DHARA VIKAS HANDBOOK

A User Manual for Springshed Development to Revive Himalayan Springs

Government of India

german cooperation

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

UNDP Empowered lives. Resilient nations.

Rural Management & Development Department
Government of Sikkim

DHARA VIKAS HANDBOOK

A User Manual for Springshed Development to Revive Himalayan Springs

www.sikkimsprings.org

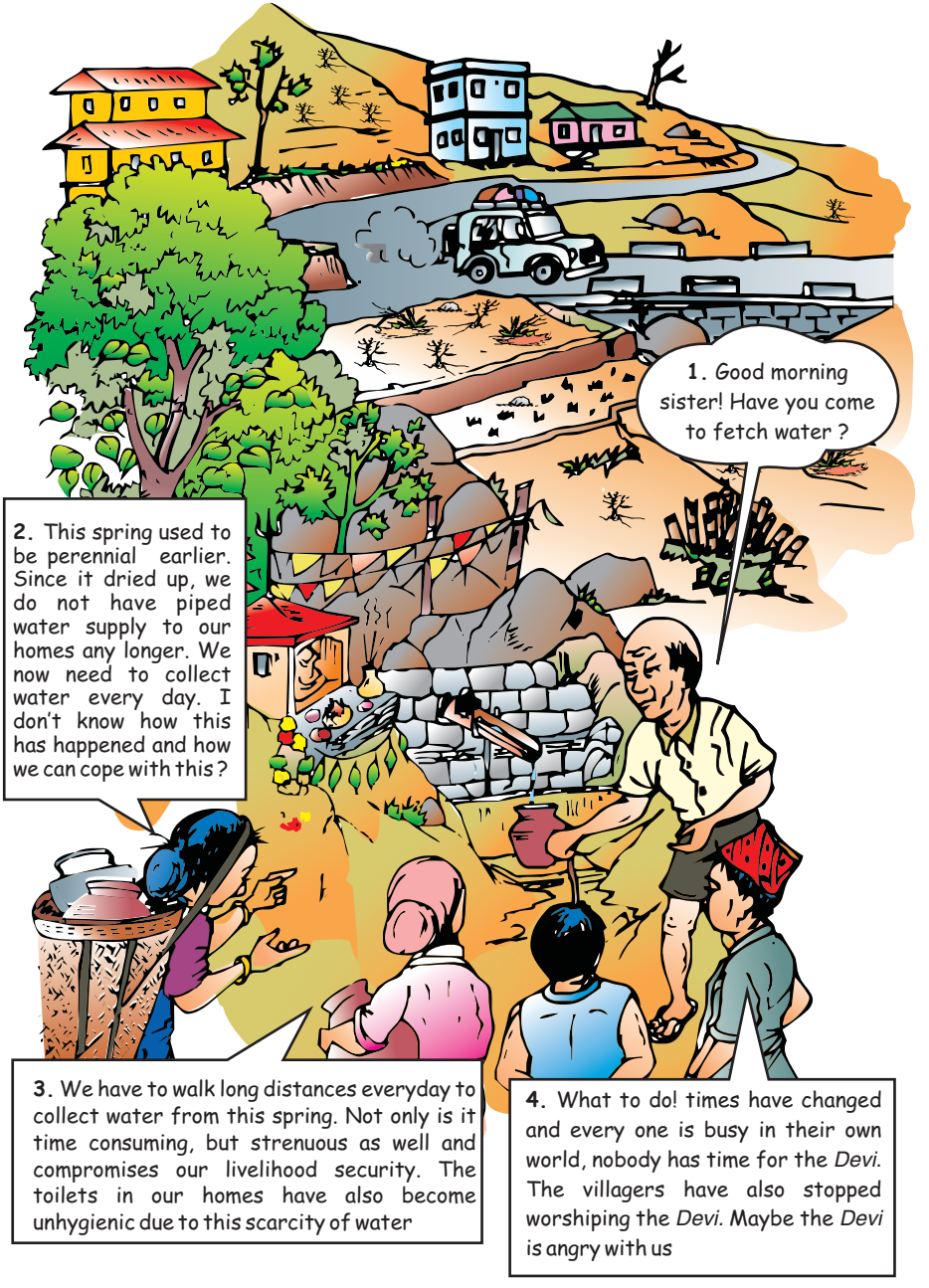
2nd Edition, November, 2014

Concept and Content by :
Rural Management and Development Department, Government of Sikkim jointly with the Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH

