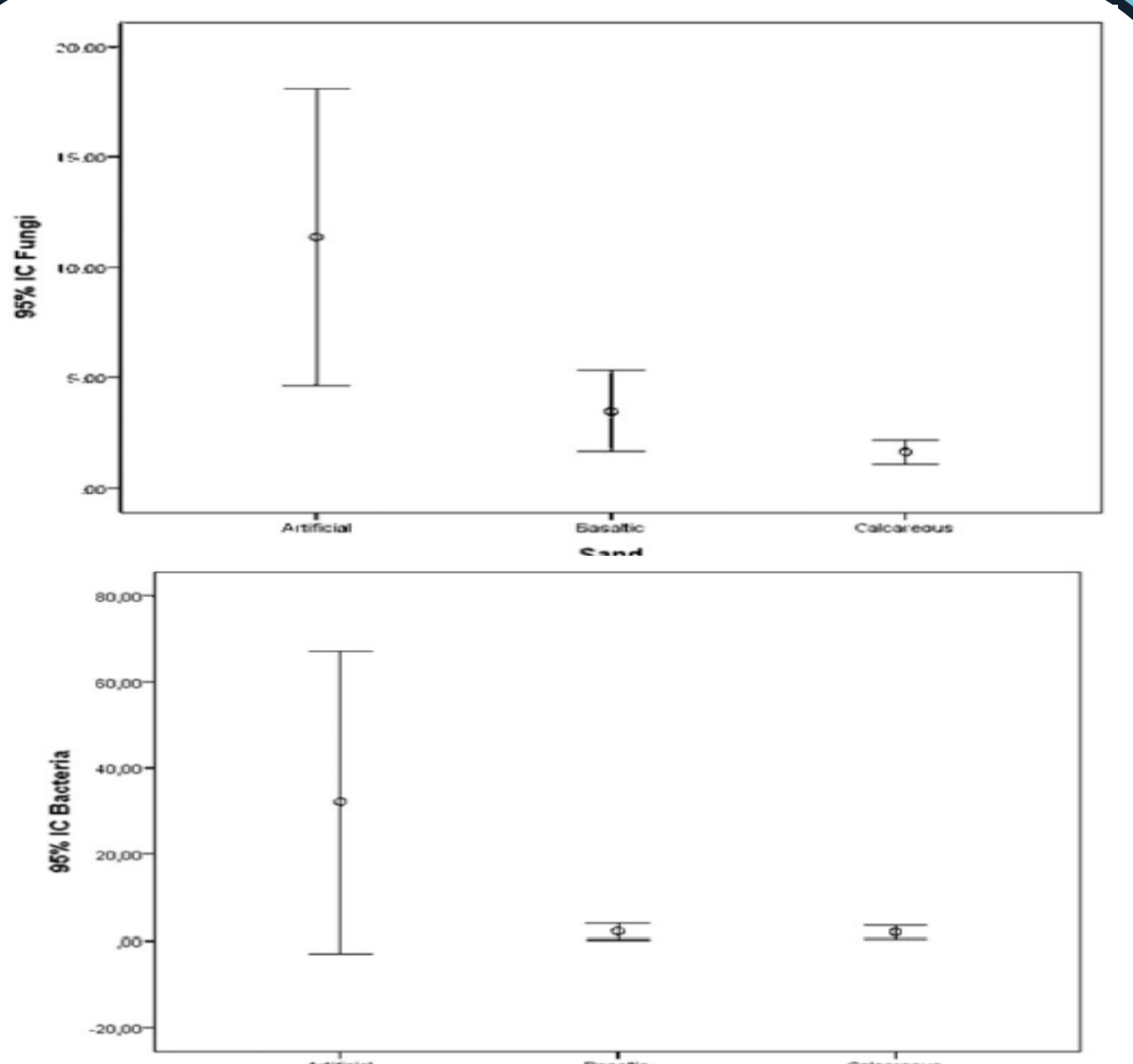
Contaminated sand is a known source of coastal water pollution, due to tides in the swash zone and run-offs. Our analysis shows the disruptive effect of the storm on beach sand quality, as published in 2016 (2), combined with a comparison of the subsequent expected effect on bathing waters for the island of Madeira for 2010 and 2011.

