Groundwater Resource Response to Changing Climate in Mid-hills of Nepal

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1. Introduction

The valleys in the Middle Hills of the Himalayas are one of the most sensitive areas to climate change in Asia. Changes in temperature and precipitation could impact both the quantity and timing of spring and river flows with subsequent impacts on the agricultural livelihoods of many of the communities living in the Mid-hills. Although future precipitation patterns and snow melt in the Middle Hills are poorly constrained, there is growing recognition that *groundwater storage* within these catchments forms an important component of the Himalayan water budget (Andermann et al., 2012) and is vital for current and future secure water supply. However, despite its current and future importance, groundwater resources are poorly characterised. This study examines the groundwater resources in Madanpokhara in western Nepal, within the Tinau River catchment (within Kali Gandaki Basin) and investigates how groundwater exists and how resilient it is to climate change.

2. Objective

During 2013 and 2014, detailed field investigations were carried out in Madanpokhara by scientists from the British Geological Survey, ISET-Nepal and ISET –International with the following objectives:

1. To characterize catchment water supplies and water usage.
2. To assess hydrogeology of the catchment within the wider hydro-geological setting.
3. To collect reliable set groundwater chemistry samples and groundwater residence times for catchment in the Himalayan foothills.
4. To improve understanding of resilience of groundwater within the catchment and coupling between groundwater and modern stream-flow and or snow melt.

Figure 1. Madanpokhara catchment

3. Study Catchment

The study was undertaken in Madanpokhara VDC within Palpa District, Western Nepal.

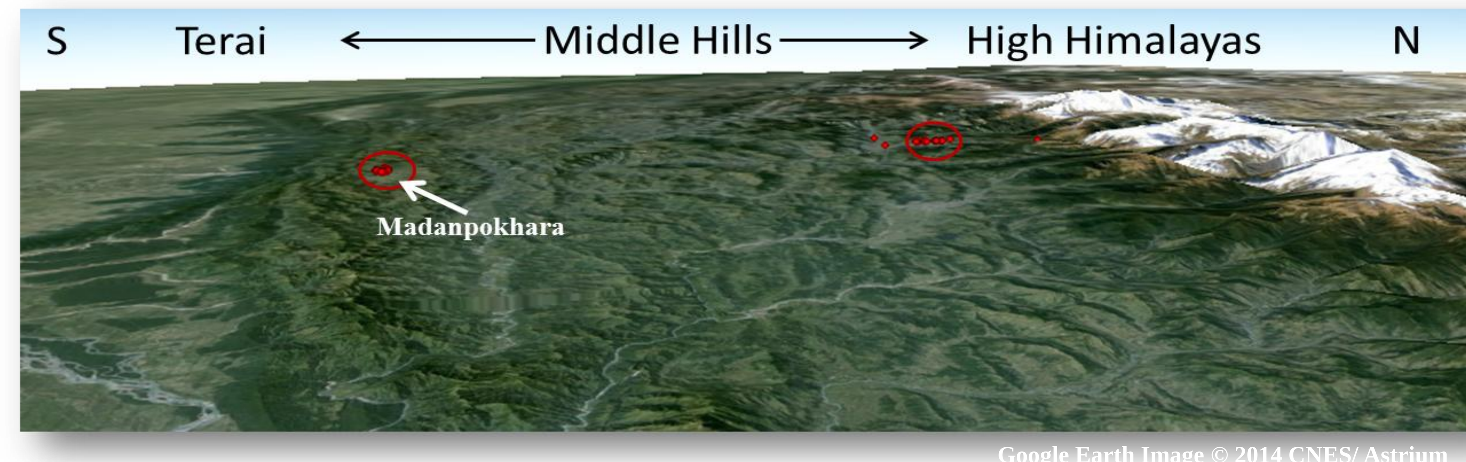

Figure 2. Study transect

Madanpokhara VDC, Palpa
Elevation: 560-1240m
Tropical to subtropical climate
Population: 6,300
Agriculture: 80%
Water sources: Springs and shallow tubewells