Funding support:
GoI-UNDP Project on Enhancing Institutional and Community Resilience to Disasters and Climate Change under Sikkim State Disaster Management Authority, Land Revenue & Disaster Management Department, Government of Sikkim

CONTENT

Current scenario

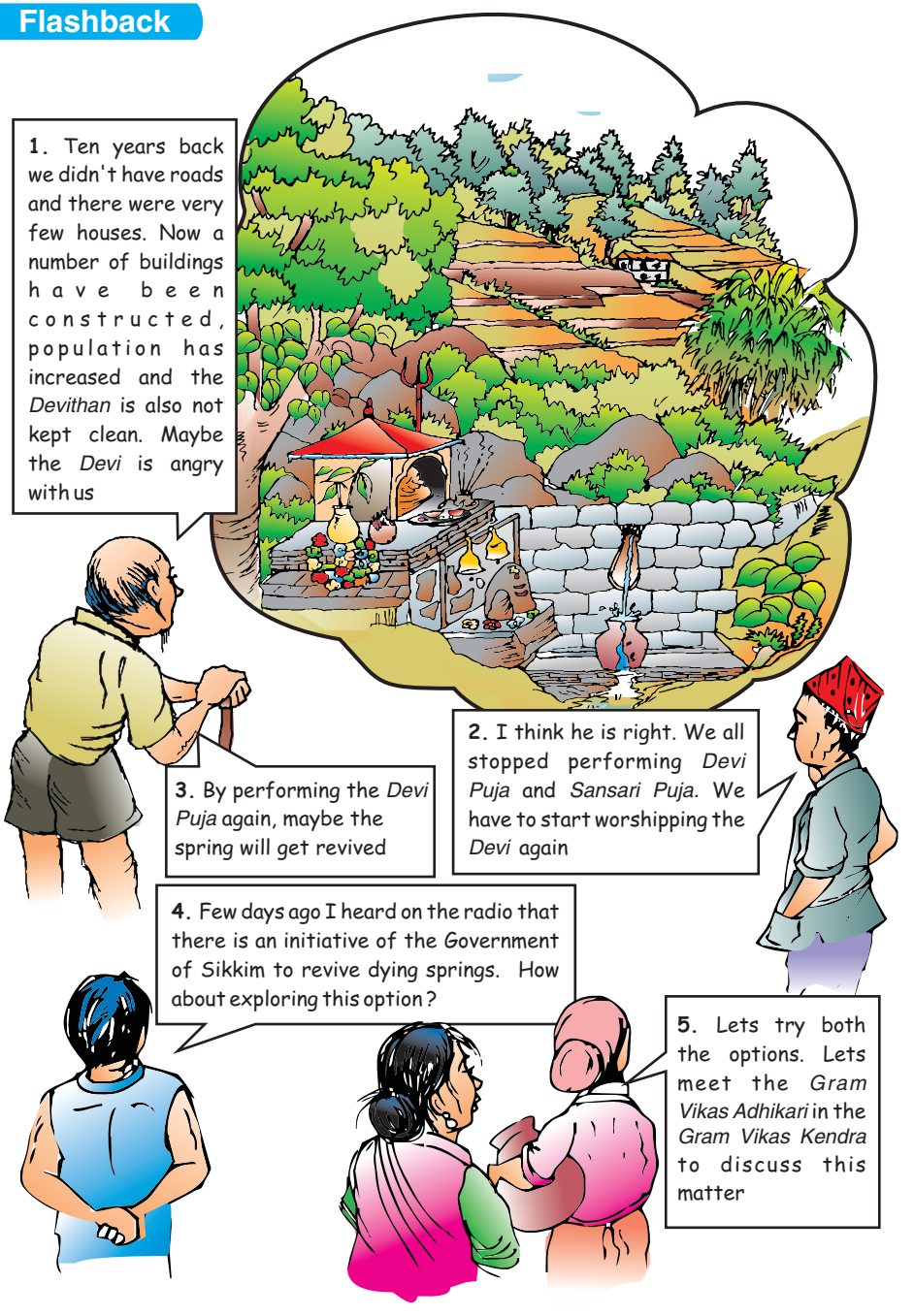


Impacts of drying springs in the lives of women

When the springs have water, gravity based water supply systems ensure piped water supply to the homes

