HEAVY RAIN EVENTS AND MICROBIOLOGICAL CONTAMINATION OF WATER

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ABSTRACT

There is information available in industrialised countries indicating that outbreaks of water borne infectious diseases are linked to heavy rains that do not originate flooding events. In our area, because of the absence of continued data basis, it is no possible yet to make this sort of tracking of the causes of outbreaks. But, through the years, and without conducting specific studies, we have accumulated data that show how heavy rains cause increases of different extent, but always very significant, in the densities of microbial faecal indicators in river water, in spite of the increased water flow of the river, coastal seawater, groundwater and drinking water.

INTRODUCTION

Though uncertainty is one of the main characteristic of the prediction of the effect of climatic change, there is a general consensus on an increase in the frequency of extreme meteorological events. In Mediterranean climates it is foreseeable a succession of droughts and heavy rain events. Regarding infectious diseases, there is information in developed countries that outbreaks of water borne infectious diseases are linked to heavy rain episodes that do not originate flooding events **(**Curriero et al., 2001. American Journal of Public Health, 91: 1194-1199; Hunter, P. 2003. J Appl. Microbiol 94:37-46). In our area it is no possible yet to make this sort of tracking of the causes of outbreaks of water-borne infections because of the absence of continued data basis. Below, we present data that we have accumulated in our area, which show the effects of heavy rains in the concentration or presence of different microbial, bacterial and viral, indicators in river water, seawater, groundwater and drinking water.

OBSERVED EFFECTS OF RAIN

River water. The Llobregat is a Mediterranean river with an average flow in its lower course that ranges from 6 to 9 m^3/sec. River rises non-associated to flooding occur several times a year. The background levels of microbial indicators are high and steady through the year, except during and immediately after rain episodes. Faecal contaminants reach the river through point pollution, mostly through reception of secondary effluents of municipal sewage treatment plants, and abundant diffuse pollution. Typical background values of faecal coliform bacteria range from $3x10^3$ to $1x10^4$ CFU per 100 ml, and enterococci from $8x10^2$ to $5x10^3$ CFU per 100 ml. A significant increase, more than 1 log_{10} unit, of the densities of both bacterial indicators occurred in two different river rise episodes studied (J. Mendez. 2000, PhD Thesis.

University of Barcelona).Therefore, river rise does not cause a dilution effect; on the contrary it causes a clear increase in the density of microorganisms of faecal origin.

Sea water. In a multiyear study performed in the eighties and nineties in four bathing sites in the area of Barcelona it was observed that the four sites presented a level of faecal coliform bacteria below 100 per 100ml. However, after heavy rain episodes there was a very significant increase, more than 2 $\log_{10}$ units, in the levels of bacterial indicators. The situation was restored to normality after a few days (2 to 4) past the rain episode. After the rain episode the evolution in the number of indicators from the high values to the background ones roughly follows a first order lineal regression. The value of the "slope" varies from beach to beach, depending of factors that need to be determined (Vidal, J.R. and F. Lucena. 1997. European Commission. Measurement and testing programme. Report EUR 17801 EN. "Technical feasibility of an *A priori* measurement approach for managing bathing water quality").

In a different study performed in 2002-2003 we observed that when increases in the numbers of bacteria occur, similar increases were noticed for the numbers of enteroviruses, which reach densities that pose a quantifiable health risk (Mocé-LLivina et al., 2004. Appl. Environ. Microbiol. 70:2801-2805).

Groundwater. In a survey of the presence of different groups of microbial indicators including bacteria and bacteriophages, a spring, likely a karst spring, was monitored. It was observed how an exceptional rain event, 200 mm in less than 24 hours, caused a dramatic increase, more than 2.5 $\log_{10}$ units, in the amounts of different indicator bacteria and bacteriophages. The exceptionally high values decreased a few days after the rain episode (Mendez, J. 2004. J. Water and Health 2: 201-214).

Drinking water. A study aimed to assay the potential value of bacteriophages infecting *Bacteroides* as viral indicators in water was performed with 97 samples of drinking water of the network of a metropolitan area during the years 1996-1997. The samples were also assayed for the bacterial indicators. Bacteriophages infecting *Bacteroides* were detected in 8.0% of samples, whereas *E. coli* and enterococci were detected in 3.5 and 4.7% respectively. In the source waters used to feed the network the bacterial indicators are much more abundant that the bacteriophages infecting *Bacteroides*. Results showed clearly that phages survive better than bacteria to the potabilisation processes. This gives them a value as viral indicators; since viruses are know to survive more efficiently than bacteria to water treatments. The presence of phages did not correlate with either bacterial indicators or physicochemical parameters. In contrast there was a significant correlation with the litres or rainfall in the area in the days previous to sampling. Turbidity also showed a low correlation with the occurrence of rain, but no correlation was noticed between turbidity and the presence of bacteriophages (J. Mendez, J. 2000. PhD Thesis. University of Barcelona).

FINAL CONSIDERATIONS

If an increase in heavy rains is envisaged for the future, their effect on the transmission of water-borne diseases may be expected. In one hand, it will be necessary to gain understanding of the phenomenon, as for example whether pathogens follow the same pattern than the indicators, or for how long the effects of these events persist in the microbiological quality of water. On the other hand some changes in the guidelines of water quality may have to be done in order to prevent the effect of these climatic changes in human health.