Investigating the Feasibility and Reliability of Citizen Science for Catchment Science

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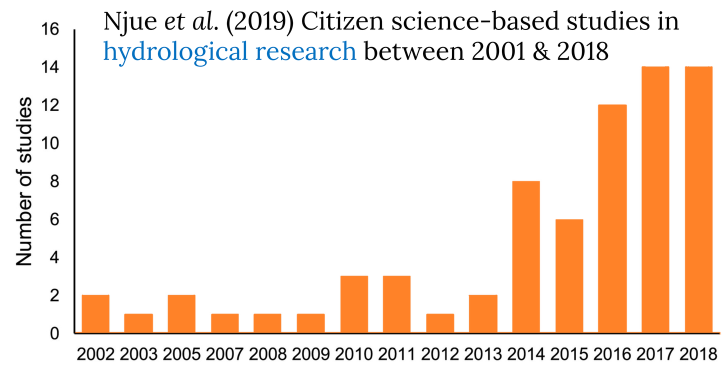
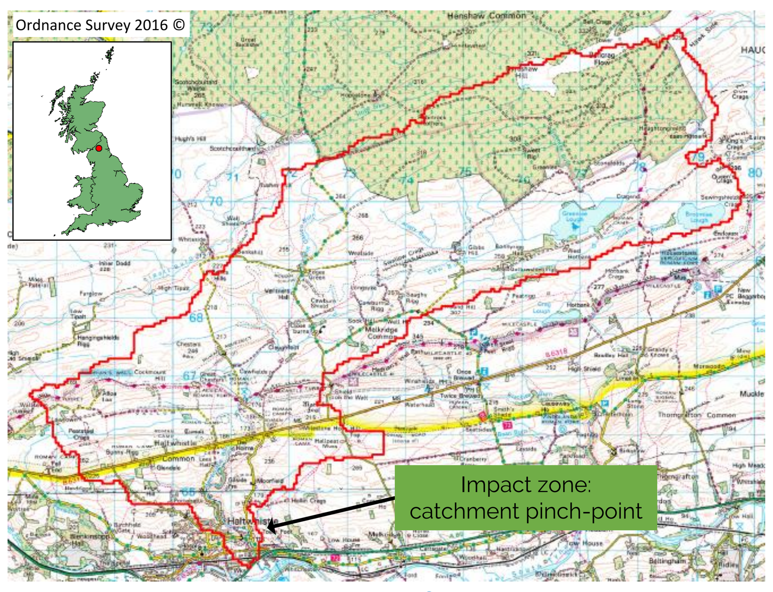
1. Introduction

Hydrological catchments are spatially and temporally complex, and even with the most advanced scientific knowledge and techniques, which exist and 'follow the rules of good science' (WMO, 2008), they are still poorly characterised at a local level. **High quality data are required** to support a wide range of catchment management activities. Whilst it has grown in recent years, "*citizen science for river and flood monitoring is currently one of the **least adopted** across the environmental spectrum*" (Blaney et al., 2016).