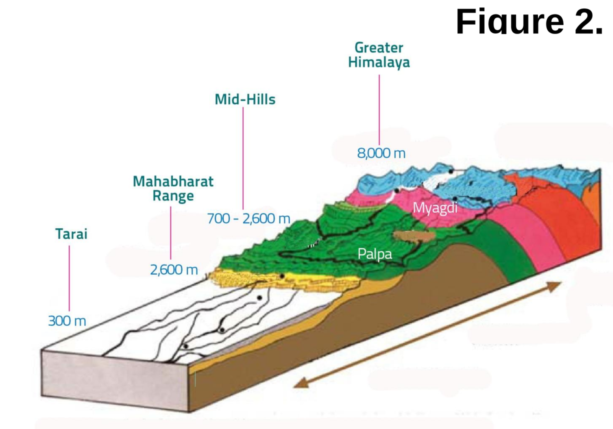

Figure 3. Geological transect (Source: Hagen, 1998)

4. Methods and Techniques

The study made attempts to use both high science and citizen based science to collect evidence. Answers were sought to following questions:

Community Discussions

I. What are the main livelihoods?
II. What are the main sources of water?
III. What is the water used for?
IV. Are there water shortages?
V. Are there water quality problems?

Field Surveys

I. Groundwater chemistry
II. Stable isotopes
III. CFC and SF_6 (residence times)
IV. Noble gases (recharge temp)
V. Spring flow and temperature

