Central Coast Council

Developing a water quality tracker and assessing site-specific swim safety by statistically modelling historical datasets alongside environmental and climatic factors

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- Microbial monitoring program
- Possible pollution sources
- Need for water quality tracking to determine when water quality is declining
- Exploring cumulative sum (CUESUM) step change
- Assessing if declining water quality can be attributed to known variables or unknown variables (GLM)
- Need to be able to factor in non-normal distributions
- Building the ability to do this for other variables and a simple? tool through the program R

Possible sources of contamination seen internationally

Pollution expected to increase by 10% every decade
Sources of bacterial pollution
- Illegal connections - private sewer to Council stormwater OR private stormwater to Council sewer – overloads
- Cracked sewer pipes or septic tanks - direct and indirect infiltration into stormwater pipes
- Infiltration of groundwater into waterway (sediment and resuspending)
- Domestic and agricultural faeces (dogs, cats, horses, cows etc)
- Natural sources: Wildlife faeces

Reservoirs – may persist in the environment for long periods of time and become available with wind and wave action
- Seaweed
- Sediment

Bacteria indicators

- Recreational water quality monitoring program
- Swimming safety with implications for ecological health
- Council tests the water quality at patrolled beaches and designated swimming areas
  - Weekly during swimming season
  - Monthly during non-swimming season
- Samples collected/tested for Enterococci (bacteria common to the faecal matter of warm blooded animals). These bacteria can be an indicator of sewage and/or stormwater contamination.

Why have an assessment method?

1. We are currently unable to clearly assess if water quality has declined in response to changing weather or site conditions, or due to e.g. failing infrastructure or illegal activity
2. Water quality monitoring data should be used to trigger proactive investigations, if water quality declines
3. Before proactive investigations are done, analysis of the data is needed to inform investigation method:
   - First step – Identify a decline in water quality
   - Second step - Quantify the influences of known factors
   - Third step – assess if other factors might be influencing the decline
   - Fourth step – brainstorm, investigate and assess other factors that might influence the decline
   - Fifth step – investigate using on-ground works

Quantifiable factors

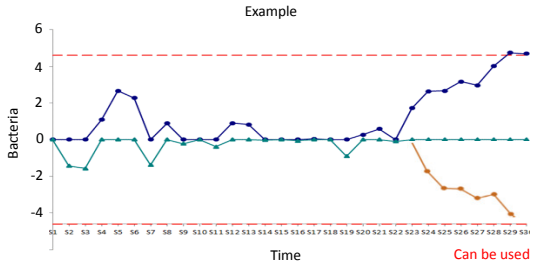
Quantifiable factors that may influence bacteria counts

- Rainfall
- Wind
- Waves
- Lagoon openings?
- Step-based events (water quality improvement works, damage to major infrastructure or malfunctioning infrastructure)

Step based events not always detectable and therefore cant be quantified – things we don't know about in the catchment

Decision makers need to know the influence of these quantifiable factors on changing water quality – need to be accounted for to assess if changes reflect natural variability or step change in water quality due to improvement works

Working toward cumulative sum

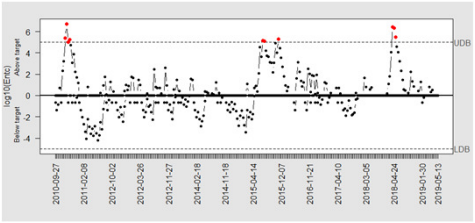


Can be used for other water quality variables

Publicly available data

Next step from Cusum charts

- STEP 1: identifying results which sit outside the norm (UCL and LCL)
- Recently a beach has started to decline and has been flagged under the NHMRC guidelines (100 samples)



Can investigate peaks exceeding expected variation

Publicly available data

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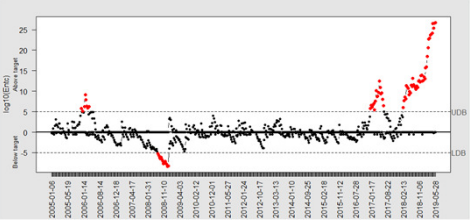


Can investigate peaks exceeding expected variation

Figuring out why there was a decline

STEP 2:
For short term assessment – easy to visually assess simple factors
More complex - Undertake regression (generalised linear model) in the program R
Work in structural components of the data