2. Case study site and focus community

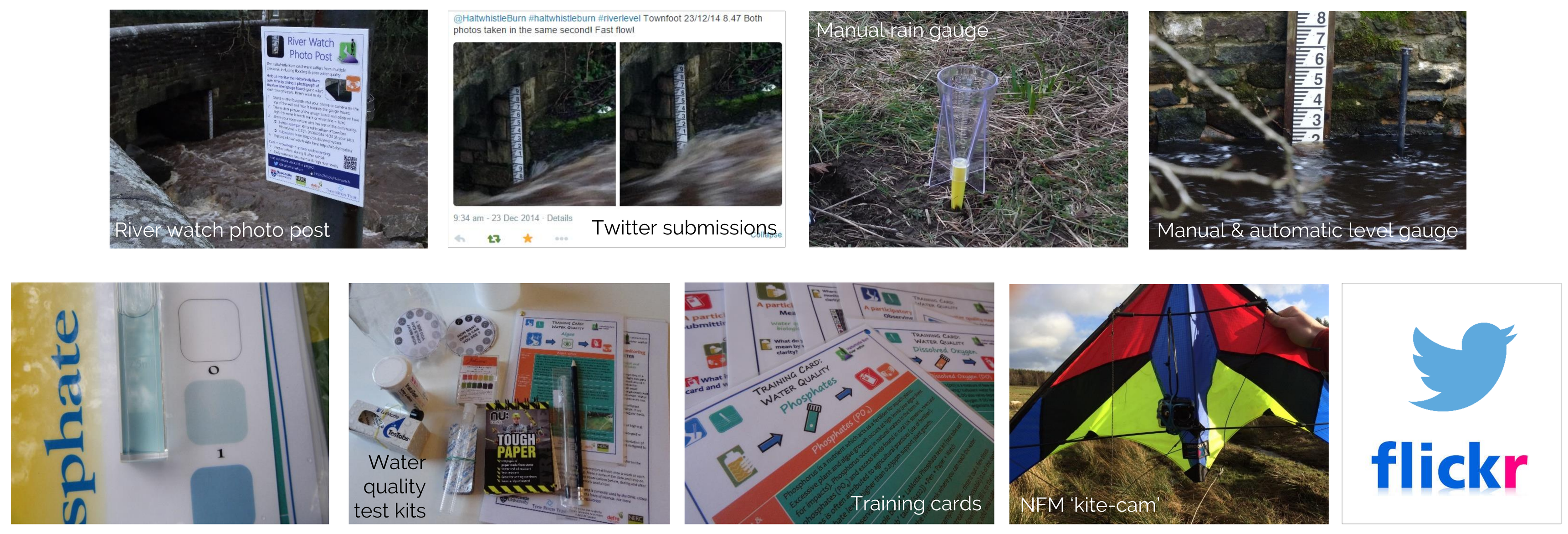


A rural case study: 42km² Haltwhistle Burn catchment, Northumberland, UK

- Catchment affected by flash floods, sediment issues and poor water quality;
- No historical datasets or live gauges;
- 'Close-knit' & active community groups;
- Tyne Rivers Trust already active.

3. Methodology

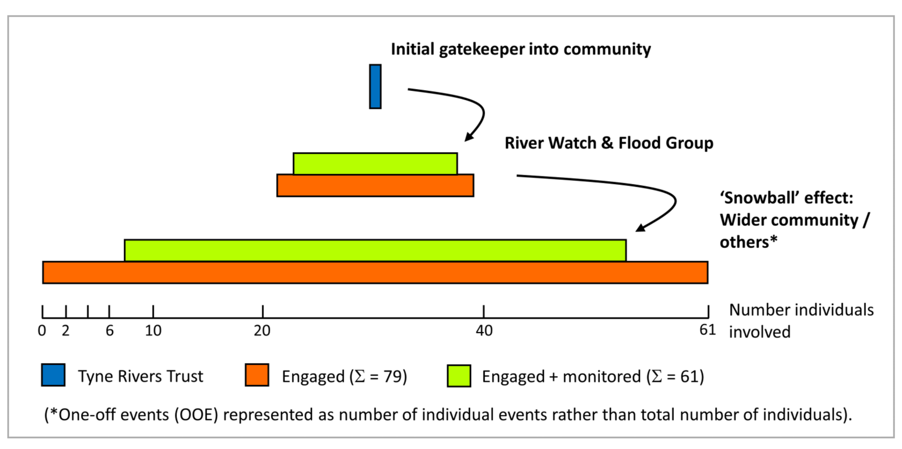
A **citizen science** monitoring scheme was implemented within the Haltwhistle Burn catchment to demonstrate the **feasibility** and **reliability** of citizen science, with focus on flood risk and wider catchment management process. Datasets were collected over a **29-month period** which has enabled the citizen science data to be **compared against automatic sensors**. Simple, manual, visual, hands-on and low-cost monitoring methods were prioritised and developed to maximise the connection between participants and the weather/water environment.



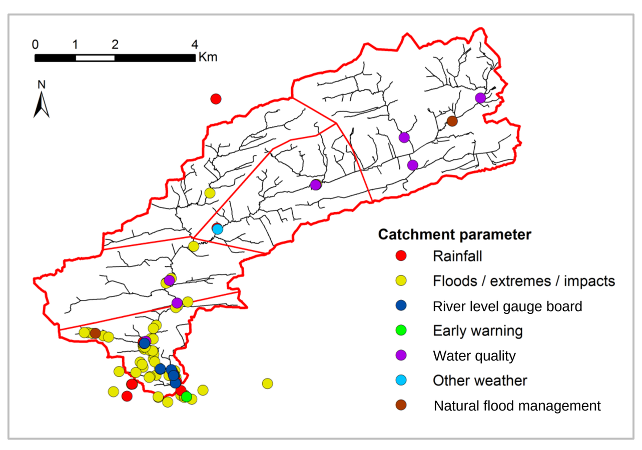
- **Feasibility:** the number, type, location and timing of the **observations received** from citizen scientists was used as a proxy to **infer** feasibility.
- **Reliability**: A hydrometric monitoring network was installed to capture catchment response (**rainfall** and **river level**) using automatic monitoring equipment, and **co-locate** (where possible) the manual citizen science observations. **Statistical** and **graphical** methods are used to **demonstrate** the quality of the data and extract meaningful hydrological information.