Beach Composition Profiling

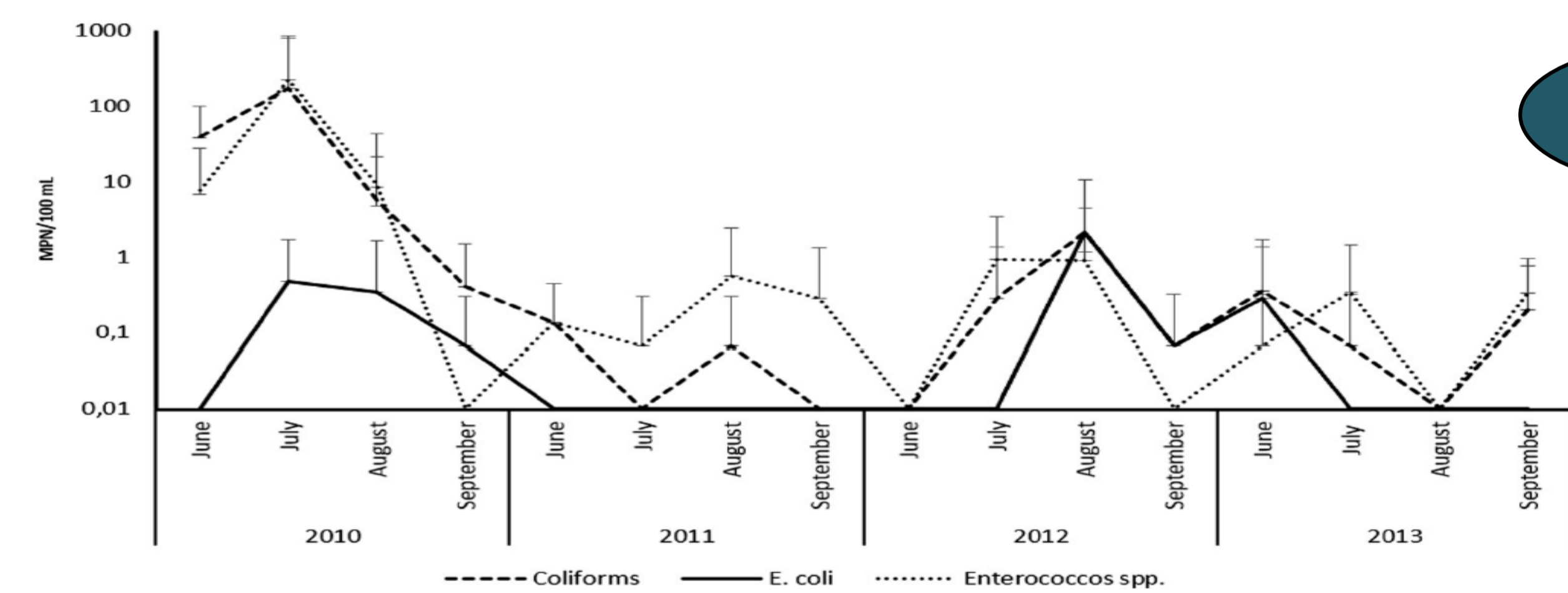


Statistical analysis suggests higher microbial contamination trends in artificial sand beaches when compared with natural ones, especially when focusing on the fungal load. Higher deviations from central values characterize the artificial sand type beaches (2)

