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Institute for Social and Environmental Transition - Nepal

Gateway to the Earth

Springs, storage and sensitivity to change – Groundwater in Nepal's middle hills

S. BRICKER, A. MACDONALD, S. K. YADAV, Y. SATYAL, A. DIXIT, R. BELL, and L.
SMITH

41st IAH International Congress 'Groundwater: Challenges and Strategies'
Marrakech, Morocco. 15-19th Sept 2014

What is the issue?

Nepal is famous for the high Himalayas...



...but what about the Middle Hills

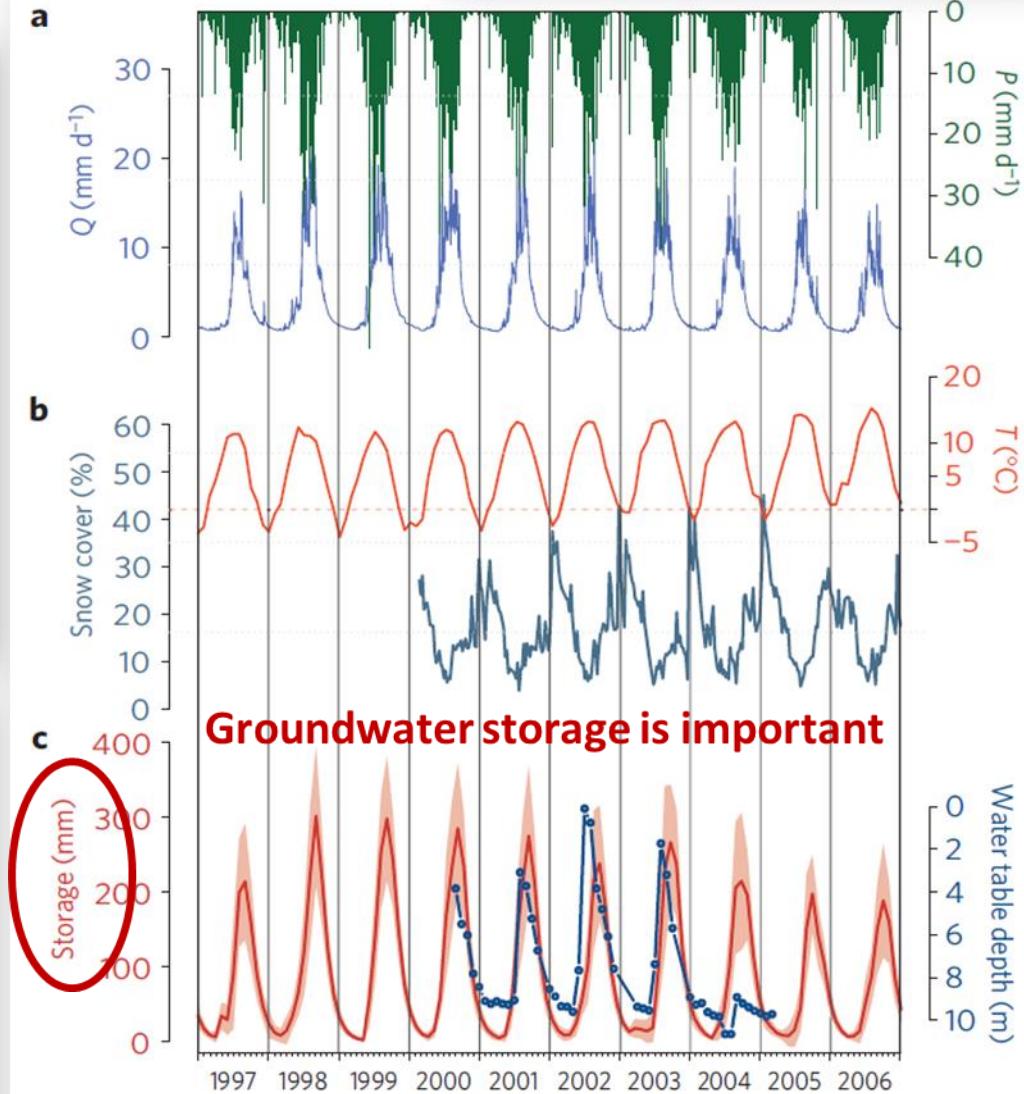


Why the middle hills are important


Rivers

NATURE GEOSCIENCE

Andermann et al., 2012

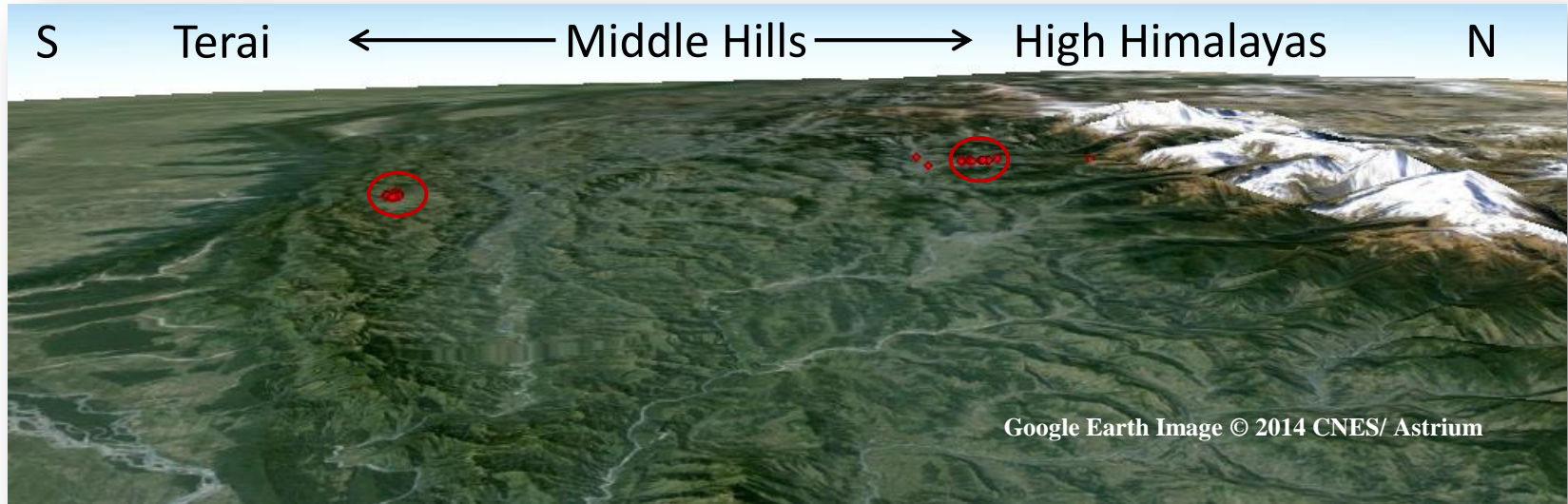


Andermann, C., L. Longuevergne, et al. 2012 "Impact of transient groundwater storage on the discharge of Himalayan rivers." *Nature Geoscience* 5(2): 127-132.