When the springs above the village dry up, women have to manually carry water from springs located downhill

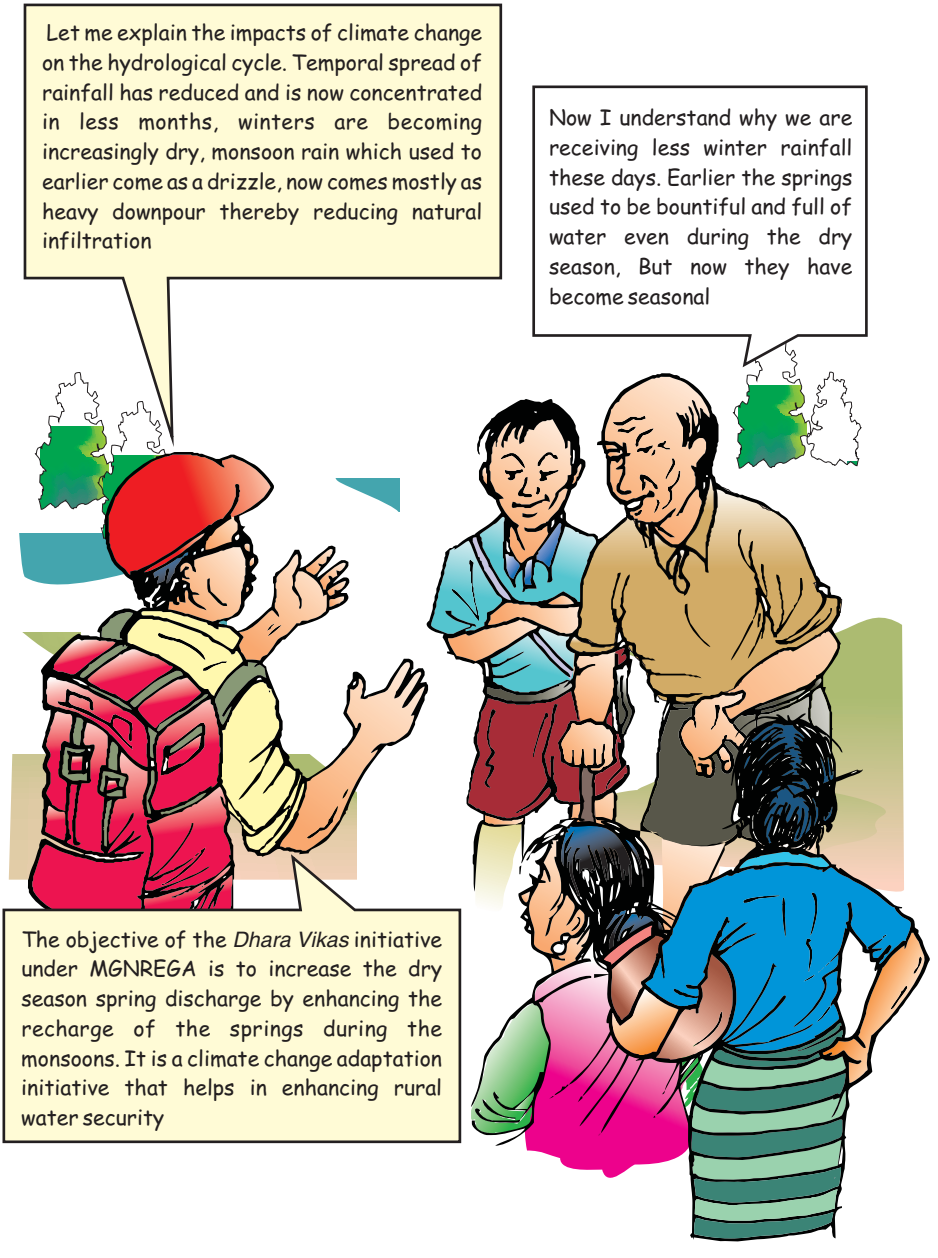
Flashback


1. Ten years back we didn't have roads and there were very few houses. Now a number of buildings have been constructed, population has increased and the *Devithan* is also not kept clean. Maybe the *Devi* is angry with us
2. I think he is right. We all stopped performing *Devi Puja* and *Sansari Puja*. We have to start worshipping the *Devi* again
3. By performing the *Devi Puja* again, maybe the spring will get revived
4. Few days ago I heard on the radio that there is an initiative of the Government of Sikkim to revive dying springs. How about exploring this option?
5. Lets try both the options. Lets meet the *Gram Vikas Adhikari* in the *Gram Vikas Kendra* to discuss this matter