SAND



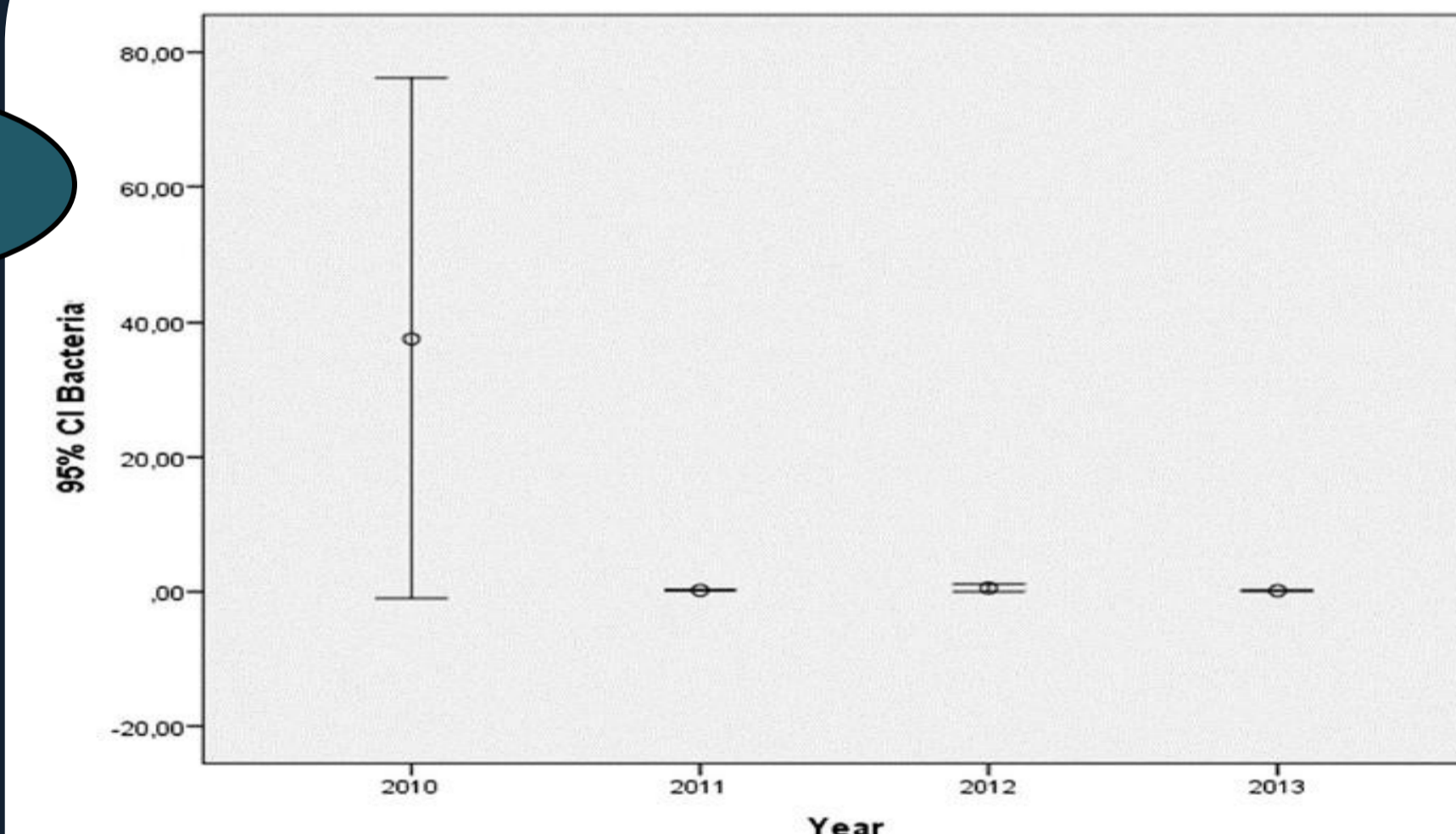
Bacteria: A story of ups and downs



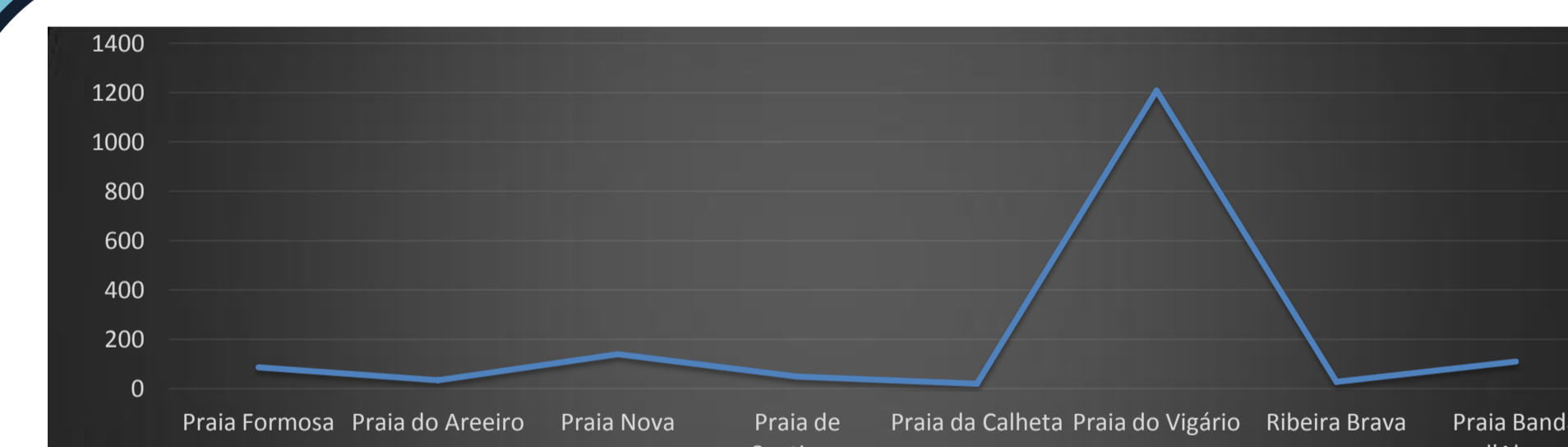
Annual trends showed high values in 2010, and a gradual decrease throughout the years, with a small occurrence for bacteria in the following years (2).

