Marine Pollution Bulletin 129 (2018) 284–292

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Optimising statistical models to predict faecal pollution in coastal areas based on geographic and meteorological parameters

Robson Ventura de Souza[a,*], Carlos José Alexandre de Campos[b], Luis Hamilton Pospissil Garbossa[a], Luiz Fernando de Novaes Vianna[a], Walter Quadros Seiffert[c]

[a] Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (Epagri), Rodovia Admar Gonzaga, 1.347, Itacorubi, Florianópolis, SC 88034-901, Brazil
[b] Centre for Environment, Fisheries & Aquaculture Science (Cefas), Weymouth Laboratory, Barrack Road, The Nothe, DT48UB, UK
[c] Universidade Federal de Santa Catarina (UFSC), Rodovia Admar Gonzaga, 1346, Itacorubi, Florianópolis, SC 88034-001, Brazil

ARTICLE INFO

Keywords:
Perna perna
Florianópolis
Escherichia coli
Regression models
Coliforms
Faecal pollution

ABSTRACT

This article describes a methodology for optimising predictive models for concentrations of faecal indicator organisms (FIOs) in coastal areas based on geographic and meteorological characteristics of upstream catchments. Concentrations of FIOs in mussels and water sampled from 50 sites in the south of Brazil from 2012 to 2013 were used to develop models to separately predict the spatial and temporal variations of FIOs. The geographical parameters used in predictive models for the spatial variation of FIOs were human population, urban area, percentage of impervious cover and total catchment area. The R^2 of models representing catchments located within 3.1 km from the monitoring points was up to 150% higher than that for the nearest catchment. The temporal variation of FIOs was modelled considering the combined effect of meteorological parameters and different time windows. The explained variance in models based on rainfall and solar radiation increased up to 155% and 160%, respectively.

1. Introduction

Recreational use of sewage-polluted coastal waters and consumption of raw or lightly steamed filter-feeding bivalve shellfish harvested from such waters pose a significant human health risk worldwide (Prüss et al., 2002). To reduce these risks, public health officials and water resource managers are increasingly using mathematical models to predict water quality and communicate to the public when pathogenic microorganisms in hazardous levels are likely to be present in the waters. These predictive models usually integrate variables that represent the sources of sewage contamination impacting the waters, concentrations of faecal indicator organisms (FIOs) (faecal coliforms, *E. coli*, enterococci) and/or pathogens measured in the waters/shellfish and the environmental conditions at or near the time of sampling (Francy et al., 2013; Olyphant and Whitman, 2004). The model output is an estimate of water/shellfish quality that is relevant in space and time to the risk of human exposure to the pathogen(s).

Regression-based models (RBMs) have been widely adopted to predict FIO levels in water. The main advantages of RBMs are that they rely on relatively basic statistical concepts and are easy to implement (de Brauwere et al., 2014). The environmental variables commonly used in RBMs to predict the spatial variations in FIO levels include land use or land cover characteristics of the catchment(s), resident human or animal populations, urbanized area and percentage of impervious cover (Campos et al., 2013; de Brauwere et al., 2014). The variables commonly used to predict temporal variations of FIO levels include meteorological and hydrological parameters (Campos et al., 2013; de Brauwere et al., 2014).

While changes in the spatial variation of FIOs in waters in response to changes in land use have been well documented for freshwater systems, few studies have been carried out in estuarine environments (Van Dolah et al., 2008). Where these studies exist, they are generally limited to shallow headwater portions of tidal creeks and it is unclear whether the associations detected are also valid for deeper areas of estuaries (Van Dolah et al., 2008). The water quality of estuaries is commonly influenced by multiple sources of pollution on the shoreline or upstream areas of the different catchments. Thus, the concentrations of FIOs and pathogens in the water/shellfish within a given estuary can vary significantly over short spatial scales (Beliaeff and Cochard, 1995; Kelsey et al., 2004).

Concerning temporal variation, rainfall is commonly associated with the variations in FIO levels in rivers and coastal waters. To study the cumulative effect of this parameter, time windows ranging from 24 h to 30 days before water sampling are reported in the literature

* Corresponding author.
E-mail address: robsonsouza@epagri.sc.gov.br (R.V. de Souza).

https://doi.org/10.1016/j.marpolbul.2018.02.047
Received 6 November 2017; Received in revised form 22 February 2018; Accepted 23 February 2018