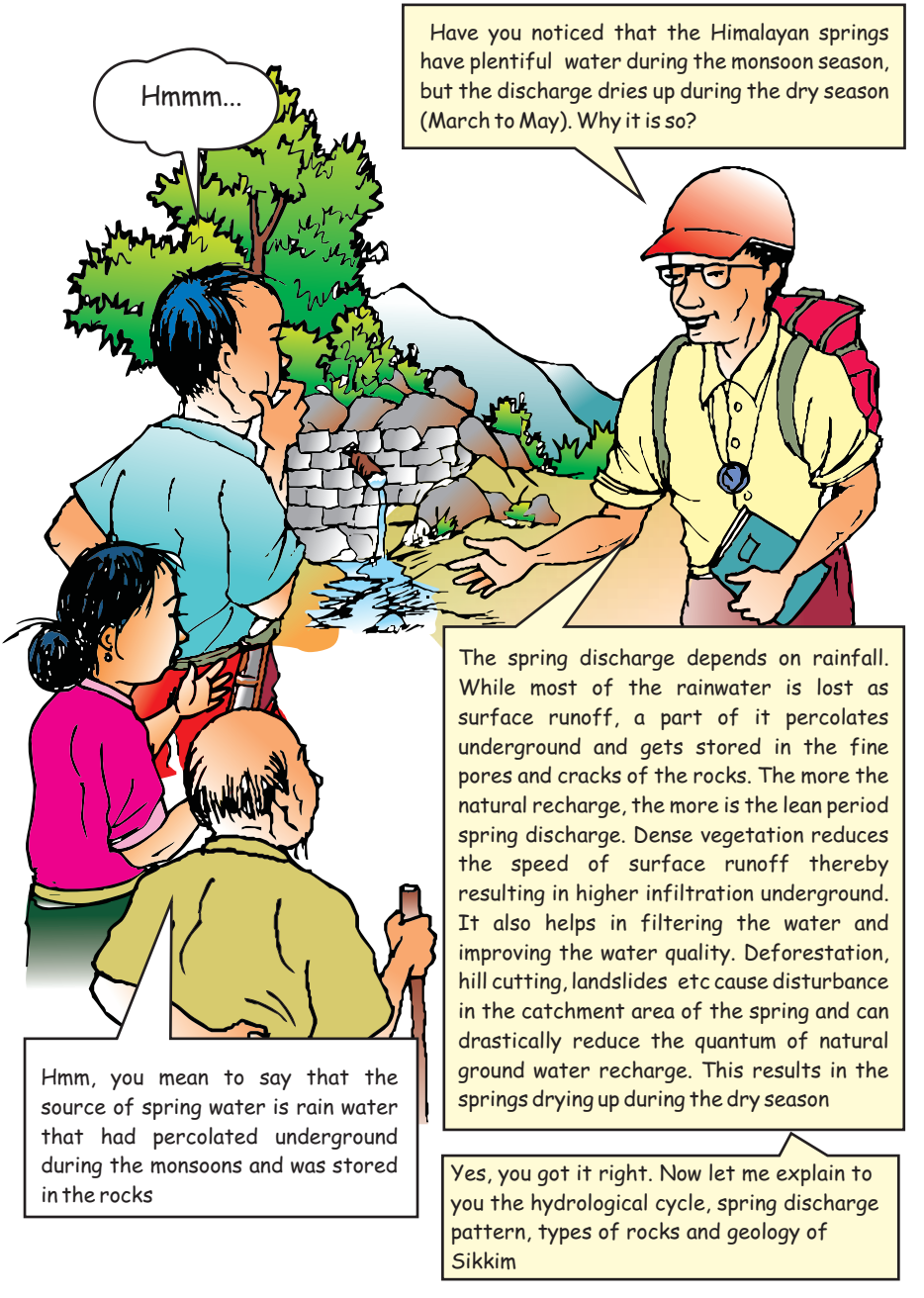
Entry of para hydrogeologist

Understanding springs

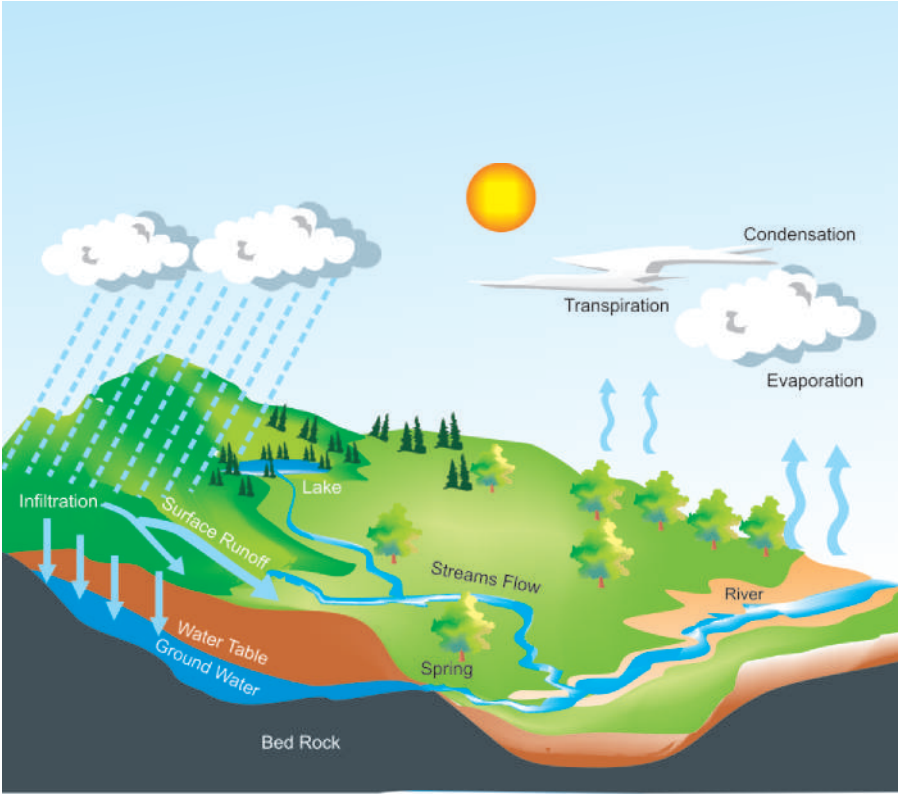
Climate change impacts in Sikkim



Where is the ground water stored?