SAND

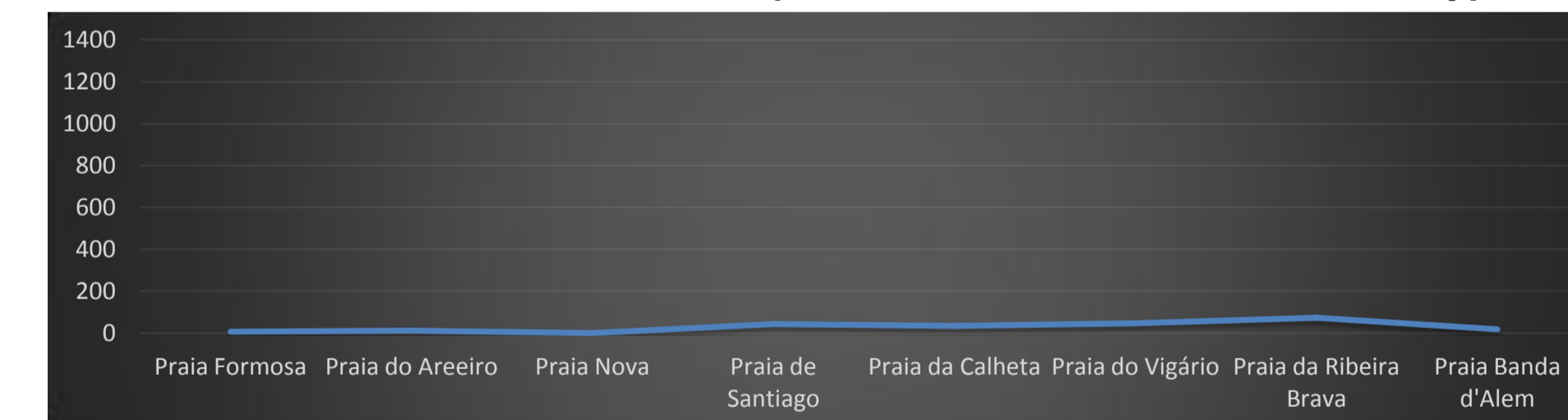
2010 shows higher variation when compared with following years



Madeira's geographic features outflows from damaged sewer lines, and stranded wreckages that resulted from the flash-flood event were responsible for high levels of FIB in 2010 (2).



Beach water *E. coli* profiling of 2010 shows that Praia do Vigário is one of the most affected areas (data from Madeira island only)