A project specific citizen science framework was applied – including engagement.

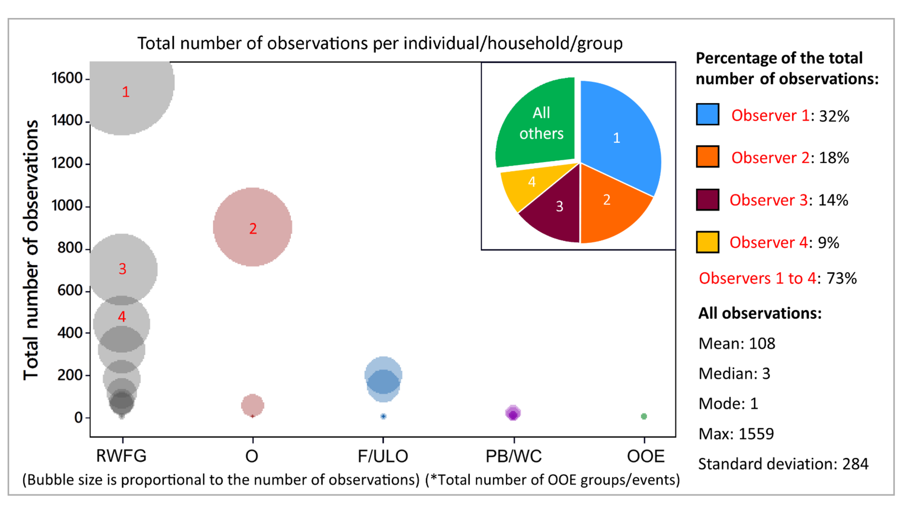
5. Feasibility



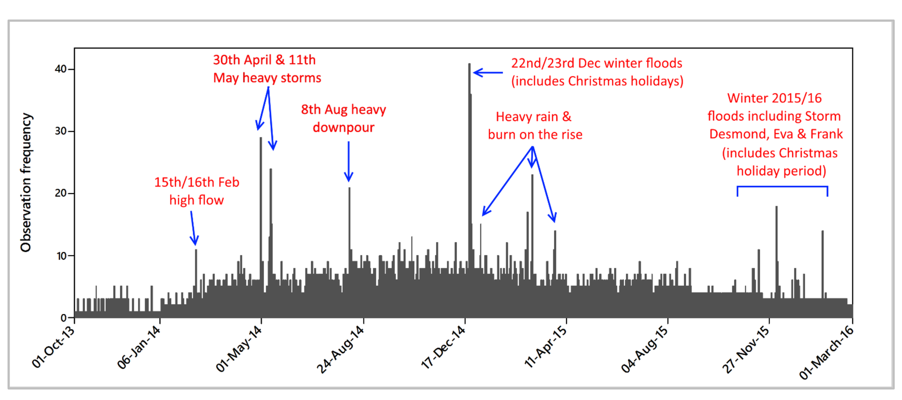
Number of participants: extrapolates via 'snowball' effect



Spatial patterns and parameter type



Who participated: River Watch Flood Group (RWFG); Farmer & upstream land owners (F/ULO); Passer-by and wider community (PB/WC); Other (O); One-off events (OOE).