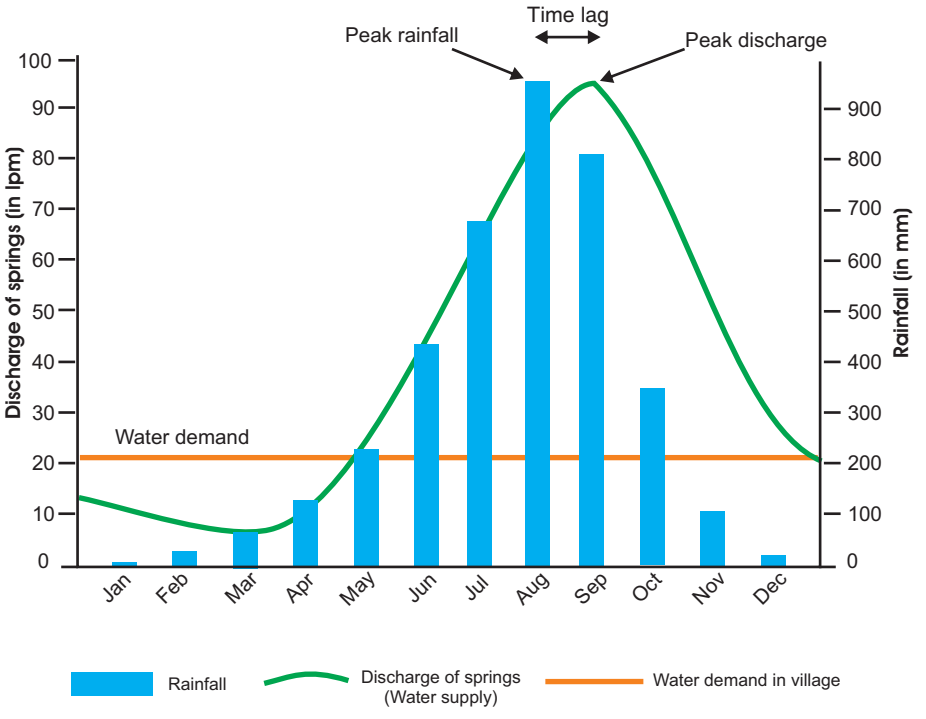


Hydrological cycle



The hydrological cycle describes the continuous movement of water on the surface, above the surface and below the surface of the earth. Above the surface of the earth, water moves in the form of vapour. On the surface of the earth it flows in the form of glaciers, rivers and surface runoff. Below the surface of the earth, water seeps through the soil as well as cracks and pores in the rocks and finally exits through cracks or openings to form springs, streams or lakes. It is the circulation of the earth's water, in which water evaporates from the sea into the atmosphere, where it is condenses and falls as rain or snow into the ground. Again water from snow or rain will return to the sea in the forms of rivers or it will return back to the atmosphere by evapotranspiration. The process is called water cycle or hydrological cycle.

Pattern of spring discharge with rainfall



The spring discharge follows an annual periodic rhythm, mirroring the rainfall pattern. As the rainfall declines during the post monsoon season, the spring discharge reduces exponentially and reaches a minimum during the period March to April. However, there is a lag between the peak rainfall and the maximum spring discharge. During the months of January to April, the water supply from the springs is not sufficient to meet the water demand of the village.