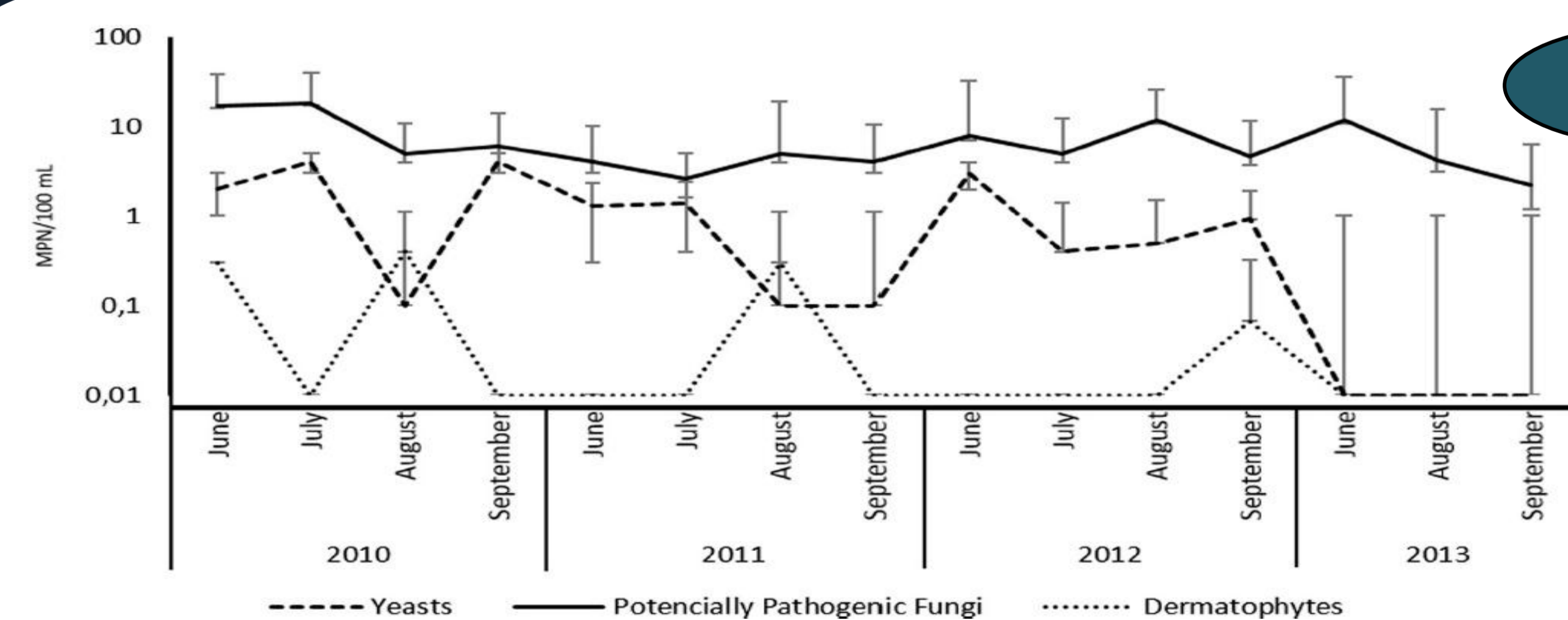
Beach water *E. coli* profiling of 2011 showing return to normality (data from Madeira island only)

WATER

Concluding Remarks

Bacteria suffer a higher fluctuation, but fungi populations such as yeasts and dermatophytes are also affected (2). Artificial sand beaches also seem to take more time to recover from these extreme weather events, specially when focusing on fungal microorganisms (2). The complexities of topography, atmospheric and ocean circulation systems means that the nature and impact of abrupt climate changes cannot, yet, be accurately predicted by climate scientists (1). Surveillance and rapid public health response can restrict infectious diseases from spreading but, knowledge of microbiological profiles of exposed, and therefore susceptible, environments can also help predict the emergence of potential pathogens (1,2).

