Focus on CSIR Research in Water Resources

Modelling complex biophysical processes associated with diseases. Case study: The ecology of Vibrio cholerae in the Mozambican channel.

Cholera is an acute bacterial infection of the small intestine, caused by Vibrio cholerae and characterised by massive diarrhoea with rapid and severe depletion of body fluids and salts. The bacteria enter the body through the mouth, by ingestion of contaminated water and foods, causing an infection in the mucous membranes lining the lumen of the small intestine.

Research over the past 30 years clearly shows an association between Vibrio cholerae and plankton, providing further evidence for the environmental origin of cholera and its complex interaction with the environment. Coastal environmental conditions, such as sea surface temperature and sea height, as well as abiotic conditions, such as land surface temperature, pH, salinity, sunlight, iron concentration, and eutrophication of inland water sources, are apparently responsible for triggering cholera outbreaks or epidemics. These complex interactions may hold an explanation for the erratic occurrence of cholera epidemics. On a global scale, cholera epidemics can now be related to climate and climatic events and variability. Examples are El Niño and global warming which is currently changing the global distribution of plankton (a reservoir of cholera bacteria).

Accordingly the multi-disciplinary team investigated the ecology of the bacteria to determine possible linkages between cholera outbreaks in the area and various land and sea conditions with the overall aim to develop research capacity in modelling the bio-complexity of diseases. The research focussed on an area in Beira, a coastal city in Mozambique. The long term aim of this and other related projects is to develop algorithms that can accurately predict a potential cholera outbreak, 3-4 weeks in advance.

Findings to date are:

- A correlation between certain environmental data (meteorological data) and the cholera case data. It did not, however, prove a causal relationship between these


variables and the occurrence of cholera cases.

- A correlation between certain physical chemical data (accumulated rainfall and salinity) and the presence of V. cholerae in samples collected in Beira was observed.
- No significant correlation between chlorophyll a concentrations and cholera cases in Beira was noted, this is in contrast to trends noted elsewhere (Bangladesh)

Thus a need was identified to understand the microbiological factors contributing to environmental drivers associated with persistence of cholera bacteria and cholera outbreaks, and consequently the

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Actual vs Forecasted cholera — Multivariate
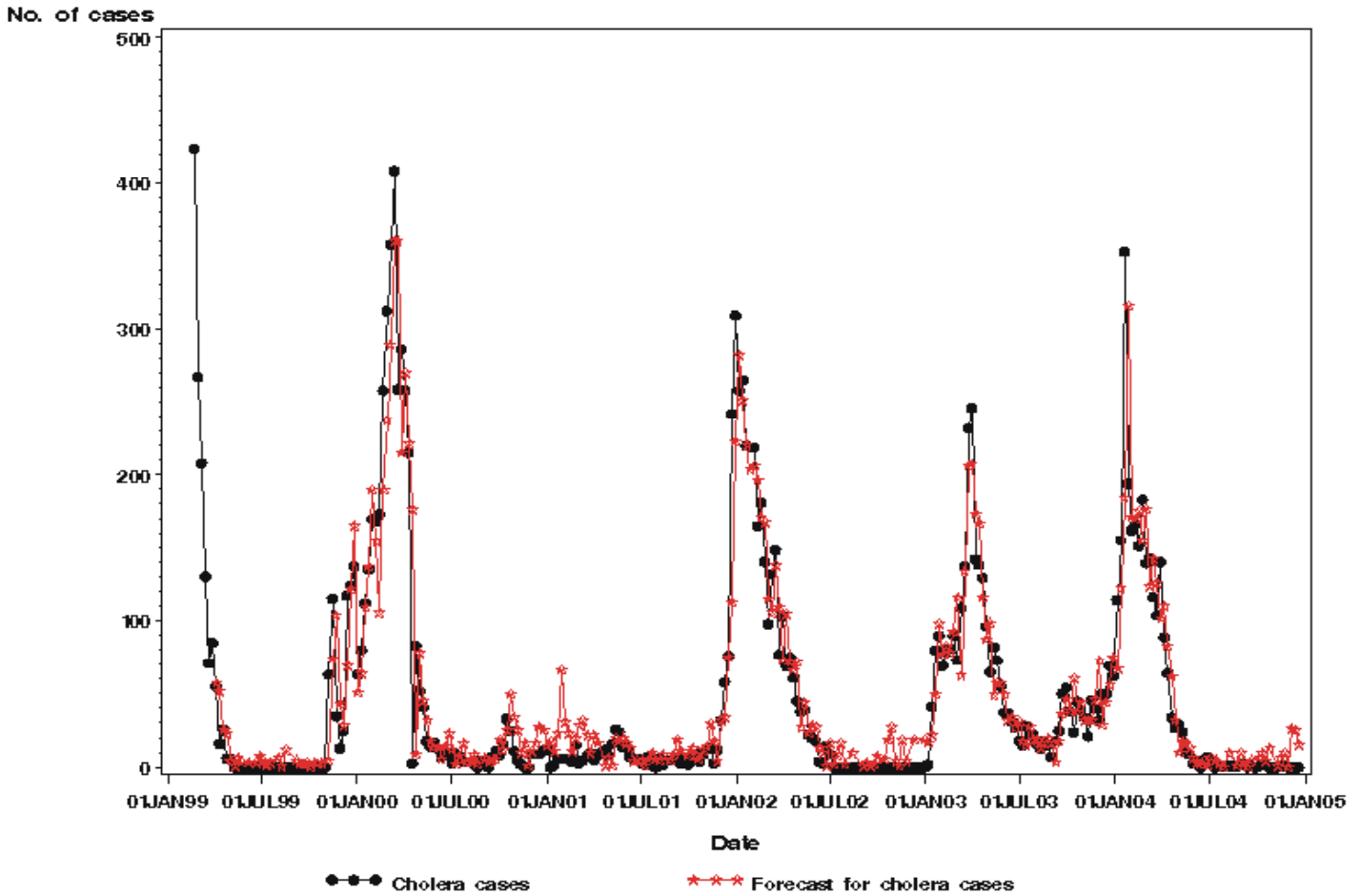
Actual versus forecasted cholera cases, modelled using accumulated rainfall, temperature, and preceding cholera case data.

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extent to which they contribute and influence the macro-level drivers. Further investigations into the role of the various identified reservoirs, the role of Vibrio cholerae O139 and human risk factors will be undertaken. Non-linear dynamics and chaos theory will be applied to enhance our understanding of the link between the microbial ecology, remote sensing and meteorological data.

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