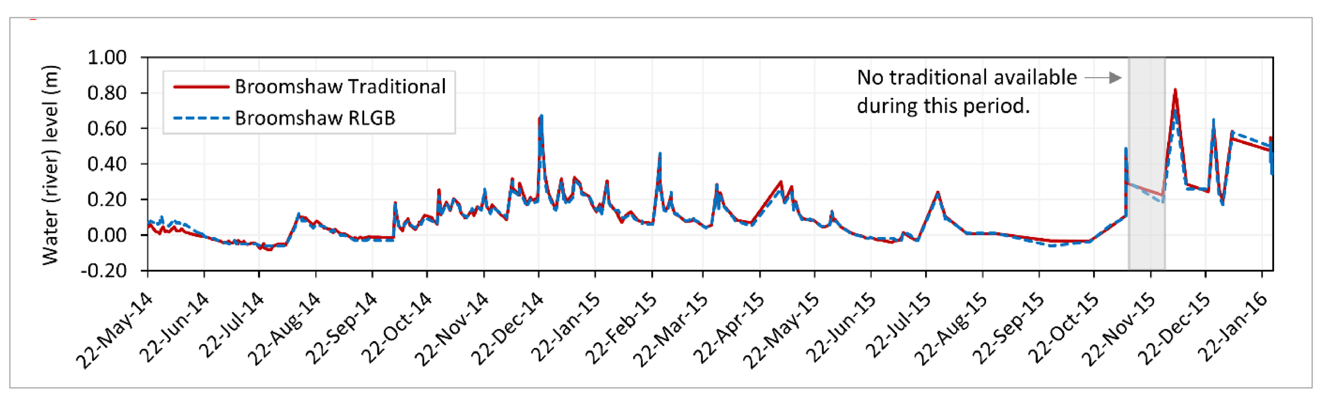


Temporal patterns: closely aligns with timing of high flow (flood)/rainfall events

Community-based monitoring for catchment science is feasible; this example has produced 4877 **snapshots** of **heterogeneous data** in a range of formats, and for a variety of parameters over the 29-month period of interest. The majority of observations were collected by a small number of regular volunteers (**almost three quarters of the total observations submitted were generated by just four participants**). However, monitoring efforts are **unpredictable** and **sporadic.** Rainfall, river levels and flood-related observations were favoured by volunteers.

6. Reliability (data quality)

'There is a perception that the quality of research carried out by citizens does not match that of research carried out by scientists' (Science Communication Unit 2013).



Comparison against paired traditional sensor and manual citizen science river level observations.

Area / region of interest	Nov-15 to Jan-16 rainfall total (mm)	Rank	Source
Solway	919	Wettest	Marsh et al., 2016
North-west England	783		
Broomshaw	**716**		**Traditional**
Tweed	708		Marsh et al., 2016
Townfoot	**701**		**Community-based**
Blenkinsopp Hall	**698**		**Traditional**
Central Haltwhistle	**684**		**Community-based**
Areal	**664**		**Traditional**
UK	571		Marsh et al., 2016
Gibbs Hill	**650**		**Traditional**
Yorkshire	444	Driest	Marsh et al., 2016
England	376		

Comparison between winter 2015/16 extreme rainfall totals (red = citizen science, blue = traditional, black = published national/regional figures). Data covers Nov-15 to Jan-16.

One community-based river level observation:

- Check: equipment still in place
- Check: flood risk (no overtopping or debris)
- Check: no damage
- River level: 0.41m
- Discharge / velocity: possible to estimate if video supplied
- Water quality: indication of clarity / turbidity / colour
- Metadata: embedded automatically (date/time)
- Data quality: self-verifying
- Check: general weather conditions

Traditional equivalent:
26/01/2016 11:45 = 0.44m

- Unknown quality without full QC investigation.
- Limited value when used alone by most stakeholders (unless it represents Q*peak*).
- Not normally available to the public in real-time.

Comparison between one citizen science observation and its traditional equivalent. Multiple attributes can be extracted from a single photograph.

Useful quality control checks:

- Completeness (temporal)
- Consistency (spatial precision)
- Tolerance / expected trends
- Format
- Trust and reliability
- Cross-checks
- Expert judgement
- Triangulation

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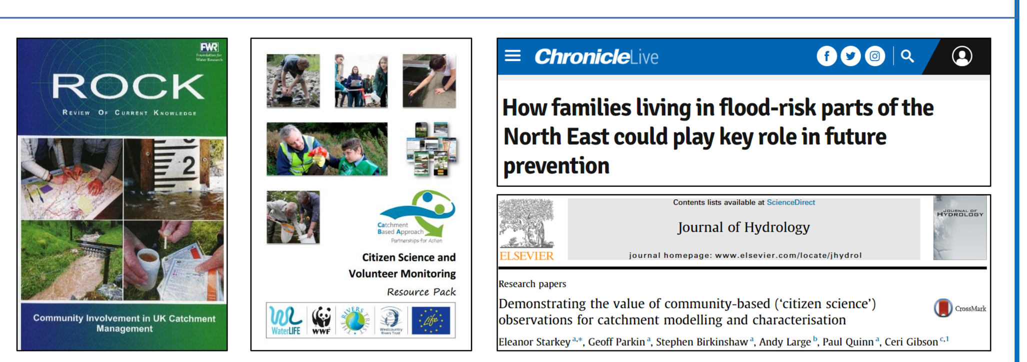
7. Summary

Results demonstrate the importance of public participation to fill local data gaps. Whilst difficult to summarise the quality of citizen science in one statement, examples presented collectively suggest that members of the public have the potential to collect high quality and reliable data pertinent to the weather and water environment.



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