



Water use and Management in a Changing Monsoon Climate

Background

India's underground water supply, which may have accumulated over centennial timescales (Lapworth et al 2015), is being consumed rapidly, depleting aquifers in the process (see refs Petrie cv; CGWB 2010; WRI 2016). Vira (2016, see cv) has argued that local recharge of water supplies requires policies for use and management (such as free electricity for farmers) to be modified, and

consideration to be given to adopting climate-smart farming to enhance catchment hydrology. Northwest India is one of the most agriculturally productive regions in the subcontinent, but this has been possible because of extreme levels of ground-water depletion. Other regions of India require catchment management in order to support sustainable intensification of agriculture (Whitbread refs, cv).

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Outline of Programme Activities:

- **Examine evidence for past and present water availability** in relation to cropping practices;
- **Identify water efficient crops** suitable for specific localities with high and extreme water stress as well as high vulnerability to climate change, and crop-modelling;
- **Document evidence to identify water sources** and groundwater recharge using stable isotopes signals;
- **Assess trade-offs between yields/income**, water consumption and other ecosystem services;
- **Model sustainable practices for resilience** under a variable and changing climate.

Practical Description of Research and Allocation of Responsibilities to Staff in UK and India

The PDRAs working together will systematically collect data on energy use for ground-water pumping, water availability and water use in northwest India in the past and present by compiling available archaeological and palaeoclimate data sets, collecting samples for stable isotope analysis (18O) to define catchment hydrology (see Petrie, Griffiths cvs). Two ancient case studies will include

the Bronze Age Indus Civilisation and the Historic Kakatiya period. Archaeological data sets indicate a high degree of variability in crop choice and growing conditions, and this appears to have been a sustainable system, resilient to climate change, where diversity may have been encouraged. Data will be compared to modern practices, particularly in areas of diversity and sustainable water use.

Engagement with Stakeholders

- Co-Is engage with Prof. R.N. Singh (Department of AIHC, BHU), Prof Upmanu Lal (Director Columbia Water Center), and the three PDRAs to investigate resilient and sustainable farming and water-use practices from the past to inform policy and practice in the present;
- Structured interviews with administrators and farmers in different zones of India to assess diversity and sustainability practices and identify likely social, economic, and political impediments for implementing

change in management of water resources for northern and southern India.

- Relevant state government officials in Haryana, Punjab and northern Rajasthan, and Telangana/ Andhra Pradesh, will be informed via workshops of project outputs, on aspects of sustainability and resilience for water use in the face of past and present climate change.

Outcomes, Deliverables and Impact

Quantitative measurements of catchment hydrology , water storage and groundwater abstraction;	Insights into historical cropping diversity by Indus populations and water storage during Kakatiya period will provide lessons for today's farming monocultures.	Models of sustainable practices will include packages to account for 'capacitance' of water system-harvesting, storage, energy requirements , and subsequent supply for crops and communities;	Sustainable business models will synthesize crop, water and energy use by local industry and households and mitigate risks from climate change for northern and southern communities in India;	Provide socially and politically acceptable management solutions for sustainable water use;	Engagement with practitioners at a local level is critical for the success of this work-package, and it will be essential to assess both fears and expectations;
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Cambridge Lead:

C.A. Petrie; UCam Co-I: M Jones; Co-I H. Griffiths; Co-I India K. Vatta, CIPT/Punjab Agricultural University (PAU), A. Whitbread ICRISAT

HR Career Stage Requirements:

Employment in UK: 1 PDRA; India: 2 PDRA at key Institutions;

Capacity Building India-UK and UK-India Exchanges:

3 Senior Investigators; 3 PDRA/PhD extended exchanges; techniques workshops.

