Rural Water Supply and Sanitation Project in Western Nepal Phase II

2016

Analysis and Mapping of Climate and Source Yield in Tanahun District

RWSSP-WN BRIEF 5-2016

WHAT DID WE STUDY?

Springs are an important component of hydrosphere where ground water flows into the surface by gravity. These springs are the most common source of drinking water for rural hill communities. In recent years, many spring sources are reported to be decreasing in yield or dried out across the country due to changing character of rainfall and increasing evaporative losses.

This study focused on the changes in source yield in Tanahun district between 2004 and 2014, comparing source yield changes with climatic changes during the same period. Both source discharge and climate data were used for the analysis.

What is the condition of water sources in terms of water yield/ discharge?

Is there difference in source yields when compared to situation 10 years ago?

What are the observed changes in climate, and how do these affect source yields?

What can be done about declining or drying sources?

What are the spatial features in rainfall and source yields in Tanahun district?

This Brief is based on the consultant report by Dr. Binod Shakya (2015). The conceptual idea was developed and data collected by RWSSP-WN II. The source measurements in 2004 were collected by RWSSSP phase 3 (Lumbini project). This Brief was prepared by Sini Pellinen.

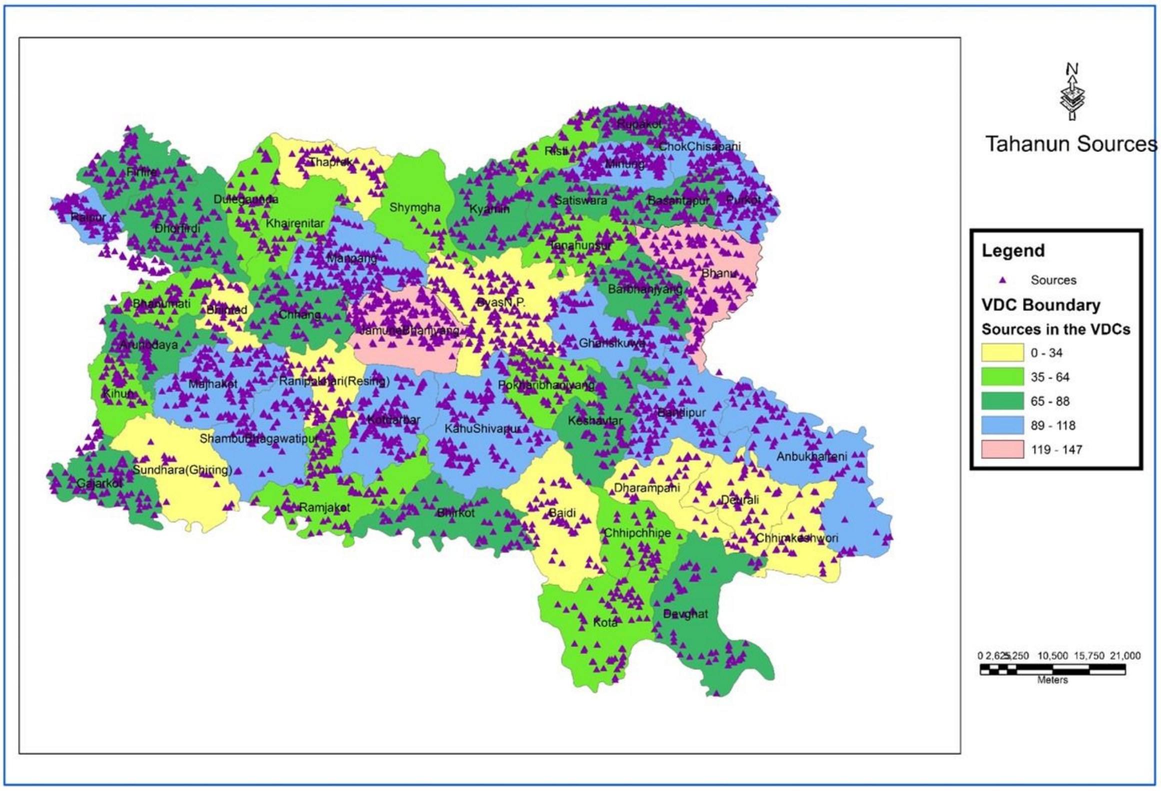
WHAT METHODOLOGY DID WE USE?