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- An aerial photograph of a mountainous region featuring terraced rice fields. The terraces are filled with water, reflecting the sky, and are surrounded by lush green vegetation. A prominent house with a blue roof is situated in the middle ground, surrounded by trees. The background shows a dense forest covering the hillsides.
- Groundwater is very important in mid-hills
 - Even more important with forecast environmental change.
 - BUT groundwater systems and water usage are both poorly characterised

Study catchments

Elevation 600m – 3000m

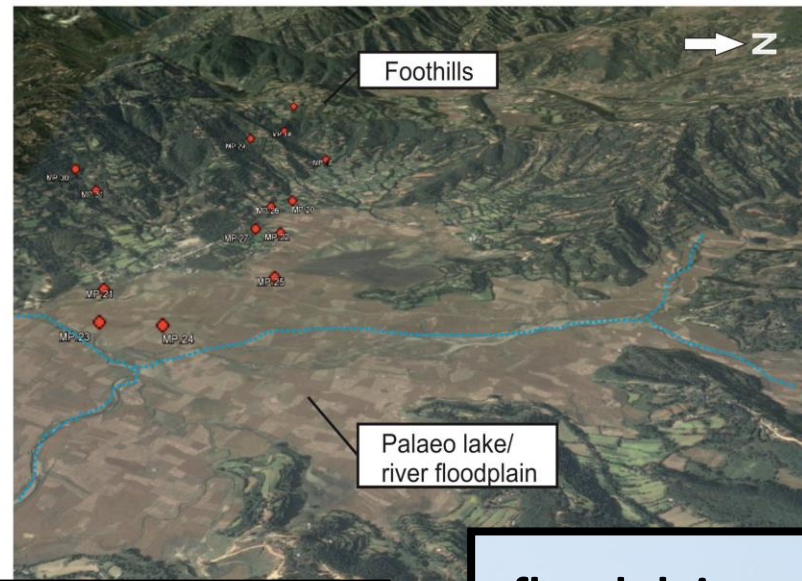
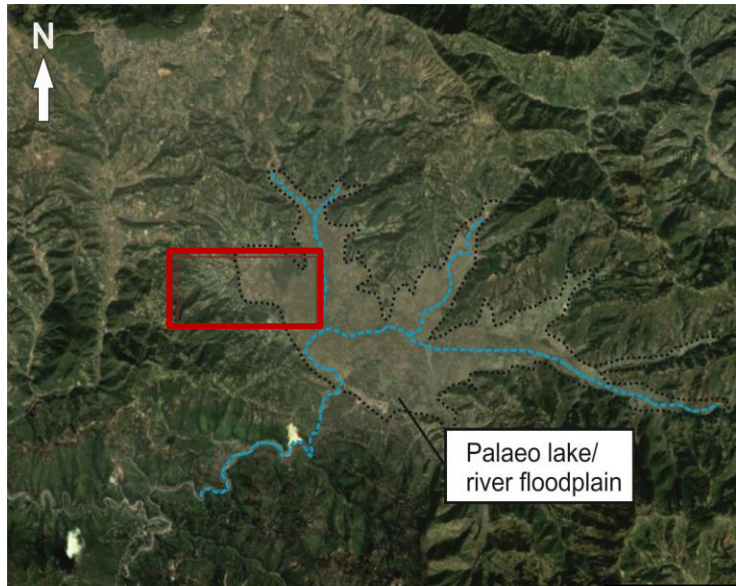


Madan Pokhara

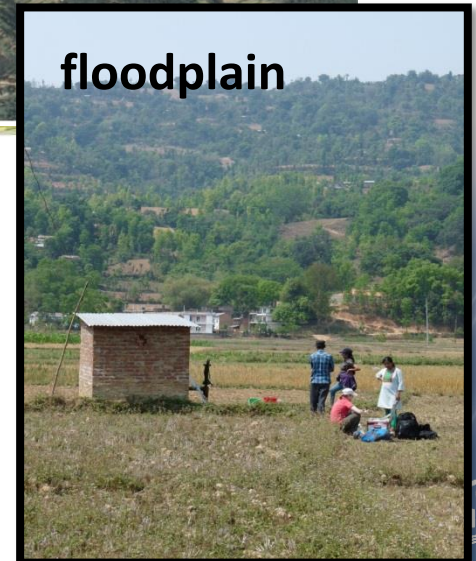
Elevation: 600-1000m

Tropical to subtropical climate

Population: 6,300



Google Earth Image © 2014 CNES/ Astrium



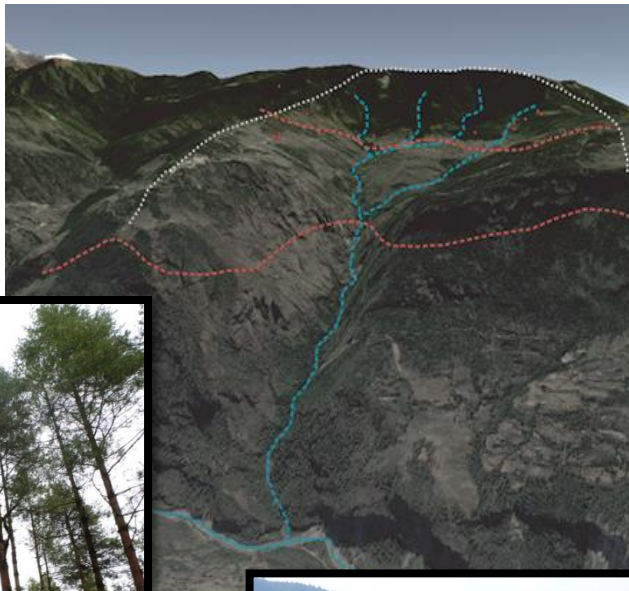
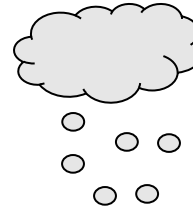
Nangi and Ramche

Elevation: 900-3300m

Temperate climate

Population: 1,600

Snowmelt



Google Earth Image © 2014 CNES/ Astrium

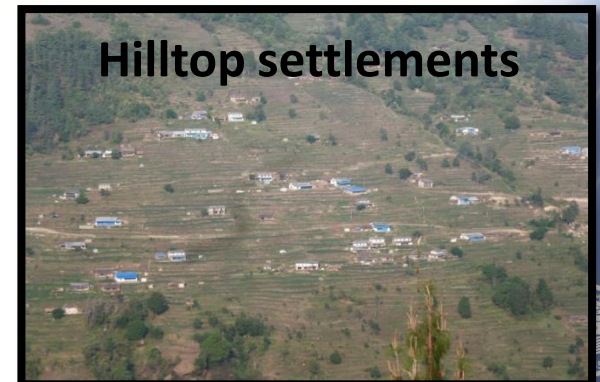


Community forest
(90%)

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Agriculture
(10%)



Hilltop settlements

What did we do?