Type of rocks in Sikkim

Phyllite: Phyllite is a common low grade metamorphic rock found in Sikkim in the 500 to 2000 meters elevation zone. It has a number of fine layers and has a tendency to split into sheets. The foliation is commonly crackled or wavy in appearance. It is formed under low grade metamorphic conditions and is usually black to gray in color. On weathering it gives a clayey texture to the soil. It has fine grained mica flakes in a preferred orientation. Cracks and fractures provide an avenue for groundwater movement. Since the pores are not connected to each other, hence uniform flow of water is not maintained.

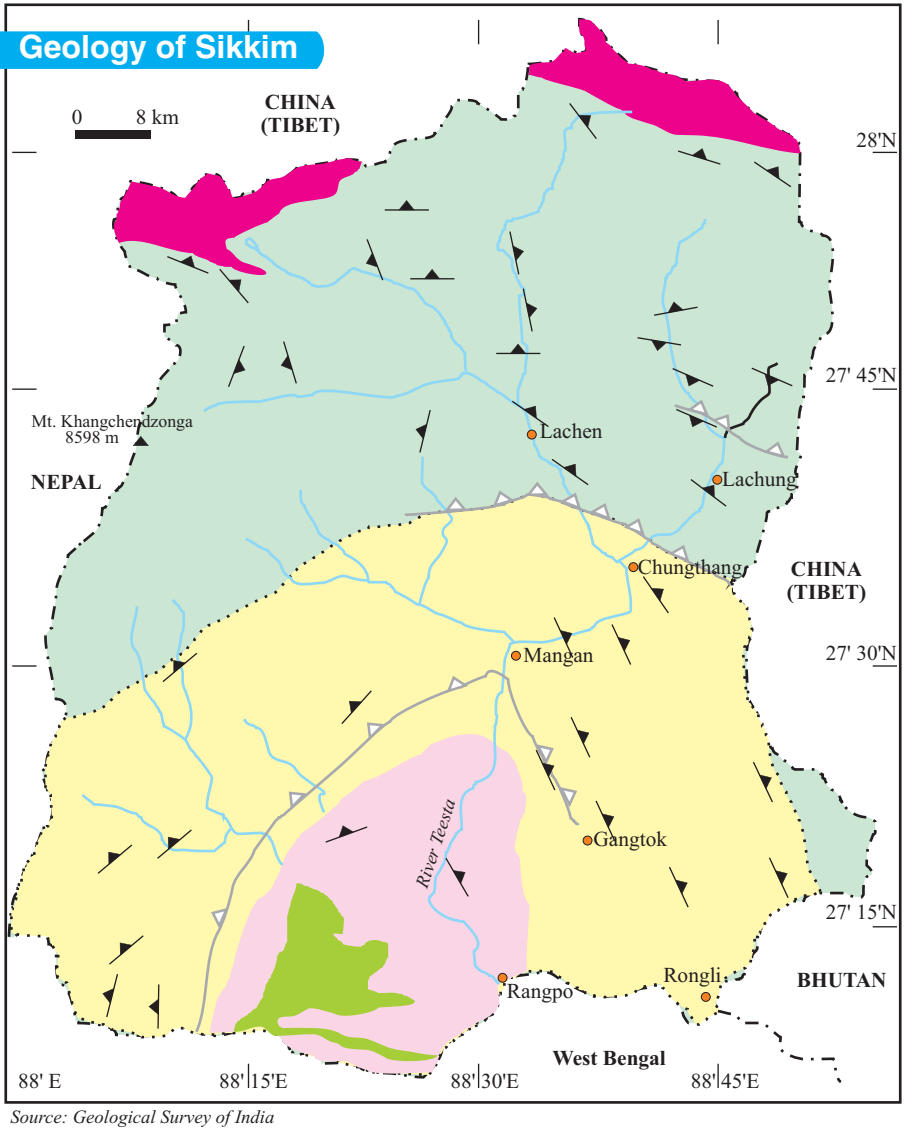
Quartzite: Is another common low grade metamorphic rock found in Sikkim in the 500 to 2000 meters elevation zone. It is a hard rock with few layers and is blocky in shape. It emits a sharp sound when hit with a hard object. Cracks and fractures provide the avenue for groundwater movement. Since the pores are not connected to each other, so uniform flow of water is not maintained. Phyllite and Quartzite rocks are normally found in close proximity occurring in alternative bands.

