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Unlocking the Potential of Integrated and Applied Groundwater Research

Differing styles of integration and associated challenges across the UPGro consortium projects

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Overview

• **Report of study:** assessment of attempts at social and natural science integration in 5 large groundwater research projects

• Method:

- Analysis of project documents
- key informant interviews
- coding of qualitative interviews using Nvivo

• Questions:

- How and why research is being integrated?
- What challenges and solutions are being found?
- What explains differences between the projects and approaches?

• Presentation:

- Introduce the UPGro programme and 5 Consortium projects
- Compare methodological approaches and 'styles' across 4 themes
- Discuss main findings and implications

Increasing complexity in groundwater research



Increasing scope of hydrogeology taken from Gleeson and Cardiff 2013

Calls for integrated and applied groundwater research

Karen Villholth (2006): "A far more coherent understanding is needed of the relationship between human/institutional and physical factors in actual and potential driving forces that direct human interactions with groundwater.

Physical scientists and the socio-economic community need to develop common language, integrated tools and methodologies, and specific interdisciplinary projects and databases."

But how do we do this in practice?

We need to develop conceptions of different types – or 'styles' – of integration in the context of applied groundwater research.

Five UPGro consortium projects

UPGro – 7 year (2013-2020) research programme funded by UK NERC, ESRC and DFID

Aim: Generate new knowledge on groundwater resource and management that can be used to benefit the poor in a sustainable manner



Terms:

- 1. Interdisciplinary research across the social and natural sciences.
- 2. Working closely with stakeholders and demonstrating impact.

Three thematic priorities:

- 1. Understanding the resource
- 2. Governance, institutions and access
- 3. Impacts of future trends



Hidden Crisis

- Identified problem: Why are there so many poorly functioning water points in Sub-Saharan Africa?
- Analysing 250 water points across Uganda, Ethiopia and Malawi from social science, engineering and hydrogeological perspective
- Developing new, more nuanced, definitions of functionality
- Statistical analysis combined with in-depth intensive study
- Integration of social and natural science through statistical analysis, in depth accounts and Bayesian network analysis

GroFutures

- Two problems: Lack of knowledge of groundwater resource and unequal power relations inhibiting sustainable access
- Aiming to develop better understanding of groundwater recharge processes through Groundwater Observatories
- Pathways Approach in 3 basins in Ethiopia, Tanzania, Niger
- Integration through Pathways Approach: (1) interactive identification of 'Groundwater Development Pathways'; (2) quantification and 'stress testing' of pathways; (3) evaluation through stakeholder engagement processes.





<u>T-Group</u>

- Identified problem: Dependence of urban poor on poor quality and unreliable groundwater.
- Experimenting with Transition Management approach in Uganda, Ghana and Tanzania.
- Community led solutions.
- Integration in two phases: (1) multi-dimensional system analysis of above and below ground systems; (2) use systemic understanding to inform TM cycle

BRAVE

- Identified problem: lack of understanding and planning related to the linked hydrogeological and meteorological system in the Sahel.
- Translate novel scientific knowledge from joint modeling of hydro and weather systems into user informed planning tools and run a pilot.
- Sites in Volta River Basin in Ghana and Burkina Faso.
- Three stages: (1) Vulnerability baseline; (2) Codevelopment of planning tools; (3) Piloting of planning tools and monitoring of effect on vulnerability.

Gro for Good

- Identified problem: need for improved understanding of socio-ecological system and increased institutional capacity to handle trade-offs and risks associated with competing growth (industrial, irrigation) and development (poverty alleviation) goals.
- Working in Kwale County in coastal Kenya.
- Aiming to produce a transferable and sustainable Decision Support, Risk Management Tool.
- Using innovative Smart Hand Pump Monitoring System and machine learning techniques to produce early warnings of quantity and quality issues.
- Tool uses combined socio-economic poverty metrics data and groundwater and weather modeling to identify risks.
- Working closely with local and national authorities to refine data collection and tool and ensure uptake.



Examining 'styles' and 'themes' in UPGro

- Categorise the 5 UPGro projects in terms of their 'styles' of social and natural science integration
 - Comprehensive
 - Pragmatic
 - Reflexive
- Compare the methodological approaches of the 5 UPGro consortium projects – 4 themes:
 - Theme 1 Emergent, seamless and planned integration
 - Theme 2 Bridging the divide
 - Theme 3 Relationships, attitudes and personal history
 - Theme 4 Novel reflexive approaches within UPGro
- Discuss main findings and implications for future research

Interdisciplinarity and integration

Study drew on Veronica Mansilla's (2006) classification of 'styles' of integration by validation criteria, i.e. *how are insights assessed, accepted or rejected?*

- 1. <u>Comprehensive integration</u>: seeking both explanatory and descriptive power
- 2. <u>Pragmatic integration</u>: seeking effectiveness and relevance to a defined problem
- 3. <u>Reflexive integration (our third category)</u>:
 - Reflexivity: "ways in which framings of the 'system' are plural, contingent and conditioned by divergent values" (Leach et al 2010).
 - Related to "Mode 2" research = reflexivity, framing, complexity -"socially robust" knowledge (Nowotny et al 2001; Nowotny 2003).
 - Integration validated through participatory processes.

