Peaks of Interest: Time Differences in Flood Peaks and Implications for Natural Flood Management Implementation

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Introduction

- Natural Flood Management (NFM) uses natural processes to manage flood risk.[1, 2]
- There is evidence that NFM can slow the flow of water and reduce flood peaks in small catchments during small storms; more data is needed for larger catchments and larger storms.[3, 4]
- The time difference between flood peaks is an important consideration when determining where to implement NFM.[5]
- Research questions:
  - *What is the time difference between flood peaks at key confluences in the study catchments?*
  - *What are the implications of these differences for locating NFM in the right place?*
- Case studies:
  - River Esk (catchment area: 328 km^2)
  - Allan Water (catchment area: 225 km^2)

Methods

- Monitoring equipment installed at these key places:
  - River North Esk-River South Esk confluence
  - Allan Water-River Knaik confluence
- Aqua4Plus software used to calculate water levels.
- Peak Over Threshold[6] analysis using these thresholds:
  - Esk: All peaks over 0.8 m on the N Esk or S Esk
  - Allan Water: All peaks over 1.0 m on the Allan or Knaik

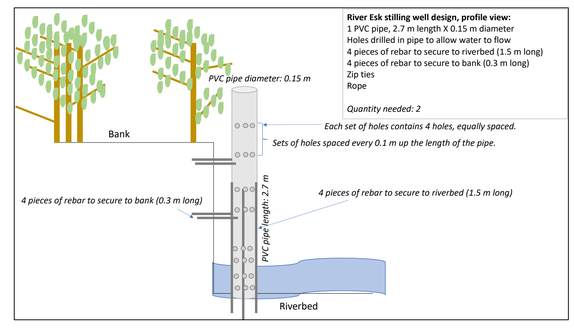

Figure 1: Stilling well design. Designs based on stilling wells built by Copper Lewis.[7]

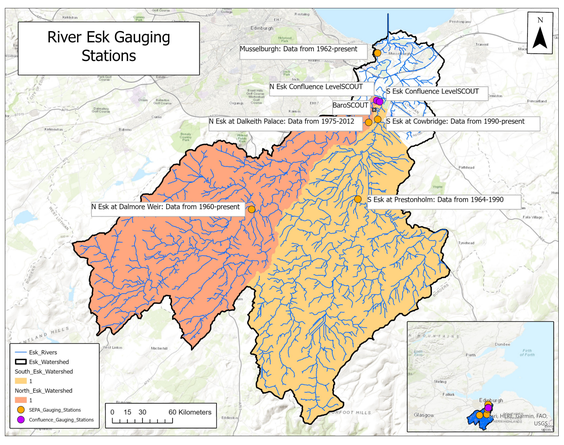

Figure 2: Stilling well locations in the Esk catchment.

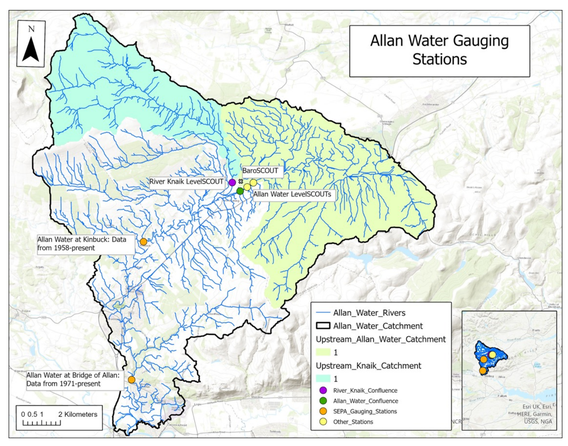

Figure 3: Stilling well locations in the Allan catchment.

Figure 4: Stilling well, River North Esk.

Results

- At the North Esk-South Esk confluence, 8 storms exceeded the threshold of 0.8 m between November 2023-May 2024. All peaks were within an hour of each other, although which river peaked first varied.
- At the Allan Water-River Knaik confluence, 7 storms exceeded the threshold of 1.0 m between November 2023-March 2024. The time difference between the peaks was up to 7.25 hours.
- In the data collected so far, one tributary did not consistently peak before the other in both catchments.
- Monitoring is ongoing in the two catchments.

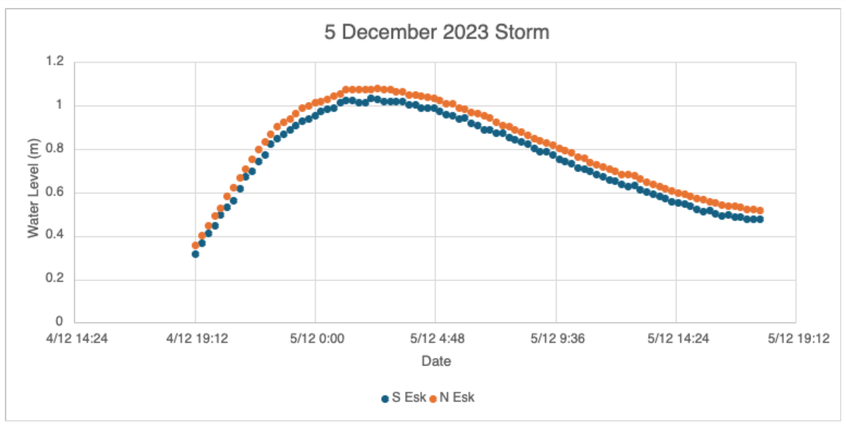

Figure 5: On 5 December 2023, the N Esk peaked first by 45 minutes.