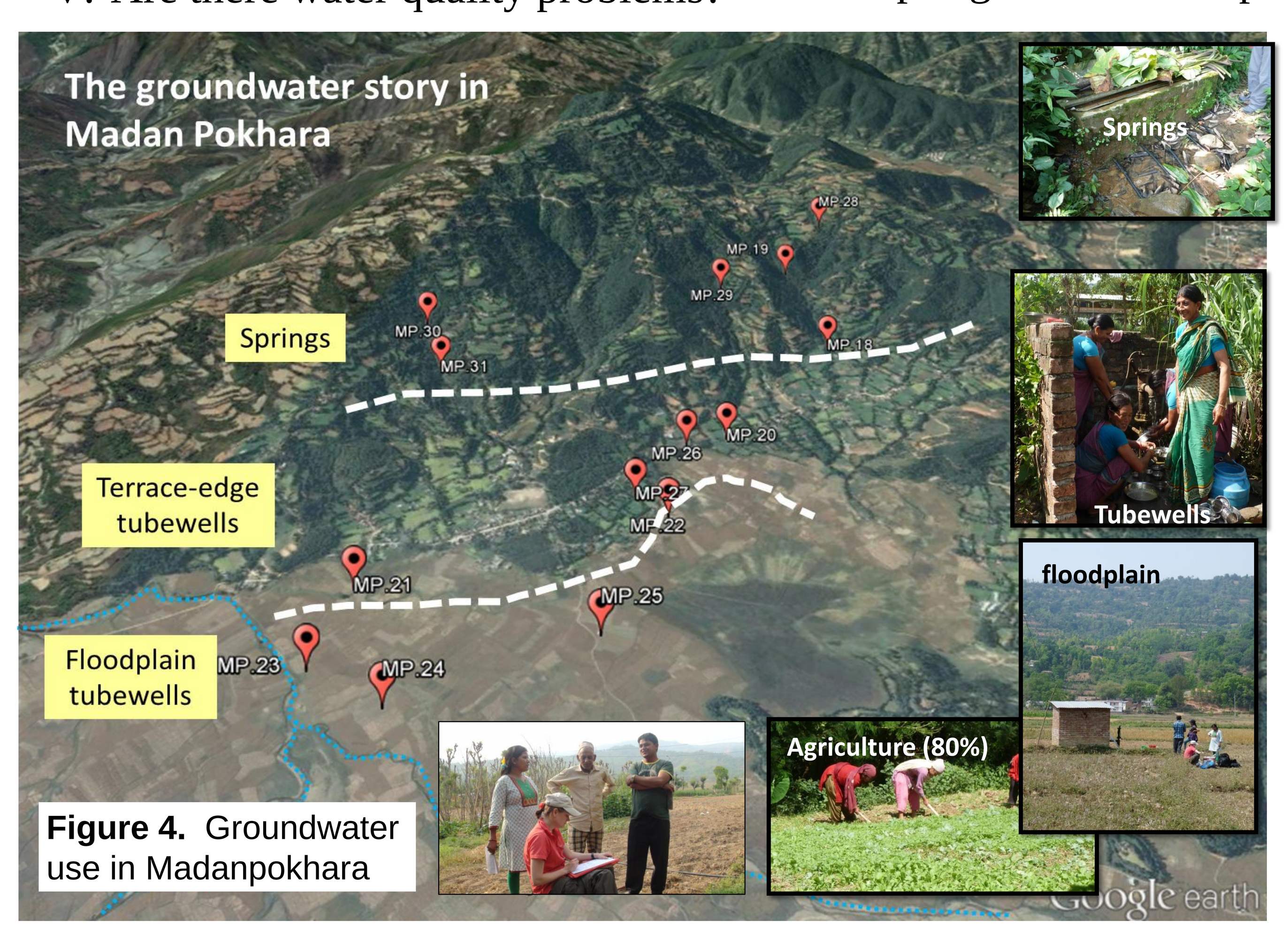

Figure 4. Groundwater use in Madanpokhara

5. Results

The study indicated a high and growing reliance on groundwater within the catchment. Spring flows were used originally for drinking water and small scale irrigation. However, groundwater in the valley floor is now increasingly abstracted through (> 40) small hand drilled boreholes for irrigation.

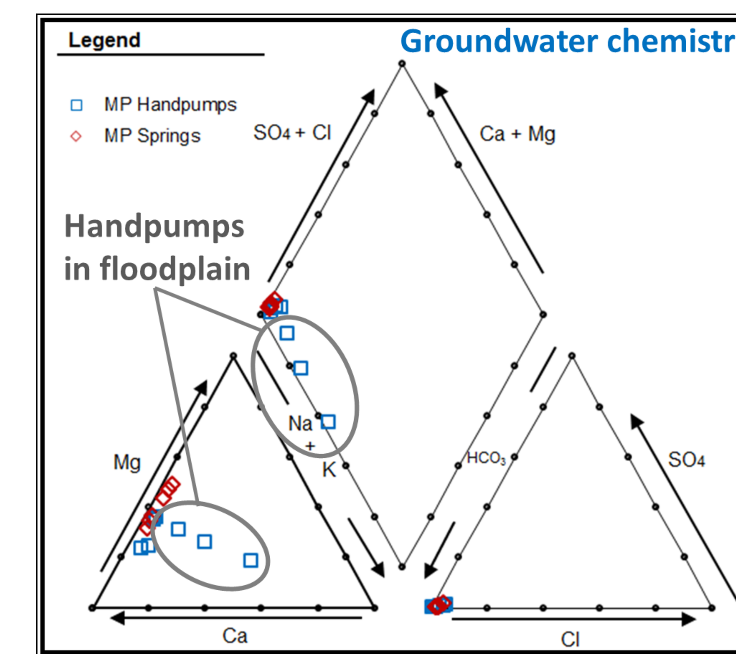

Figure 5. Piper plot of major-ion groundwater chemistry

The sampling indicates that groundwater discharging through the springs has a mean residence time of approx 10yrs and there is considerable seasonal variation. Groundwater abstracted from boreholes in the valley becomes increasingly older (>40yrs) with distance from the hillslope and is much more resilient to climate variability. However, water abstracted from boreholes can have quality issues.