The study compared both water source yield data and climate data which were collected as follows:

Source data: The first round of source yield data collection took place in Tanahun district in March-April 2004 under Rural Water Supply and Sanitation Support Project (RWSSSP) Phase III (so-called “Lumbini-project”). The same sources were revisited during March-April 2014 to identify changes (see the map below). Source locations were verified with GPS and cross-checked with the name of the source. The yield measurement was carried out with bucket method in both times so that yield collection is harmonized. *Altogether 2,387 sources were selected for the analysis*. Some sources were discarded due to lack of comparable data from 2004 and 2014. The data sets cover entire Tanahun, except for Ghiring Sundhara VDC and Byas municipality (which were not covered in 2004 data collection).

Climate data: The study utilized rainfall data from 15 meteorological stations and temperature data from 4 stations operated by Department of Hydrology and Meteorology (DHM). The number of stations in Tanahun district (4) is not enough for rainfall interpolation, and therefore stations from adjoining districts were also included for rainfall analysis. The climate data covers the period from 2002 to 2013. Climate data for 2014 was not yet available at the time of analysis. This is however not considered as a limiting factor, because the rain cycle of 2013 is consider as the most effective input for 2014 April/May source yield. This is because the monsoon rain of a particular year impacts the post monsoon of the same year and the winter of the following year.

Analysis: Rainfall sample data points (meteorological stations) were generated into estimated surfaces (maps) using Kriging interpolation method. Kriging method assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface. Temperature trend and lapse rate were calculated using linear regression model.