Narrative of the catchments

- What is the catchment like?
- Land use
- Population
- What do the rivers look like?
- Where do they get their water from?
- What do they use their water for?
- Are there water shortages?
- Are there water quality problems?

What did we do?

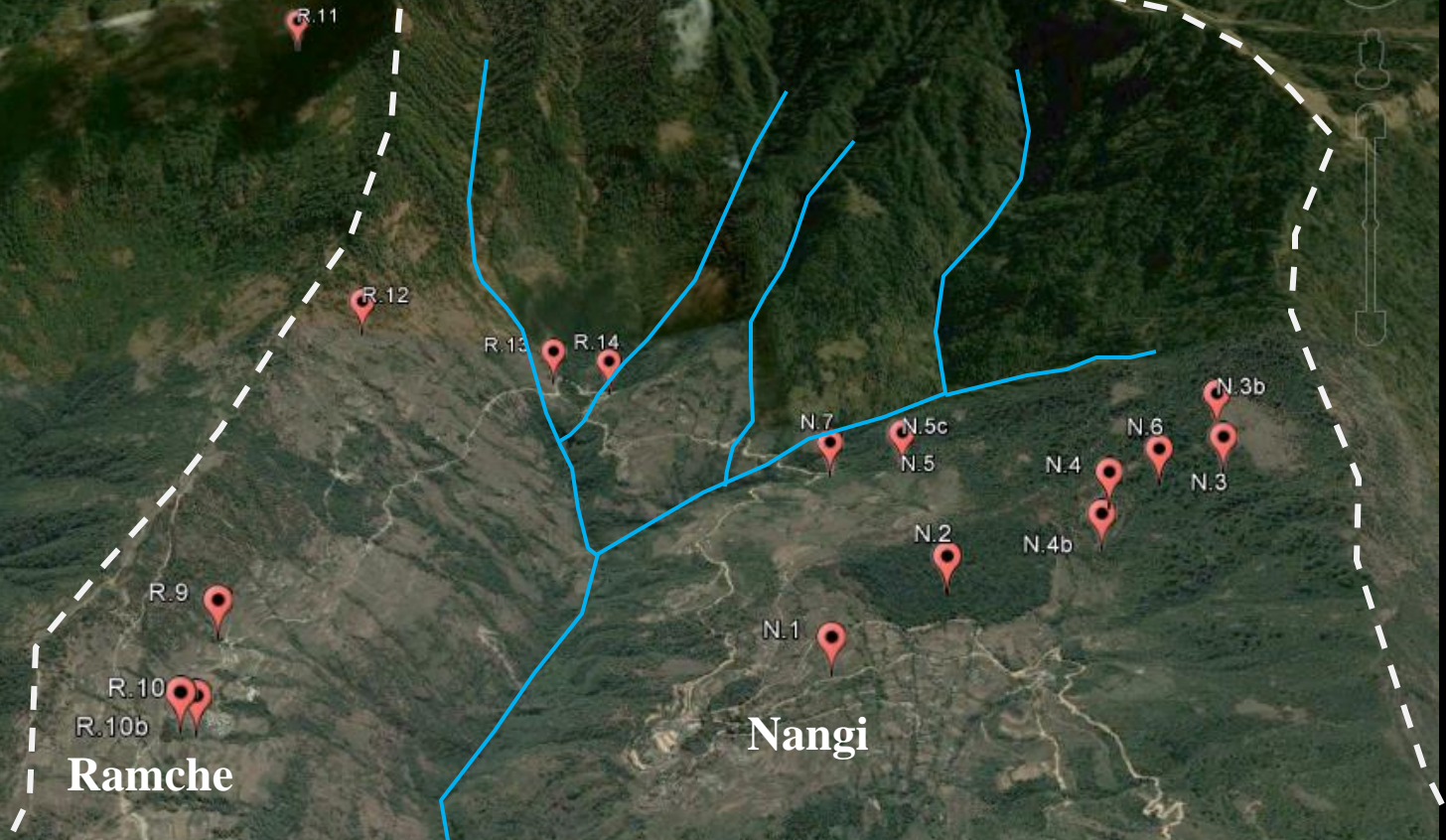


Field surveys

- Spring flow and temp.
- Stream levels
- Groundwater chemistry
- Stable isotopes
- CFC and SF₆ (residence time)
- Noble gases (recharge temp)