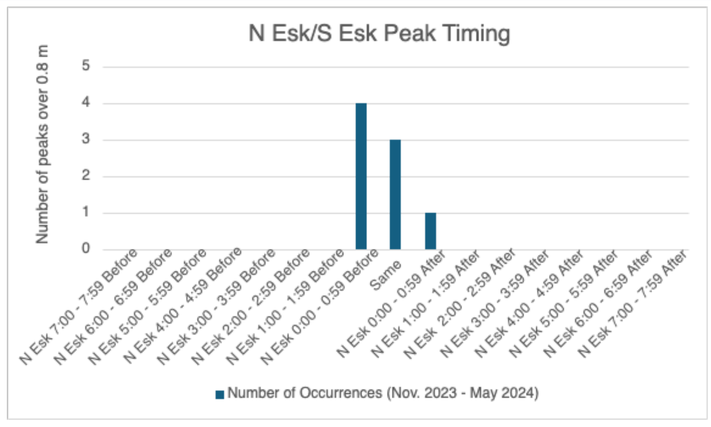

Figure 6: The North Esk and South Esk peaks occurred within an hour of each other in the events in this dataset.

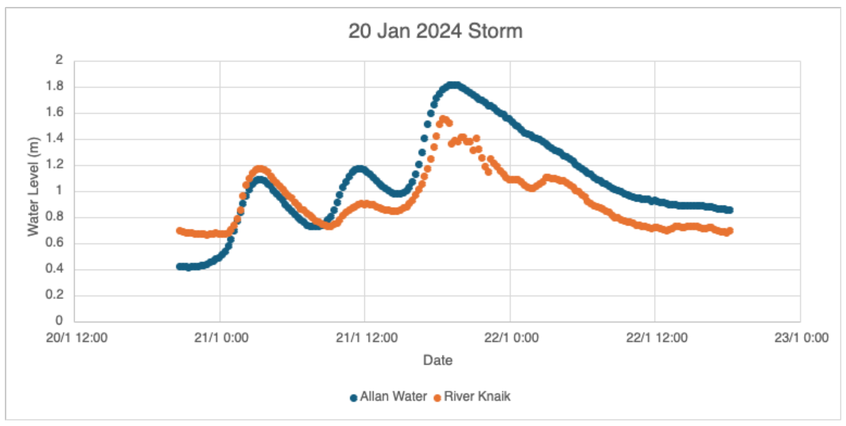

Figure 7: In the storm beginning on 20 January 2024, the Knaik peaked first by 30 minutes.

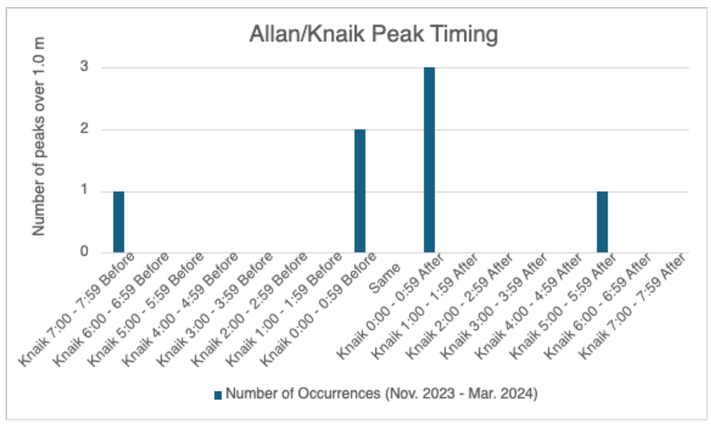

Figure 8: The Allan Water and River Knaik have larger time differences between peaks in this dataset.

Discussion

- It is important to avoid synchronizing peaks when implementing NFM.[5] This dataset shows variability in which tributary peaks first. More monitoring is needed to understand peak time differences across a larger number of storms.
- Modelling is needed to determine the ideal location for NFM in the catchment.
- This research is significant because there is widespread interest in understanding where and when to implement NFM to reduce flood impacts in the UK and internationally.

Next Steps

- Update the data loggers to collect data every 5 minutes instead of every 15 minutes for increased detail. Continue to collect data regularly.
- Incorporate Scottish Environment Protection Agency (SEPA) data on water levels, rainfall, and storm direction.

References

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