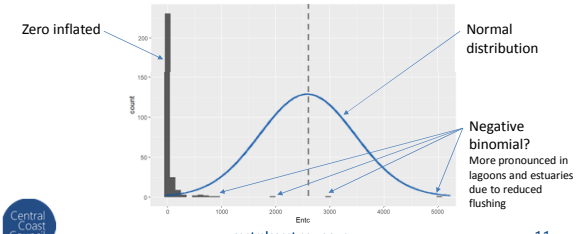
- Random effects (sampling rate summer vs winter)
- Data distribution (explained later)

Account for quantifiable factors (effects)

- Rainfall
- Lagoon openings
- Wind direction/speed
- Wave height

Data distribution – a problem for monitoring programs

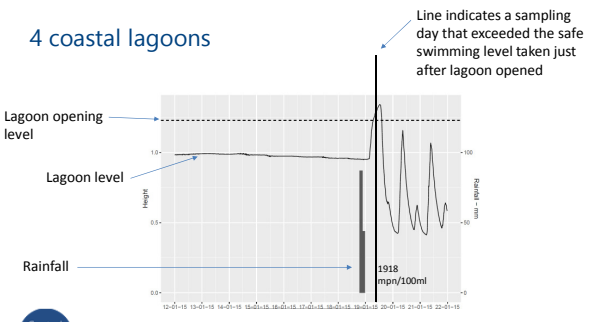
- Distributions are not always normal – need a specialised treatment dependent on data distribution
- Zero inflated and/or negative binomial common in environmental data
- Using monitoring data with a standard assessment (without data specific distribution) violates the statistical assumptions and the output of the test cannot be relied on



Publicly available data

Account for quantifiable factors

4 coastal lagoons



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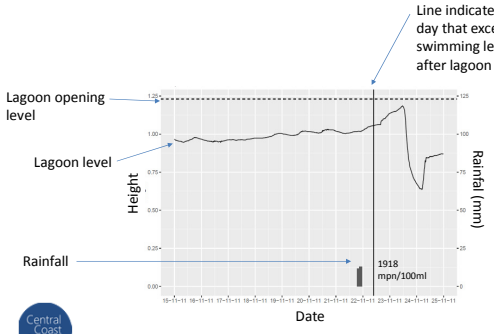

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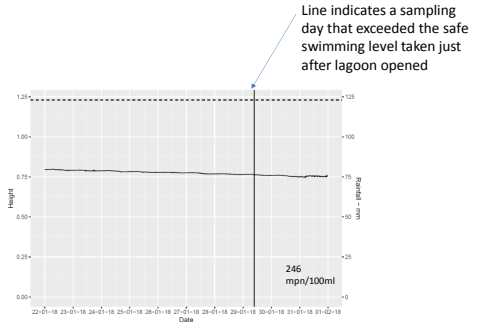
Publicly available data

Account for quantifiable factors



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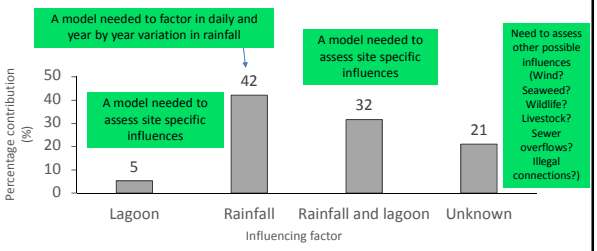
Known vs unknown factors



Exploring data allows managers to:
1. Understand trends
2. Operate proactively (for unknown factors)

Allows managers to assess current signage programs

Exploration and communication of data can provide more information to community members regarding swim safety – shows the importance of assessing rainfall and seeing if the lagoon is opened before swimming (making informed decisions)

Summary points

- Need to assess changes in water quality over time – accounting for quantifiable factors to detect if unknown factors are influencing results
- Instigate investigations if quantifiable factors don't explain changes
- Cusum a decent entry level to assessing step changes which can then be explored using regressions
- Analysing monitoring data is complex
- Can be applied to other pollutants or water quality parameters
- Providing more information to managers and community is important to improve our waterways and coast


Thank you for listening
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