Sandstone: This sedimentary rock is found in the 300 to 1000 meters zone. Sandstone usually allow percolation of water and are porous enough to store large quantities of water, making them valuable aquifers.

Granite: Granite is a light-colored igneous rock with grains large enough to be visible with the unaided eye. Granite is composed mainly of quartz and feldspar with minor amounts of mica, amphiboles and other minerals. This mineral composition usually gives granite a red, pink, gray or white color with dark mineral grains visible throughout the rock. Granite is generally poor aquifer because of very low porosity, however, when highly fractured, it makes good aquifer

Schist: Schist is medium grade metamorphic rock, formed by the metamorphosis of mudstone / shale, or some types of igneous rock. Schist is generally foliated, hard, contain grains from fine to medium size can often see crystal s with the naked eyes. It contain alternate lighter and darker band and often shiny. Schist is generally poor aquifer because of very low porosity, however, if highly fractured, it makes good aquifer

Geology of Sikkim



Source: Geological Survey of India

Dip direction of the rock

Ductile thrust

Sandstone, Limestone and Quartzite

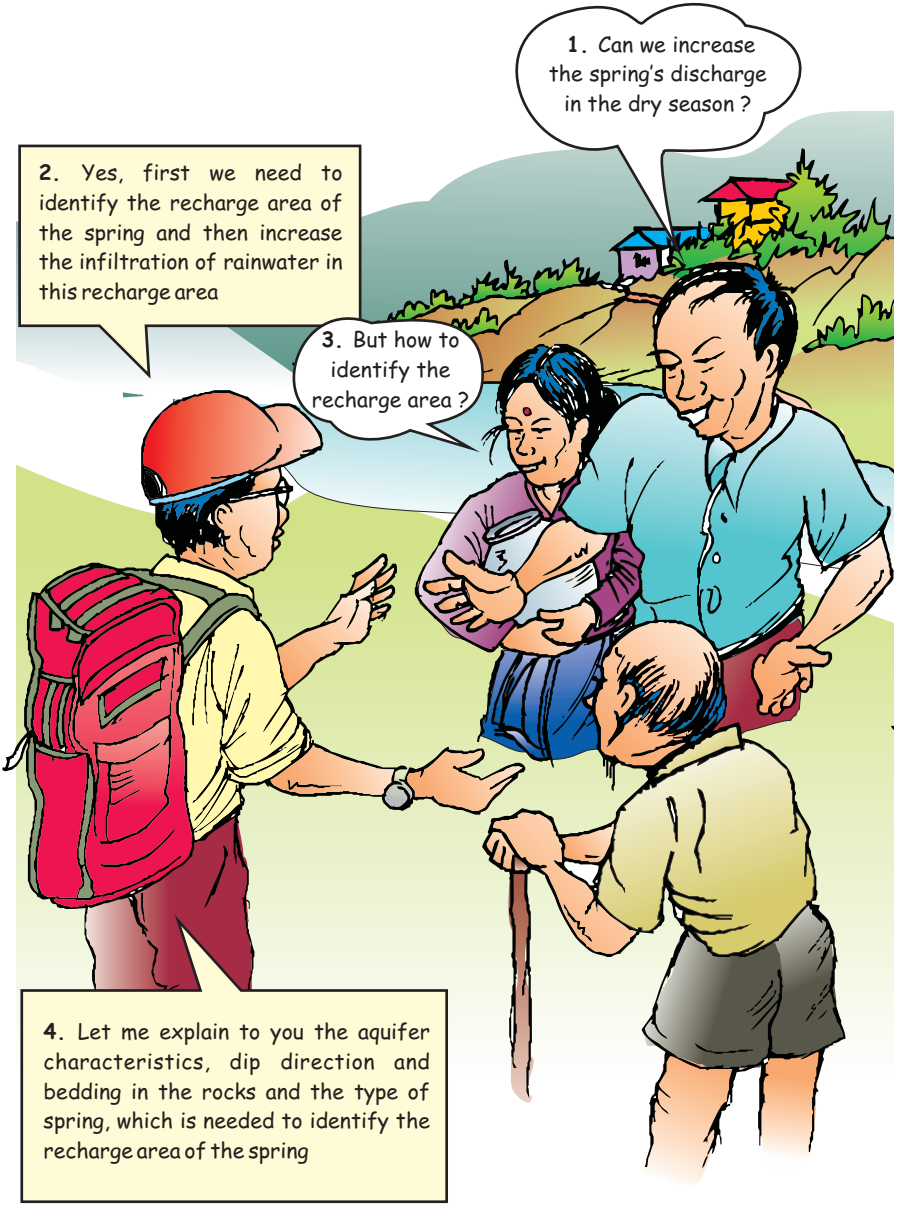
Quartzite, Phyllite Slate, Dolomite and Mica Schist