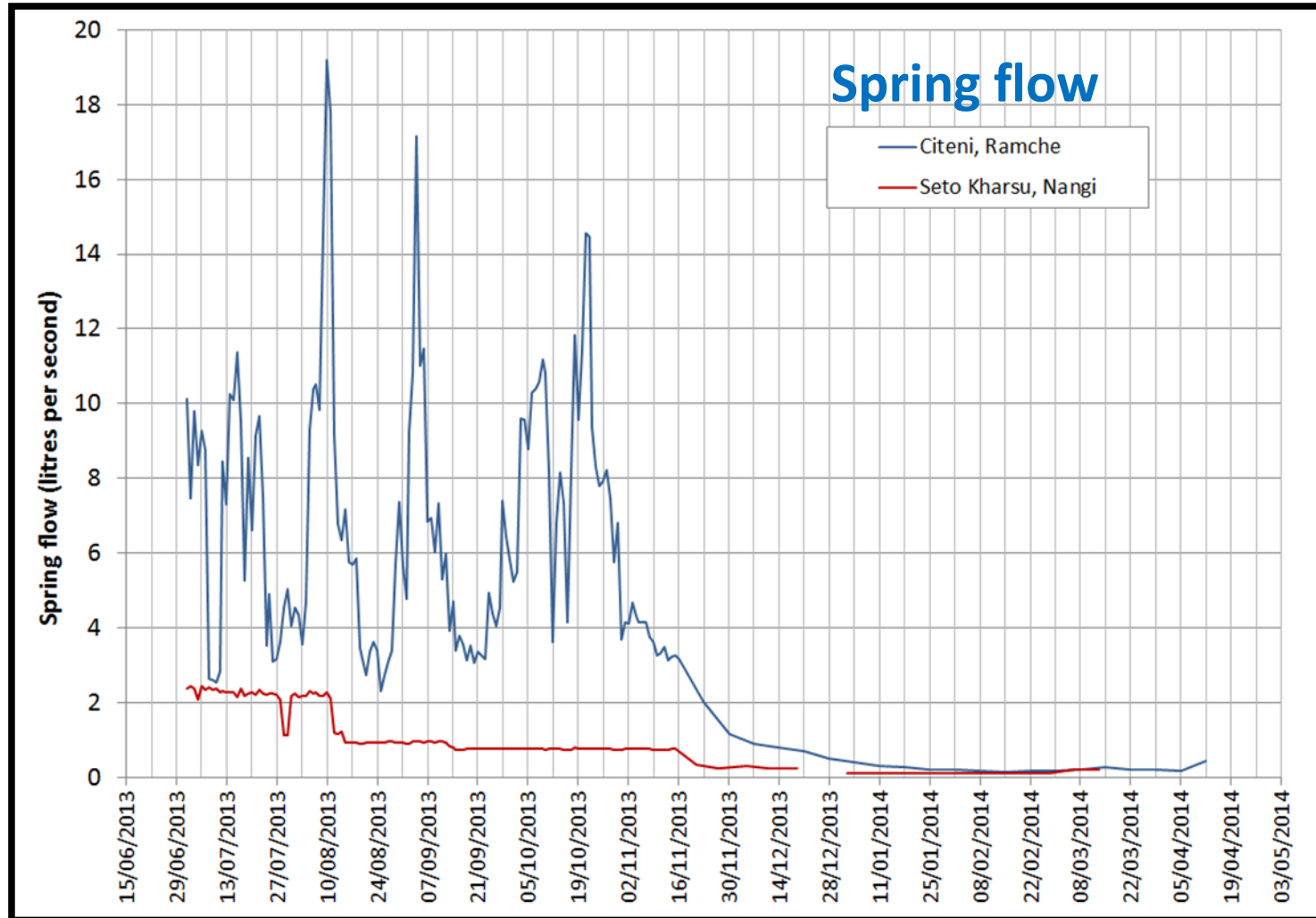


The groundwater story in Nangi and Ramche



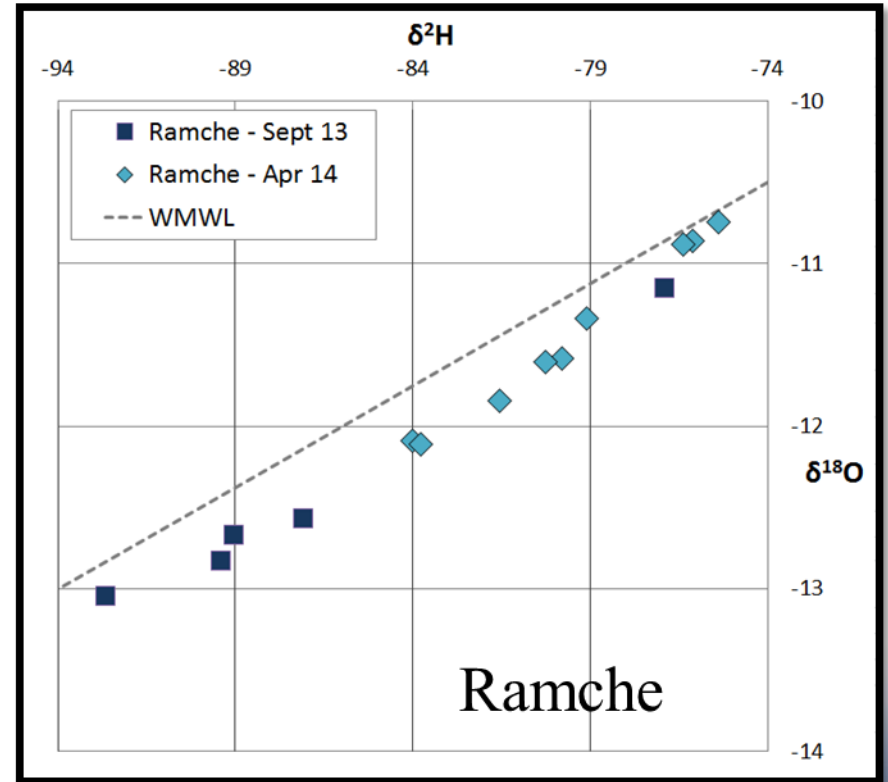
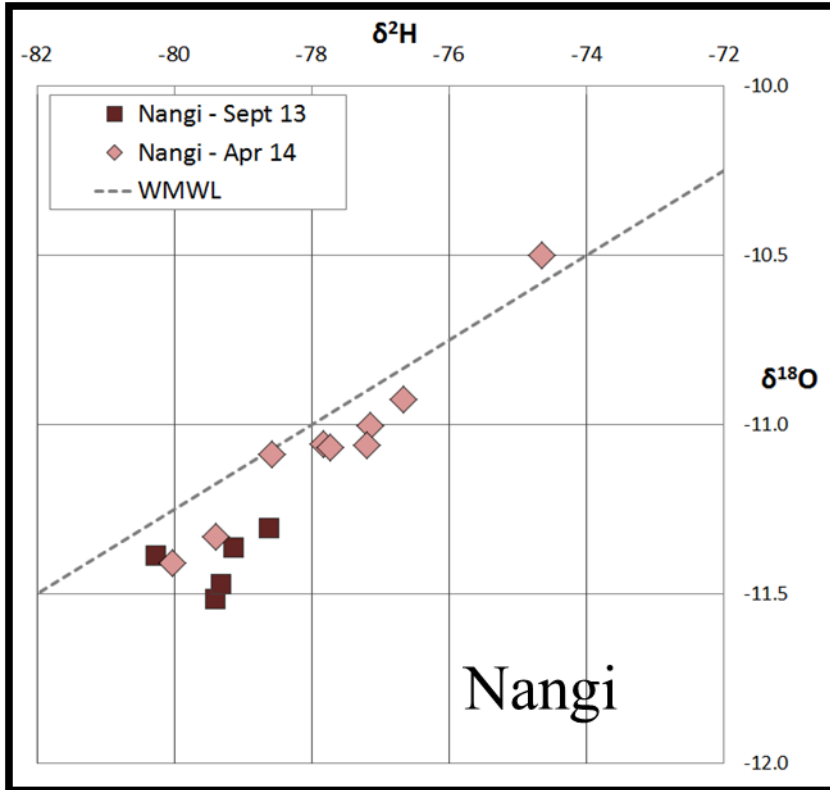
- High dependence on small spring supplies
- Snowmelt influence on higher springs
- Calcium-bicarbonate, modern groundwater
- Reduced influence of modern water/older groundwater component pre-monsoon