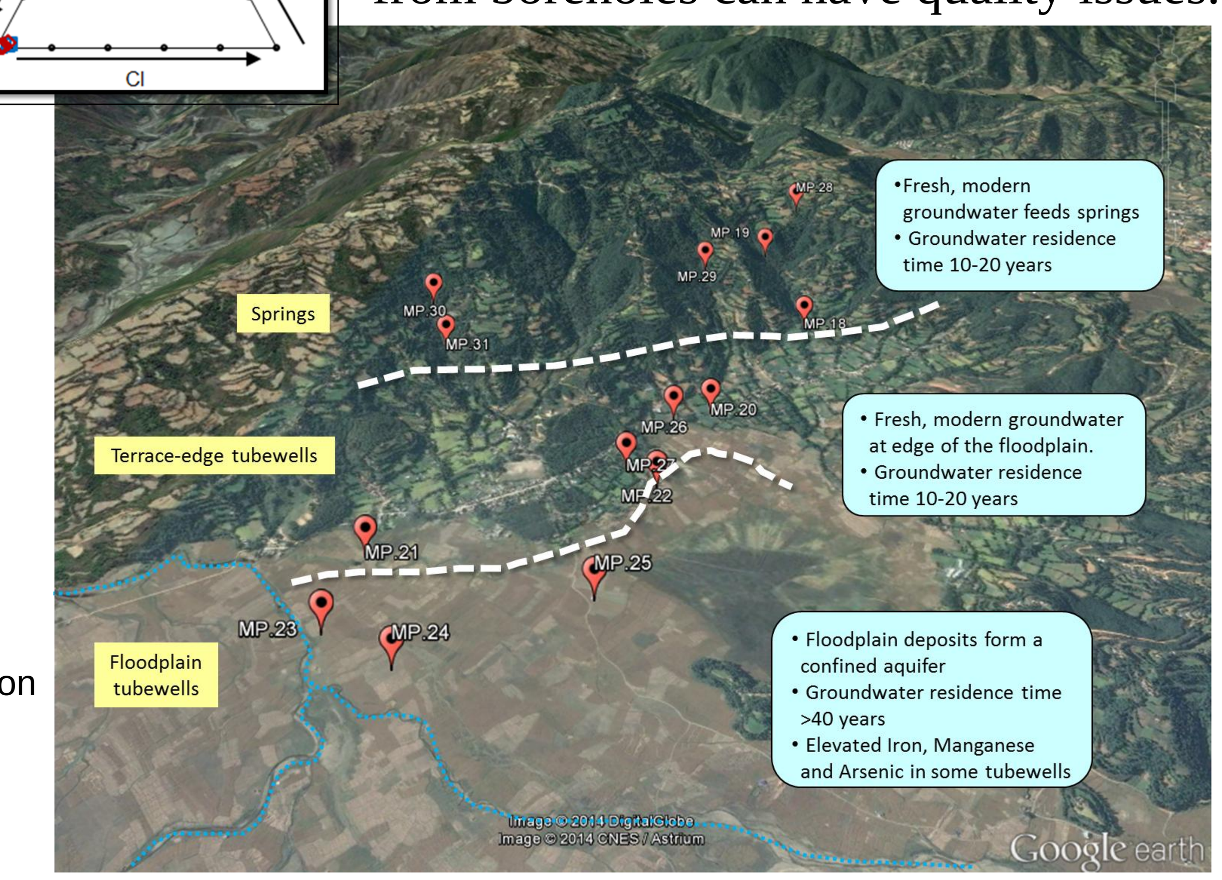

Figure 6. Groundwater chemistry evolution from springs in foothills to tubewells in the floodplain.

6. Conclusion

I. Madanpokhara is reliant on springs for drinking water but is increasingly using shallow groundwater to support irrigation.
II. The development of groundwater resources has resulted in a thriving agricultural co-operative, increasingly secure livelihoods, inward migration and a growing population.
III. Shallow tubewells exploit a more resilient water resource than the springs, but are potentially vulnerable to over-exploitation as a result of economic growth and inexpensive access through hand drilling.
IV. Systematic long term monitoring of the groundwater system, as springs flows, groundwater levels and chemistry would give a much better understanding of emerging trends and the resilience of groundwater to change.

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Indo-Gangetic basin Groundwater Resilience http://www.bgs.ac.uk/research/groundwater/international/

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