A Real-Time Monitoring Approach for Examining Water Quality Changes Upstream and Downstream From a Cattle Access Point

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Cattle access point
Schematic of a discrete cattle access site with sampling locations.
US – Upstream, CAS – Cattle access site, INT – Interface, DS – Downstream
• Unrestricted cattle access to waterbodies is known to introduce nutrients into aquatic systems.

• The exact extent and impact of how cattle’s behaviour when entering these waterbodies has not been studied in great detail.

• It may not be possible in all areas to exclude cattle from waterbodies.

• This study uses real-time turbidity measurements and real-time motion detecting camera data to examine the influence of cattle on water quality when they enter a stream.
Deployments

Two sensors were used; one placed upstream from a cattle access point, and one placed downstream.

The difference in upstream and downstream turbidity during a cattle access event was examined to determine what factors impacted the turbidity of the stream most.
The catchment stream

This field was chosen: accessible cattle access point with sufficient water levels for sensors to be placed for upstream and downstream monitoring.

The access point only accessible from one side of the bank.

The cattle enter the stream for access to water and not as a crossing point which is common in other cattle access cases.

Sensors were placed 3 m upstream from the cattle access point and 1 m downstream from the access point insuring they were at the point of deepest water.
• A) Displays the cattle access point taken from camera angle 1 when no cows were in the stream.
• B) Displays two cows in the stream taken from camera angle one.
• C) Displays four cows in the stream taken from camera angle 2.
• D) Displays three cows taken in night vision at camera angle 2.
Event characterisation

An event was described as any continues of entry of cattle into the stream.

The amount of entries to the stream was recorded as the number of cows.

When more than 5 min elapsed between cattle exit from the stream and the entry of more cattle this was counted as the start of a new event.

The length of each event from first entry to the last exit of the cattle was also recorded.
Turbidity results for each event.

There were 69 recorded cattle access events. To determine under what conditions cows impacted the downstream turbidity of a stream 3 areas were examined:

- The difference in upstream and downstream turbidity in relation to different river discharge levels.
- The difference in upstream and downstream turbidity in relation to different numbers of cows entering the stream for one event.
- The difference in upstream and downstream turbidity in relation to the length of each cattle access event.
Camera images and turbidity levels
Effect of flow

Overall river discharge level for the period remained low with only two occasions where levels went above 0.025 m³/s.

Average turbidity levels varied considerably more for the same period.
<table>
<thead>
<tr>
<th>Number of turbidity data points collected</th>
<th>Number of images taken on Camera</th>
<th>Number of flow data points</th>
<th>Number of events were cows entered the stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>13887</td>
<td>41689</td>
<td>365</td>
<td>68</td>
</tr>
</tbody>
</table>
1. Extract Data From Sonde
2. Change data to Comma Separated Values (csv) file
3. Data Cleaned in R
4. Save New CSV File
5. Extraction of event where cows entered the stream
6. Calculation of difference between upstream and downstream levels at each event
7. Turbidity Correlation With River Discharge
8. Turbidity Correlation With Cow Numbers
9. Turbidity Correlation With Cow Duration in Stream
10. Correlation and Statistical Results

- Simplify Column Names
- Remove Unwanted Columns
## Difference in turbidity

<table>
<thead>
<tr>
<th>Minimum (NTU)</th>
<th>Maximum (NTU)</th>
<th>Median (NTU)</th>
<th>Average (NTU)</th>
<th>Standard Deviation (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-8.6</td>
<td>159.9</td>
<td>2.8</td>
<td>16.2</td>
<td>± 30.7</td>
</tr>
</tbody>
</table>
No Rain and Cows
No Rain and Cows
No Rain and Cows
Less than 2.5 mm of Rain and Cows
Less than 2.5 mm of Rain and Cows
Less than 2.5 mm of Rain and Cows
Between 2.5 and 9 mm of Rain and No Cows
Between 2.5 and 9 mm of Rain and Cows
Between 2.5 and 9 mm of Rain and Cows
Over 2.5 mm of Rain and Cows
Over 9mm of Rainfall and no Cows
Over 9mm of Rainfall and Cows
Correlation results of the total number of cows entering the stream and the difference in upstream and downstream turbidity at each event.
Correlation results between the length in minutes of a cattle access event and the difference between upstream and downstream turbidity. The number of cows at each event is represented by point size.

Pearson = 0.5943
Spearman = 0.319
Mean upstream and downstream turbidity and river discharge levels for the duration of sensor deployment.
As cows only entered the stream in times of low river discharge.

A strong correlation was seen between cow numbers in stream and difference in upstream and downstream turbidity.

Results found that when there is upwards of 8 cows or any number of cows spend over 14 min in the stream there will be a higher impact on downstream turbidity.

Limiting the number of cows in stream to less than 8 and the reducing amount of time spent by each cow instream to less than 14 min has the potential to reduce impact on downstream turbidity levels.
Acknowledgements

COSAINT Project (Cattle exclusion from watercourses: environmental and socio-economic implications)

Patricia Antunes
Eleanor Jenning