The groundwater story in Nangi and Ramche



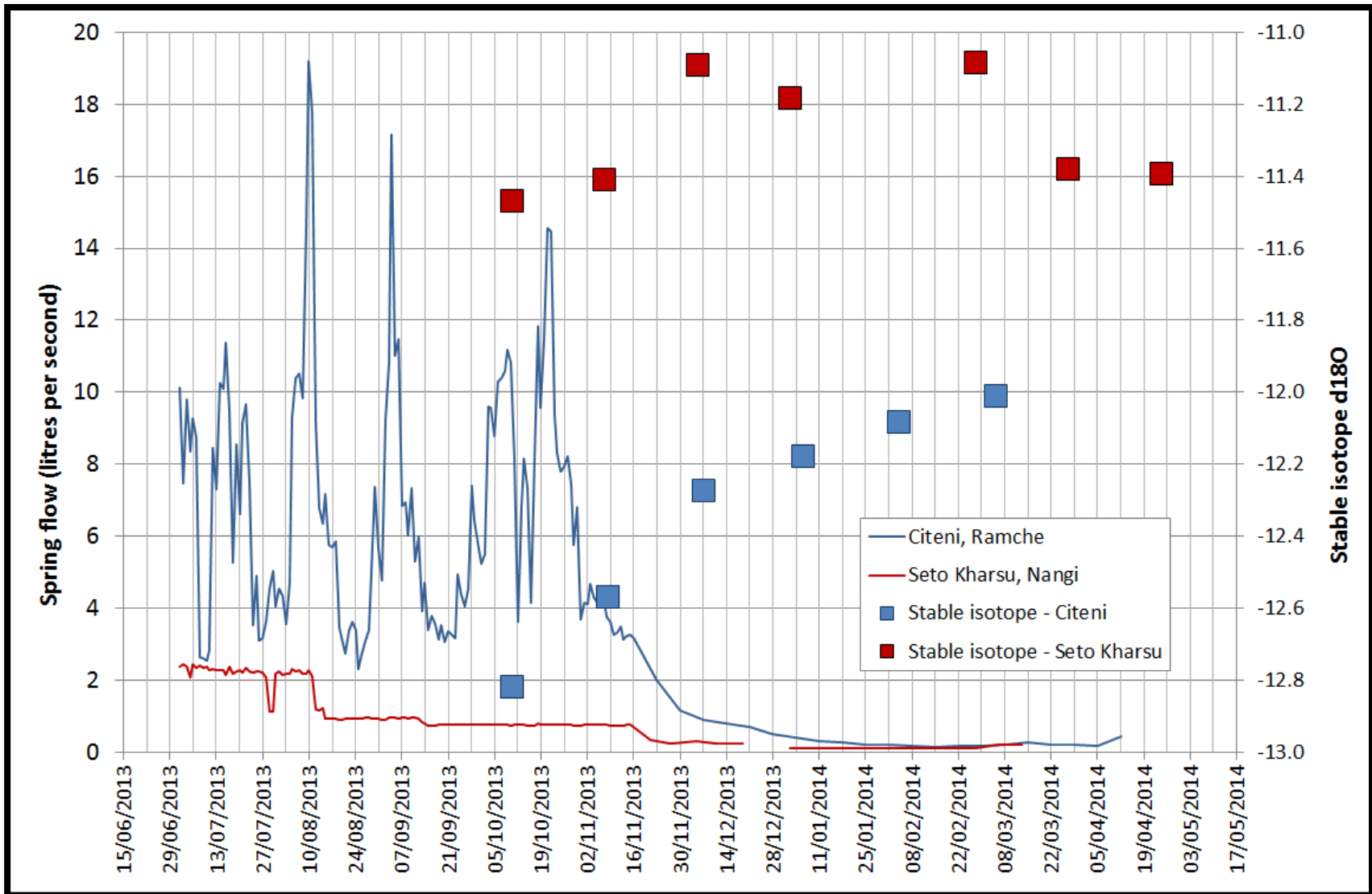
The groundwater story in Nangi and Ramche

Stable isotopes



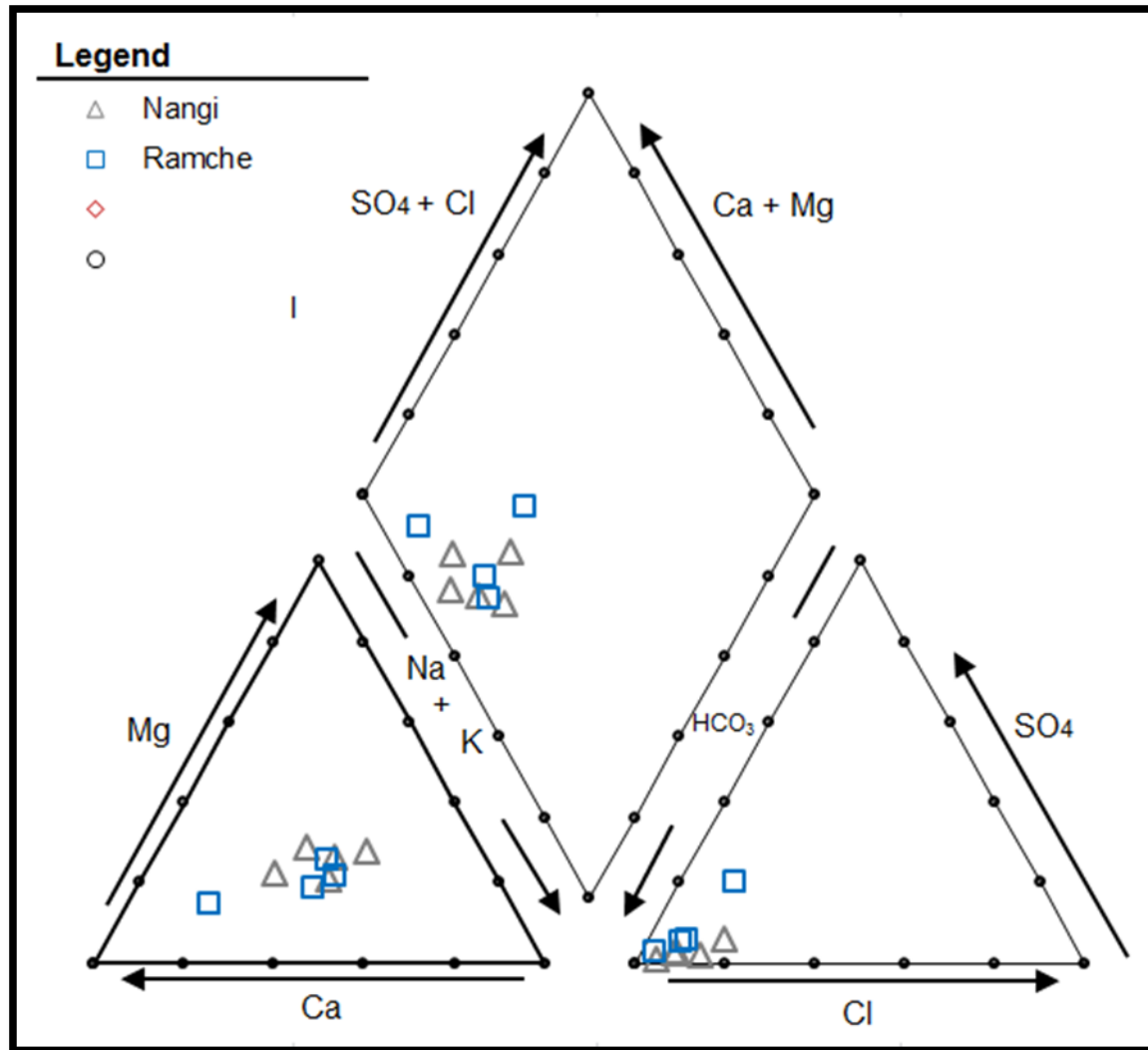
The groundwater story in Nangi and Ramche