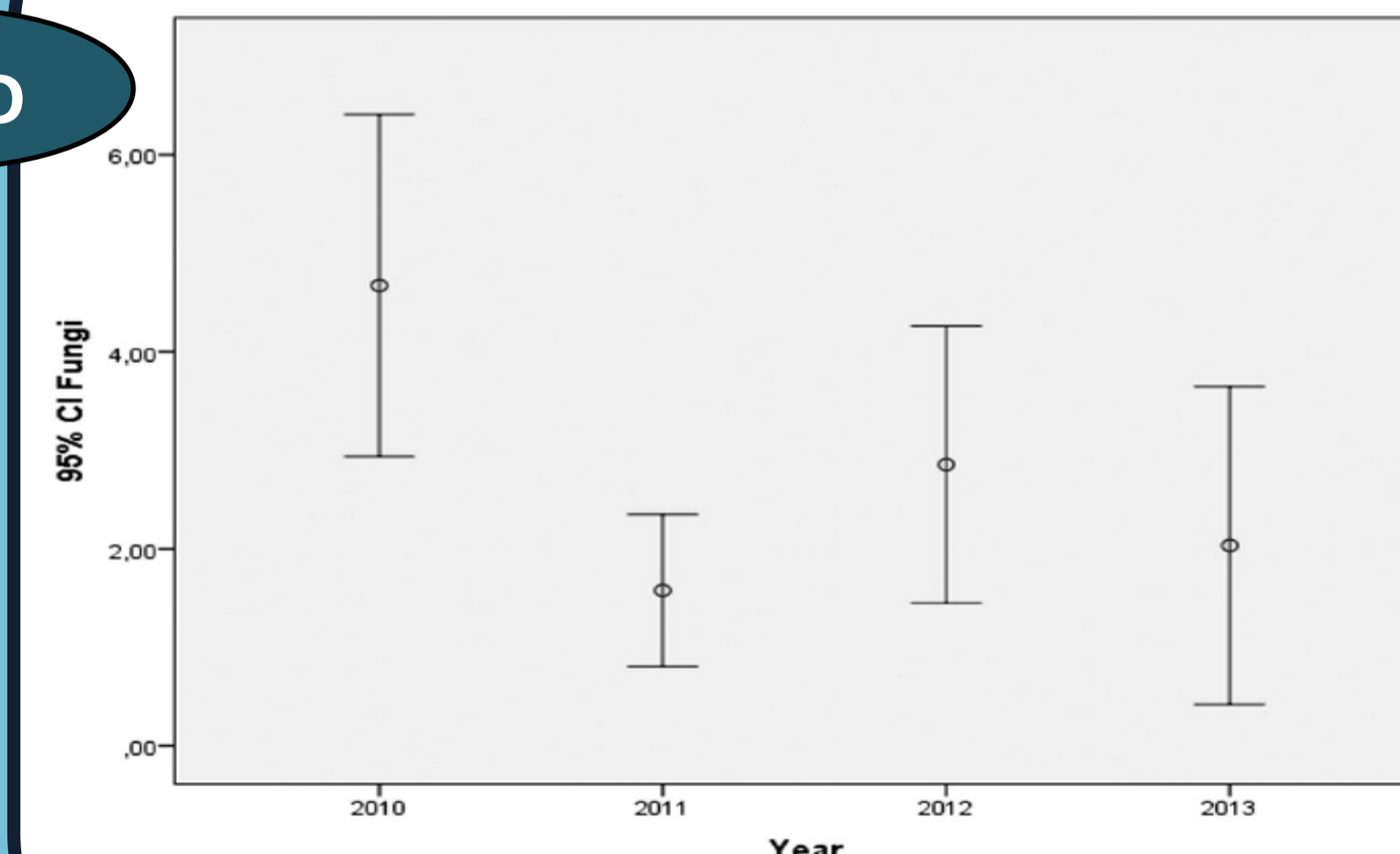
Fungi: A story of persistence



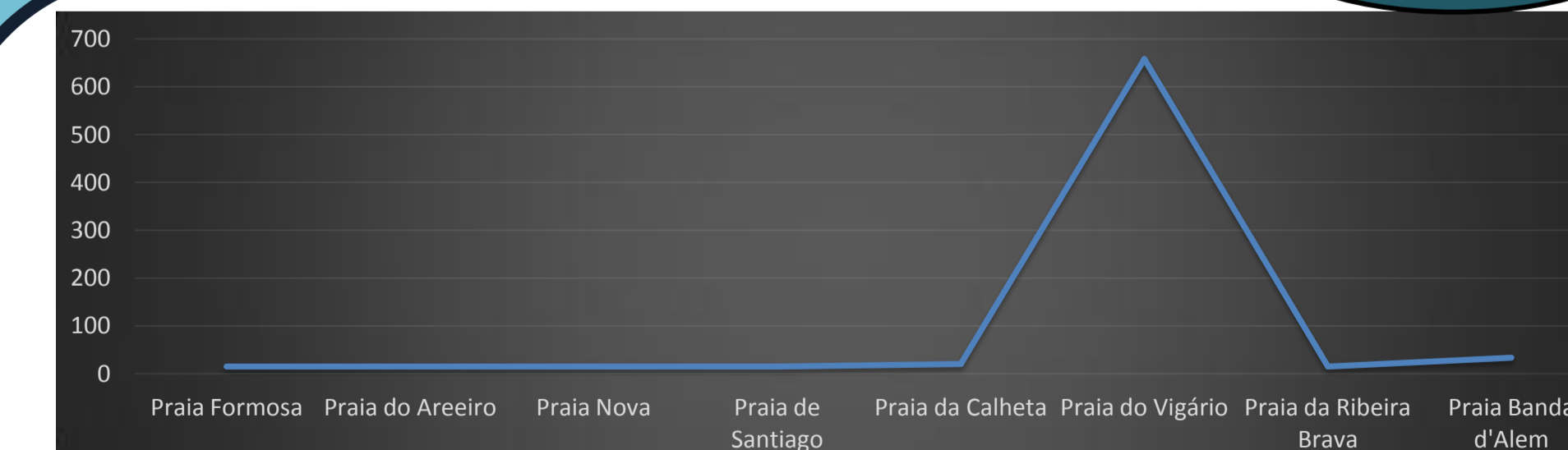
After experiencing high values in 2010, yeasts and dermatophytes tend to decrease whilst potentially pathogenic fungi seem to be persistent during the course of time (2).