Categorising the UPGro consortium projects

UPGro project	Predominant style of integration	Details
Hidden Crisis	Comprehensive	 Water point failure defined as multi-dimensional in intricate detail Reframing of disciplinary findings and articulating complex accounts Aiming to disentangle the complex roots of the problem and complete fundamental research
BRAVE	Pragmatic	 "Start where the problem isand the research develops following the line of the solutions." Overarching aim is "fit for purpose" evidence. Focus on quantifying and measuring (e.g. Vulnerability metrics baseline). Qualitative social science informs pragmatic development of tool.
Gro for Good	Pragmatic	 Focus on producing tool that can be handed over and is sustainable. This focus shapes data collection and development of interface of tool. Evaluation of tool relates to question: "Is it being used, is it effective?" As well as technical evaluation. Integrated tool has focus on quantifying and measuring in cost effective sustainable way. Qualitative social science on governance will determine how and where the tool can be used (as well as being valuable in its own right and contributing to literature).
GroFutures	Reflexive	 Pathways Approach linked to detailed measurement of groundwater recharge and use, modelling and stakeholder engagement at different levels. Focus on alternative framings and pro-poor Groundwater Development Pathways. Pathways defined and evaluated by diverse stakeholders using their own criteria.
T-Group	Reflexive	 Solutions identified as coming from the community. "Different perspectives on the future will be exchanged, visionary images of the future will be constructed, guiding principles will be formulated, and the vision will be documented." "Negotiation, adaptation, co- creation and debate" and the aim to "change their vision, redefine their position, and start perceiving the problem in a different manner."

Theme 1: Emergent, seamless or planned integration

- Comprehensive integration e.g. Hidden Crisis requires deep reconciliation, uses multiple approaches and still not certain will occur. Integrating qualitative and quantitative info to produce explanation.
- Pragmatic integration happens more naturally e.g. BRAVE and Gro for Good – Integration of quantitative information to produce tools – and qualitative information to help refine and apply tools pragmatically. *"The world has problems, universities have departments"* (Brewer 2001) becomes: *"researchers have problems...."*
- Reflexive integration e.g. GroFutures and T-Group can use well developed frameworks (e.g. Pathways Approach, Transition Management) to plan for mixture of expert analytic knowledge generation and participatory and deliberative engagement.
- Participatory methods help to validate and reinforce the integration.
 Seems possible to plan for it.

Theme 2: Bridging the divide

Biggest challenge identified was overcoming epistemological and methodological differences between how social and natural scientsts. Lele and Norgaard (2005) describe this as *"bridging the divide"*.

- One GroFutures researcher described this as a *"fundamental difference between 'convergent' and 'divergent' approaches."* Social science divergent: always complicating, where is solution? Natural science convergent: ignoring complexity, reducing into solvable parts.
- This was a major focus in both comprehensive and reflexive projects.
- Not identified as a challenge in the pragmatic projects as they appear unified in largely convergent approach. Accompanied by greater focus on quantitative social science that allows alignment with natural science.
- Technical issues of combining diverse methods and merging different types of data remain and still require planning integration from the start.

Theme 3:

Relationships, attitudes & personal history

- Relationships, attitudes and personal history were identified as crucial by a number of researchers across the different styles of integration.
- Interdisciplinary attitude:
 - A Hidden Crisis researcher stated: "Ok, it's a cerebral thing, but it's also a kind of attitude thing or a heart thing, that you begin to work with other people... but it takes a bit of effort on your own part to understand where they come from, not just to write them off."
 - Identified as needing to be *"innately curious, open, receptive"* by a BRAVE researcher.

Theme 4: Comparison of novel reflexive frameworks

Pathways Approach

- Complexity and uncertainty
- Broadening and opening up appraisal
- Interaction between expert analytic and participatory knowledge making
- Use of Multicriteria Mapping (MCM) for assessing pathways using stakeholder criteria and weightings



Transition Management

- Also recognizes complexity and uncertainty
- Experimental
- Solutions come from communities
- Expert analytic phase of developing background knowledge of system, then action research
- Learning by doing approach. Is a cycle of action, learning, reflection.



From Jefferies 2011

Conclusions 1

- Interdisciplinary research is not a single thing. Different *'styles'* exist which have <u>non-trivial</u> implications for research.
- Integration is "a head and a heart thing". Need to take attitudes, relationships and personal histories seriously. When starting a project, we should assess the extent to which an interdisciplinary attitude and good relationships need to be built up in team.
- There are different means to different ends. If seeking 'comprehensive' or 'reflexive' integration then may need to think particularly hard about how to bridge the divide between opposing approaches to research.
- Multiple, reflexive frameworks now exist. These need to be tested and evaluated to assess what works, for whom and under what conditions.

Conclusions 2

- The typology of 'styles of integration' could be built on and extended...
- Need to develop a research agenda on interdisciplinarity within integrated and applied groundwater research field to:
 - **1. Bridge the divide** between the social and natural sciences and include researchers from diverse disciplines and backgrounds.
 - 2. Address the strengths and weaknesses of different styles of integration and different frameworks (e.g. Pathways vs. Transition Management and other pragmatic tools being developed in UPGro).
 - 3. One potentially interesting way to do this could be to use Multicriteria Mapping (MCM) to assess the trade-offs, strengths and weaknesses of different styles and techniques of integration from multiple viewpoints. Could help to elucidate the underlying differences between viewpoints and approaches, to help move the debate forward.



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