Spring flow plotted with stable isotopes



The groundwater story in Nangi and Ramche

Groundwater chemistry

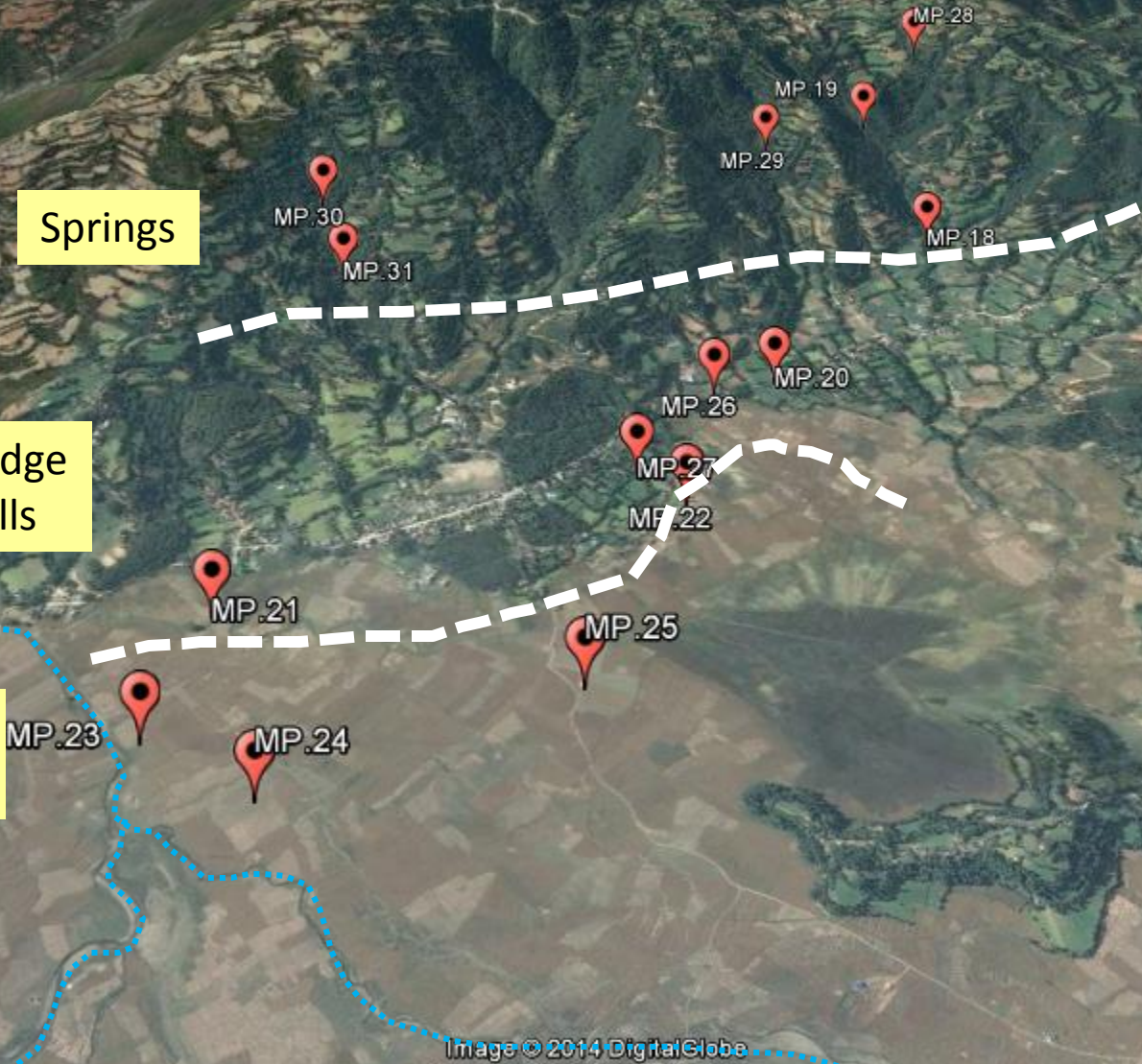


The groundwater story in Madan Pokhara

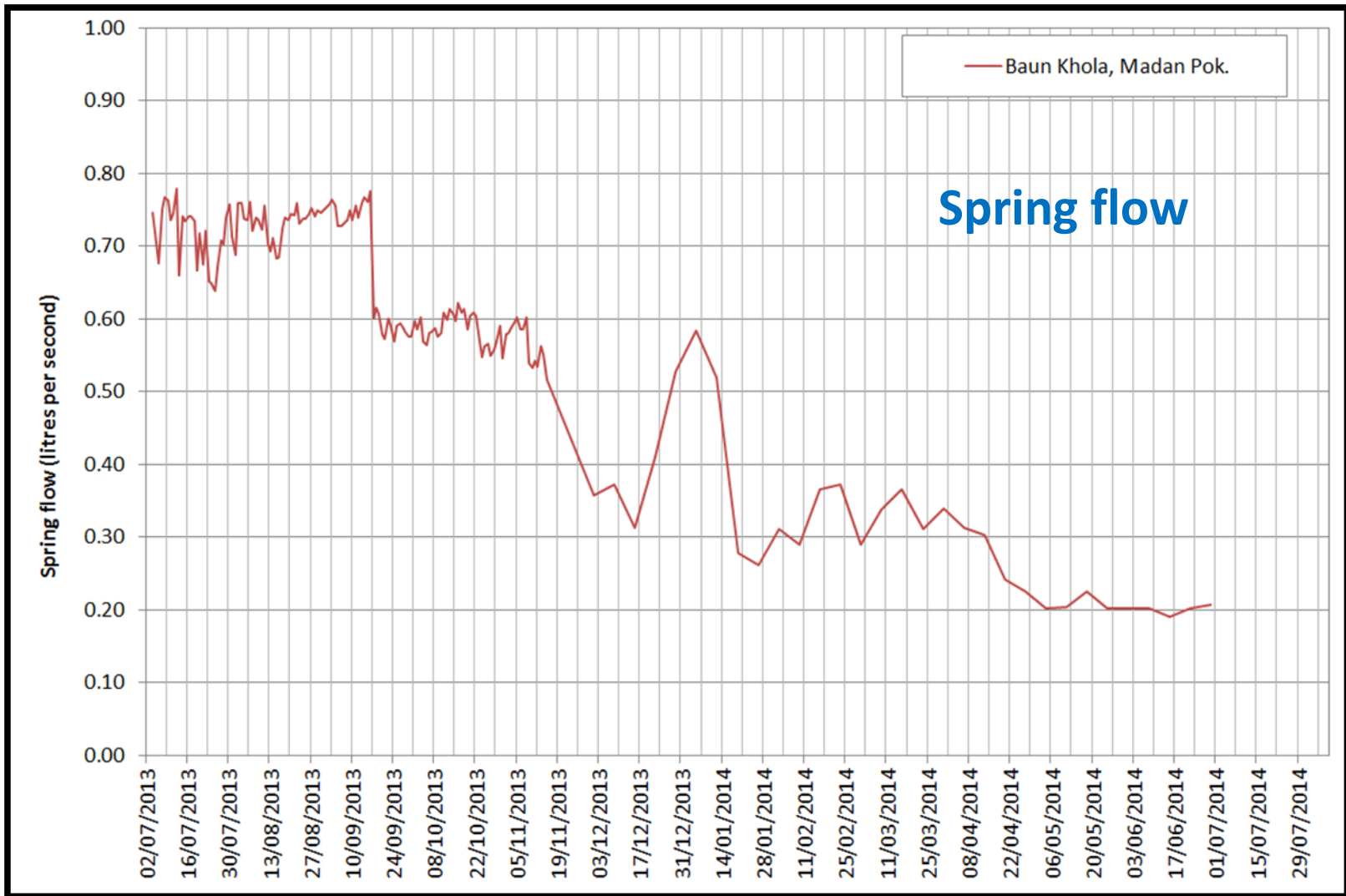
Springs

Terrace-edge tubewells

Floodplain tubewells

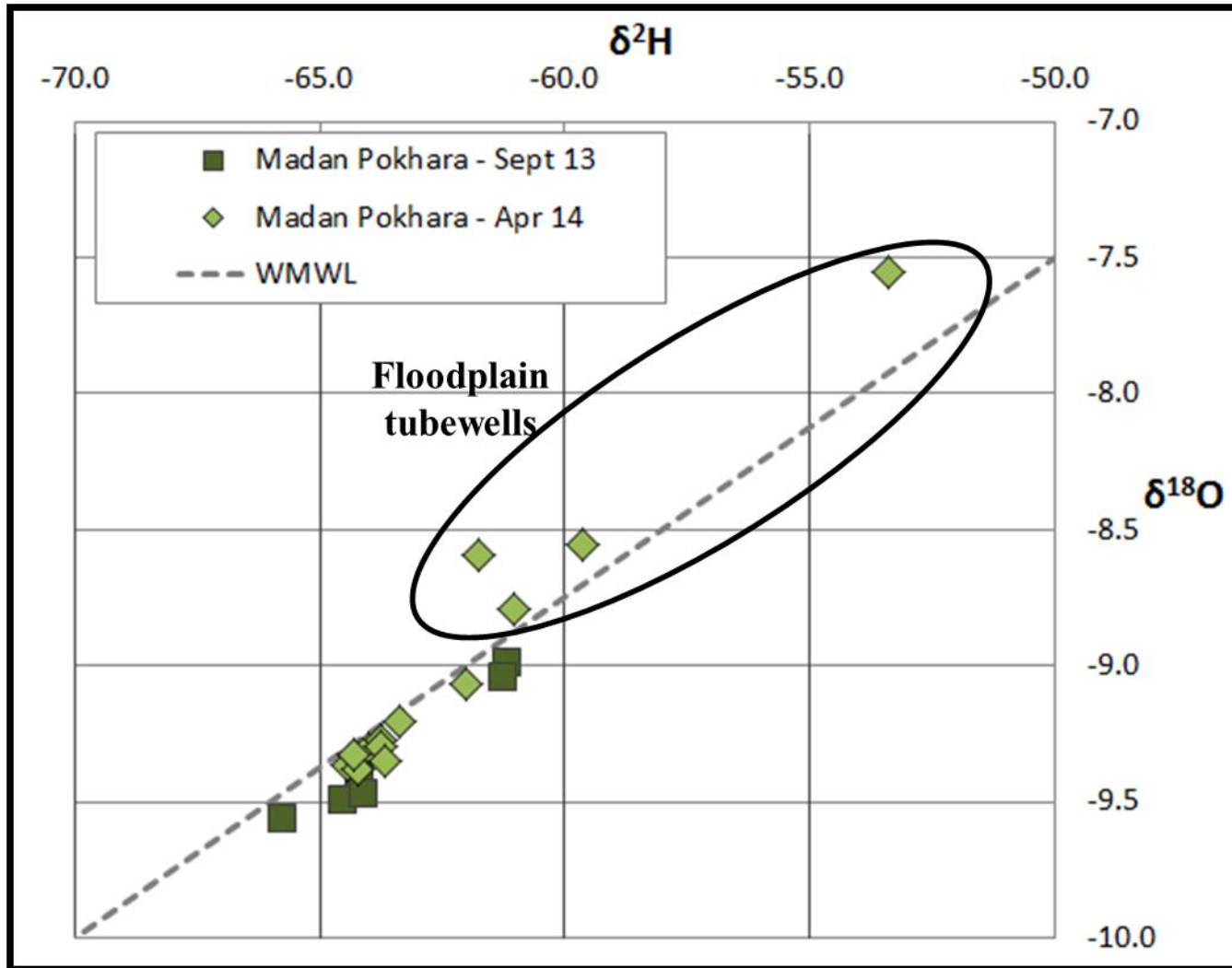


The groundwater story in Madan Pokhara

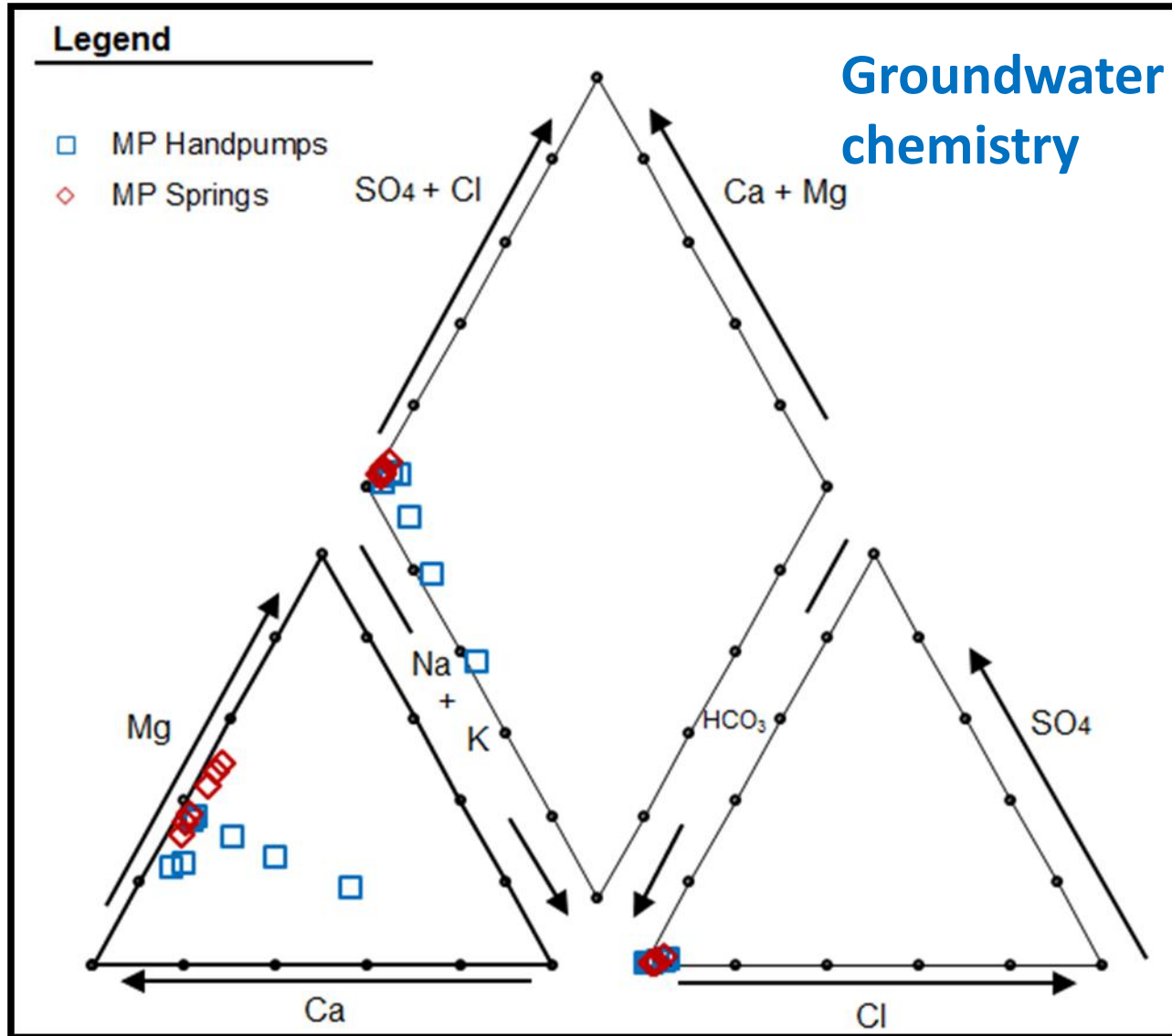


The groundwater story in Madan Pokhara

Stable isotopes



The groundwater story in Madan Pokhara



The groundwater story in Madan Pokhara

Springs

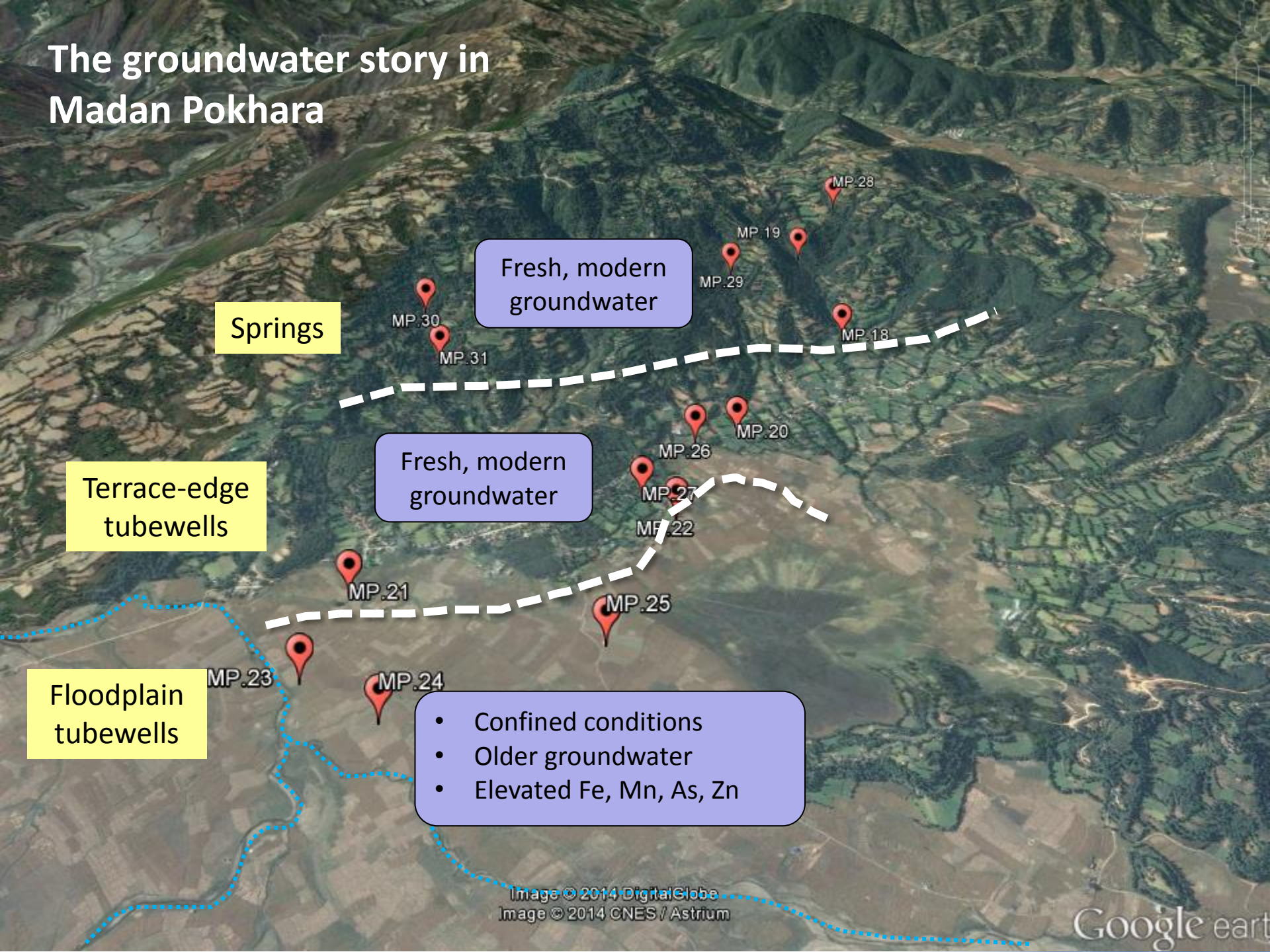
Fresh, modern groundwater

Terrace-edge tubewells

Fresh, modern groundwater

Floodplain tubewells

- Confined conditions
- Older groundwater
- Elevated Fe, Mn, As, Zn



What have we learnt?

- Two contrasting catchments but groundwater very important in both for drinking water and for livelihoods.
- **Higher catchment (Ramche and Nangi)**
 - Totally dependent on springs
 - Seasonal decline in spring flows
 - Springs: larger; snowmelt contribution to high springs; fresh modern groundwater
 - Catchment management e.g. community forest helps protect springs
 - Populations are steady and less intense agriculture

What have we learnt?

- Two contrasting catchments but groundwater very important in both for drinking water and for livelihoods.
- **Lower catchment (Madan Pokhara)**
 - Mix of springs and shallow tubewells
 - Seasonal decline in spring flows
 - Springs: smaller; drying of springs; fresh modern groundwater
 - Drilling of the tubewells has allowed increased agricultural production, increased livelihoods, growing influx of people
 - But: water quality concerns and sustainability issues with tubewells

Thank you

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Indo-Gangetic basin Groundwater Resilience

<http://www.bgs.ac.uk/research/groundwater/international/SEAsiaGroundwater/home.html>