SAND

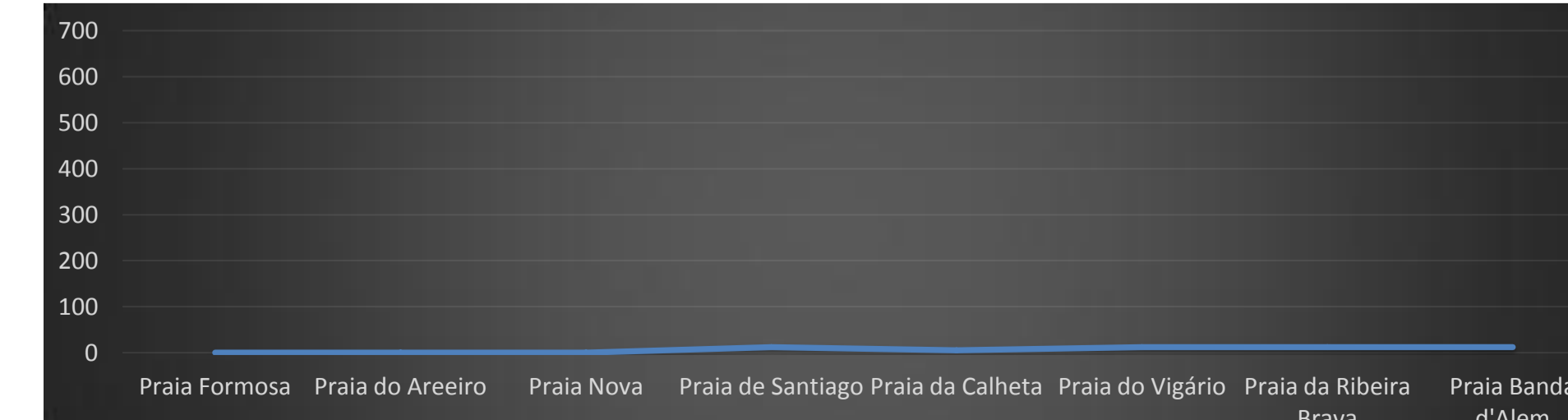
2010 shows higher maximum values, but variation is continuously high throughout the years



Potentially pathogenic fungi were the most common fungi detected. The extreme rainfall and flash flood event can be invoked to support this pattern of variation (2).



Beach water *Enterococci* profiling of 2010 shows that Praia do Vigário is one of the most affected areas (data from Madeira island only)



Beach water *Enterococci* profiling of 2011 showing return to normality (data from Madeira island only)

References

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- (2) Abreu R, Figueira C, Romão D, Brandão J, Freitas MC, Andrade C, Calado G, Ferreira C, Campos A, Prada S. Sediment characteristics and microbiological contamination of beach sand - A case-study in the archipelago of Madeira. *Sci Total Environ*. 2016; 15:573:627-638. doi: 10.1016/j.scitotenv.2016.08.160.

Affiliations

1. National Institute of Health Dr. Ricardo Jorge – Environmental Health Department, Av. Padre Cruz 1649-016 Lisbon, Portugal
 2. Faculdade de Ciências Exatas e da Engenharia da Universidade da Madeira, Campus Universitário da Penteada, 9000-390 Funchal, Madeira, Portugal
 3. Laboratório de Saúde Pública, IASaúde, Rua das Pretas n° 1, 9004-515 Funchal, Portugal
 4. Laboratório Regional de Veterinária e Segurança Alimentar, Caminho das Quebradas de Baixo n° 79, 9000-254 Funchal, Portugal
 5. Faculdade de Ciências da Universidade de Lisboa, Instituto Dom Luís, Bloco C6, 3º piso, Campo Grande, 1749-016 Lisboa, Portugal
- * corresponding author: joao.brandao@insa.min-saude.pt