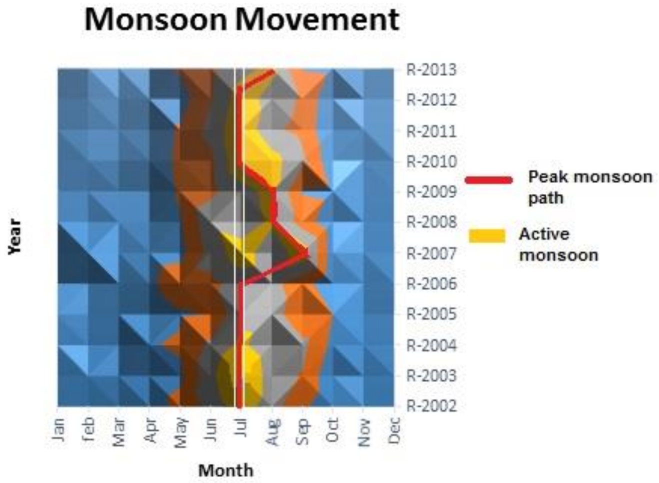


Sources measured in 2014, Tanahun district

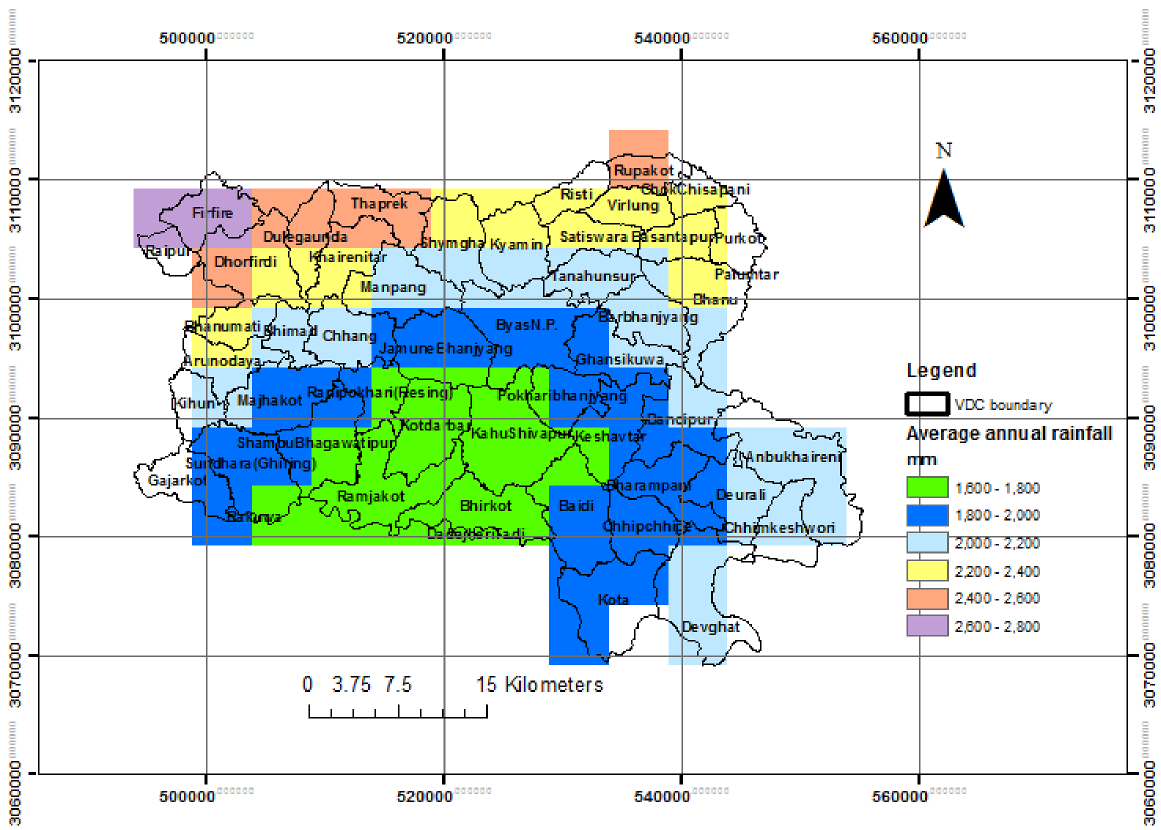
WHAT DID WE FIND OUT ABOUT CLIMATE PARAMETERS?

Rainfall and temperature

The annual rainfall in Tanahun district ranges from 1,500 to 3,500 mm with annual average rainfall of 2,298 mm (average for years 2002-2013). July has the highest rainfall and November the lowest. The monsoon rainfall is around 79% of total annual rainfall. The monsoon peak month shifts from year to year: in 2007, the peak was in September and in 2008 and 2009 in August. The rainfall record from 2002 to 2013 shows declining of -1.68 cm/year.



The air temperature is function of elevation, with a lapse rate of -4,5°C to -6,5°C/km. Other functions are sunshine and wind. In Damauli, the monthly average temperature between 2002-2013 varied between 15,5°C (January) and 29,6°C (June). The temperature between 2002 and 2013 is in increasing trend (+0.041°C/year). The Tanahun district map below shows the average annual rainfall (years 2002-2013). Out of RWSSP-WN II working VDCs, Ramjakot, Bhirkot and ShambuBhagawatipur – which are located in South Central Tanahun – have the lowest annual rainfall (1,600-1,800mm). Ghasikuwa and Barbhanjyang VDCs have average annual rainfall between 1,800-2,200mm. High rainfall area is observed in Northern part of the district, also encompassing Thaprek VDC, with annual rainfall of 2,400-2,600mm.



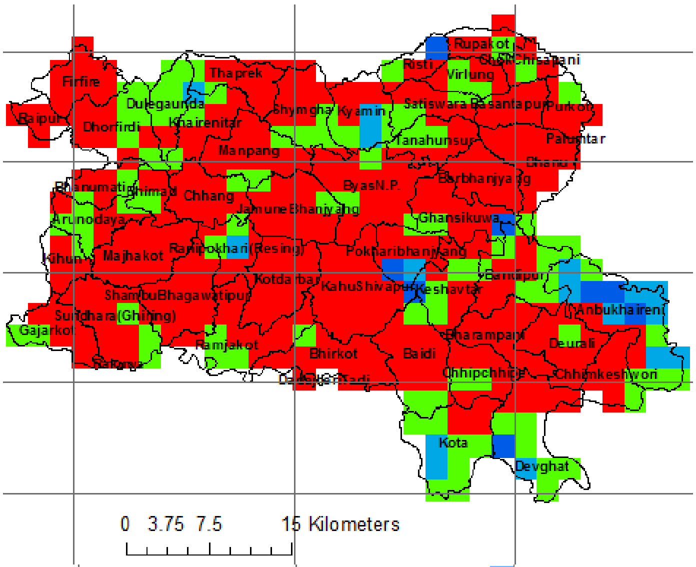
Average annual rainfall for years 2002-2013, Tanahun district

WHAT DID WE FIND OUT ABOUT SOURCE YIELDS?

