Resilience to Fluvial Flooding: Knowns and Unknowns

Ian Pattison[1], Copper Lewis[1], Andrew Tabas[1]
[1]School of Energy, Geoscience, Infrastructure and Society, Heriot Watt University,
i.pattison@hw.ac.uk @GoWithTheF1ow

What do we know and what we don't know about fluvial flood risk, resilience and management? Here we critique both scientific understanding through literature review and stakeholder knowledge through engagement to give us a clear picture of the current state of the art and provide recommendations for Scotland's Flood Resilience Strategy.

Background

Policy Fellowship critiqued our current state of knowledge with respect to fluvial flood management to inform Scotland's Flood Resilience Strategy.

Research

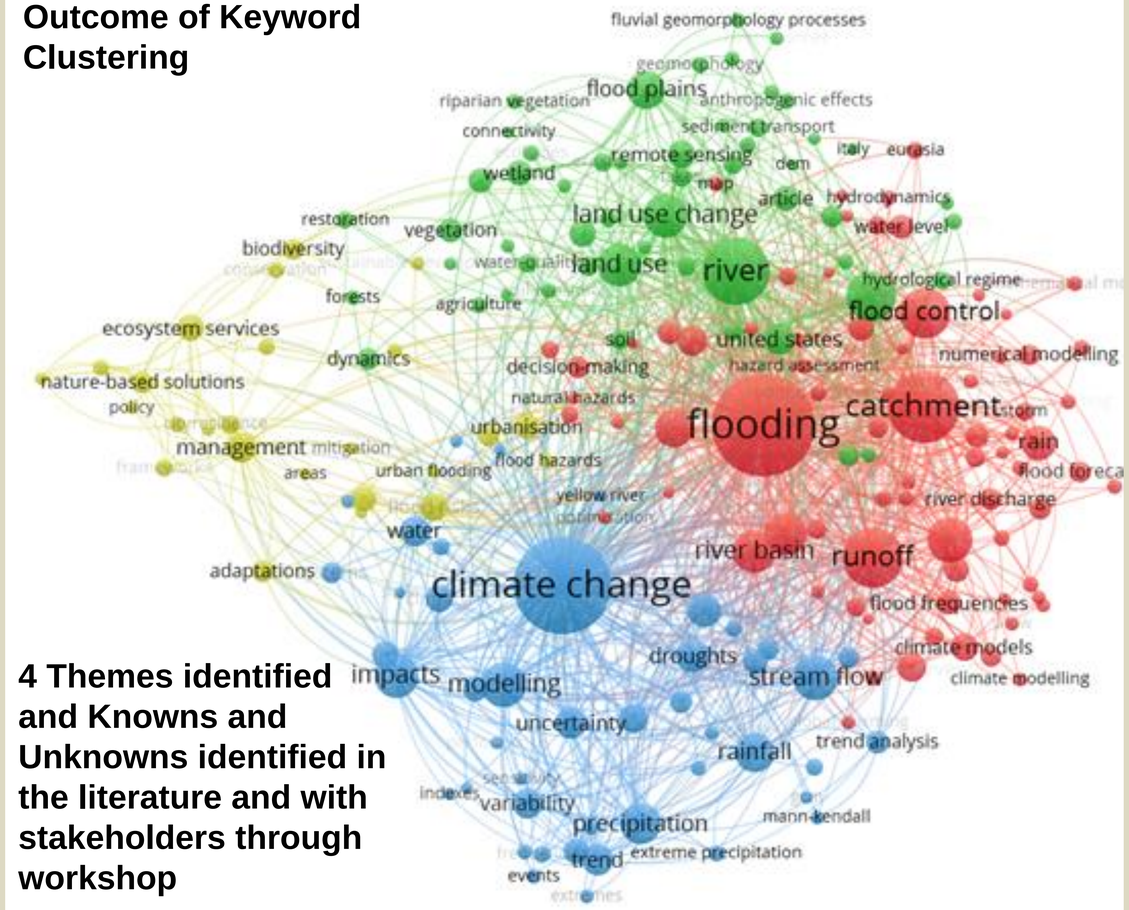
We have used the epistemological construct of "Known Knowns, Known Unknowns and Unknown Unknowns" to assess scientific knowledge on fluvial flooding through a literature review and stakeholder workshop.

	Knowns	Unknowns
Knowns	**Known Knowns** *Things we are aware of and understand.*	**Known Unknowns** *Things we are aware of but don't understand.*
Unknowns		**Unknown Unknowns** *Things we are neither aware of nor understand.*

We used a wide range of search terms and combinations thereof relating to fluvial flood risk generation, management, and resilience using the Scopus and Web of Science platforms.

We utilised the power of AI to synthesise a large volume of information in an efficient manner to highlight emerging themes. This was done using VOSviewer, which analyses and visualises bibliographic networks. A co-occurrence analysis of the top 1000 keywords was conducted.

Outcome of Keyword Clustering



4 Themes identified and Knowns and Unknowns identified in the literature and with stakeholders through workshop

Climate Change

Knowns	Unknowns
Increased rainfall in winter months expected to increase the frequency and severity of fluvial flooding.	Absolute estimates of climate change impacts on rainfall and flooding are uncertain.
Changes not spatially uniform; it is estimated that catchments in the N and W of Scotland impacted most.	Complex regional climate models and projections are probabilistic and provide estimates of uncertainty.
	Compounded by uncertainty of other forcing factors e.g. land use change

Flood Generation

Knowns	Unknowns
Lag times between peak flows from different tributaries control the the magnitude and shape of the downstream hydrograph.	Can NFM achieve time lag delays needed to desynchronise tributary peaks and reduce downstream floods in larger catchments?
Desynchronising flood peaks from different tributaries reduces the magnitude of the flow downstream.	Hydrograph convolution from upstream catchment vary in space and time and are context-specific.
Conversion of rainfall to runoff is a non-linear process and is dependent upon the catchment characteristics.	Complex non-linear and scale dependent processes.

Natural Flood Management

Knowns	Unknowns
Proven effective for high-frequency, low return period, small storms.	Not proven effective for large storms or in large catchments.
Increase the "lag time" between rainfall and peak river levels.	Lack of data and relatively small-scale implementation to date.
Combined with hard engineering approaches to increase effectiveness	More data needed range of events, locations, and contexts.
Brings additional benefits e.g. biodiversity, carbon storage	

Working with Stakeholders

Knowns	Unknowns
Funding is only one of many issues that can affect NFM implementation.	Uncertainty in realm of politics and decision-making processes.
Calls for increased and meaningful public participation in management.	Making management equitable, providing benefits across society
Memory is an important factor in community perceptions of flood risk.	Finding right balance of NFM, grey infrastructure, do-nothing, and retreat is a difficult task that requires input and negotiation from affected people

Recommendations

1. Mainstream and upscale Natural Flood Management (NFM) and/or Nature-based Solutions (NbS) implementation, supported by monitoring and maintenance. Ensure NFM is assessed holistically for use alongside hard engineered solutions.
2. Contextualize flood management decisions to take into account hydrological complexity, non-linearity, and the unique geography of each catchment. One solution does not fit all.
3. Shift to adaptive planning, to account for future uncertainty associated with climate change, including in terms of mindset of planners, economic appraisal, and funding mechanisms.
4. Encourage community co-creation of flood management for place-based, socially accepted policies, relating to standard of protection, risk perception, and balance of options.
5. Address the many gaps in our knowledge, highlighted by scientific confidence assessments and Unknown Unknowns, which need future research.