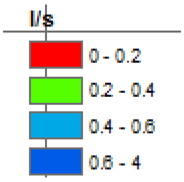
Comparison of source yields of 2004 and 2014 reveals that 65% of all sources had declined in the past ten years, whereas the remaining 35% had either improved or constant yield. The trend is similar in all spring types: out of all point and spring sources, 63% had declined between 2004 and 2014, while 37% had either remained the same or increased. Out of all stream sources, 72% are declining when compared to flows measured in 2004.

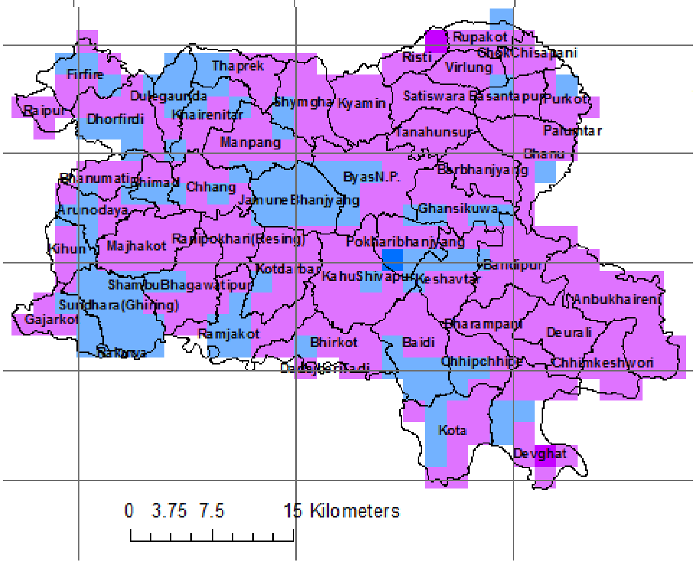
The average yield in point sources was around 0.045 l/s in 2014, while in 2004 it was twice as high (0.09 l/s). The maximum measured yield in 2014 was 1.87 l/s, whereas in 2004 it was 3 l/s. Likewise, spring source mean and maximum yield measured in 2014 were 0.16 l/s and 3.33 l/s, whereas in 2004 they were 0.204 l/s and 3 l/s respectively. Small streams average yield measured in 2014 was 0.32 l/s with the maximum of around 4.99 l/s. In 2004, mean and maximum yields of streams were 0.485 l/s and 5 l/s respectively.

	Changes between 2004 and 2014		
Source type	% of sources in declining condition	% of yield change	Sample size
Point source	63%	-50%	685
Spring source	63%	-21.0 %	1,115
Stream source	72%	-34 %	587

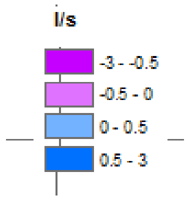


Source yield in 2014 (all sources)
As shown in the adjoined map, highest yields are measured in sources located in the south-eastern part of Tanahun district. In RWSSP-WN core VDCs, source yields are mostly below 0.2 l per second.





Source yield changes between 2004 and 2014 (all source types)
In purple colour areas, the source yields have reduced between 2004 & 2014. Interestingly, in part of Thaprek VDC, which has relatively high rainfall, source yields have declined. In part of Ramjakot VDC, which has comparatively low rainfall, the source yields show increment.



WHAT ARE WE RECOMMENDING?

The main climatic factors behind source decline – as observed in Tanahun district – include decrease in annual rainfall, erratic rainfall distribution and increase in temperature. Land use also counts: as temperatures increase, evaporation increases particularly in barren lands, with less percolation of water into ground.

The long term average rainfall between 1970 and 2010 is 2,748 mm annually in Tanahun. The average rainfall for the last 12 years (2002-2013) is 2,298 mm annually, showing a significant decline. Based on the existing trend, it is predicted that the annual rainfall will continue to reduce. Therefore, further decrease in water source yields is also expected to take place in future. It is also highly possible that especially in low rainfall areas, where source yields are already low, some sources will dry completely due to lowering ground water table.

The following recommendations were made by the study or based on lessons learnt in RWSSP-WN II:

- Recharge ponds and pits to improve ground water recharge. It is advisable to study the overland and subsurface flows before construction of ponds to ensure that the pond will have an intended effect.
- Numerous recharge pits (or contour bunding, trenching) can be more effective than a large recharge pond. Recharge pits are also easy to dig in hill slope and do not require large flat areas.
- Rise in temperature may increase the evaporation of water to atmosphere. This is particularly true in barren lands, where percolation of ground water is also poor. In such condition, numerous recharge pits are recommended, especially in areas where source yield is critically falling.
- Besides changing climate, human induced changes in the catchment area can also cause decline in water sources. Barren lands have poor water retention capacity and therefore are not conductive for ground water recharge. Therefore it is advisable to protect catchments from land degradation, and plan for catchment improvement with the resources available in the site.
- After implementation recharge improving measures, the source yield should be monitored and recorded monthly for at least few years to track down changes (increment) in the yield.
- Generally source yield declines sharply when its water table is disrupted by construction activities. Particularly road construction in hills cuts water table easily; this should be assessed and addressed already when the road is planned.
- As adaptation to climate change, rooftop rainwater harvesting and overflow recharging ground are recommended to be promoted in large scale.
- Water reuse is a matter of very simple actions, such as diverting waste water from tap stands to kitchen gardens or reusing hand washing water to flush or clean toilets.

DEFINITIONS

For the purpose of the study, three different spring types were defined as follows:

Spring and point source: Spring and point source is formed when the pressure in an aquifer causes some of the ground water to flow to the surface. Difference between the two source types is that in spring source, water flow from the rock/soil is visible. In point source there is no visible water flow but the water accumulates in the source. Nepali word for such spring is 'kuwa' or 'pandhero'.

Stream source: These are water steams that are fed by one or more springs. Stream source is different from those streams that are fed by rain water or surface water.

REFERENCES & SUPPORTING DOCUMENTS

Research references:

- Climate Portal, DHM 2010, Nepal (www.dhm.gov.np)
- Climatological Records of Nepal, DHM publication.
- Forest & Landscape Development and Environment Series 2-2005 and CFC-TIS Document Series No.110., 2005, ISBN 87-7803-210-9, retrieved Nov 22, 2013.
- IPCC 2007: Climate change Assessment Report 4
- IPCC 2013: Climate change Assessment Report 5
- Ramakar Jha and Vladimir Smakhtin 2008: A Review of Methods of Hydrological Estimation at Ungauged Sites in India, IWMI Working paper 130
- Shakya B. 2004, Practical Hydrology and Meteorology for environmental studies, BS publication

Relevant RWSSP-WN II publications:

- MoFALD/DoLIDAR (2013). Handbook on Community-wide Water Safety Planning. RWSSP-WN I
- MoFALD/DoLIDAR (2013). Recharge Ponds Handbook – For WASH Programme. RWSSP-WN I
- RWSSP-WN II (2015). Rural Water Supply and Sanitation Project - Water Safety Planning Guidelines for Gravity Schemes/Lift Schemes/Overhead Tank Schemes – With integrated Operation & Maintenance Plan and Water Tariff Calculation (English and Nepali)

RESULTS INDICATORS FOR RWSSP-WN II

This brief relates to the following RWSSP-WN II indicator:

2.1 **Safe water:** # of water supply schemes supported by the Project fund in the Phase I and Phase II apply a Water Safety Plan with CCA/DRR component.

2.2 **Improved services**: # of water supply schemes supported by the Project fund in Phase II provide improved water supply services for previously unserved households in the programme VDCs (previously unserved means no access to improved water supply). Scheme defined as improved and functional when it has the Service Level 1 for quantity, access, reliability and water quality.

Rural Water Supply and Sanitation Project in Western Nepal Phase II is a bilateral development cooperation project funded by the governments of Nepal and Finland, and implemented through local governments and users' groups under the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR), Ministry of Federal Affairs and Local Development. RWSSP-WN II works in 14 districts in Western and Mid-Western development regions in Nepal.

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