Quartzite and Phyllite

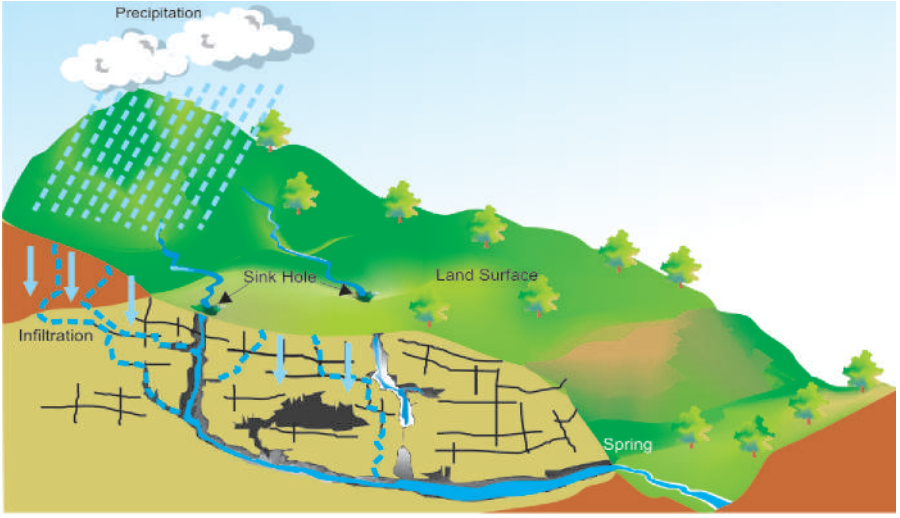
Quartzite, Schist, Gneiss and Granite

Unclassified

Is it possible to increase the spring discharge ?



Aquifer characteristics



Any geological formation with interconnected pore spaces which is filled with water stores and readily transmits ground water to springs is called an **Aquifer.**

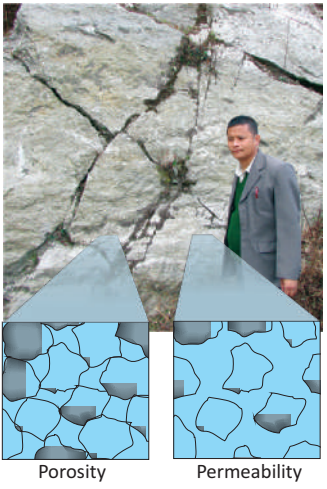
Porosity , Permeability and Storativity

The properties of rocks that allow the storage and transmission of water is known as the hydrologic properties of rocks - Porosity and Permeability. Material that contains voids or openings is said to be porous. This property is called Porosity. Rocks have openings of different types. The presence and type of openings depend largely upon the characteristics of rocks (this is the reason why geology is so important in understanding groundwater).

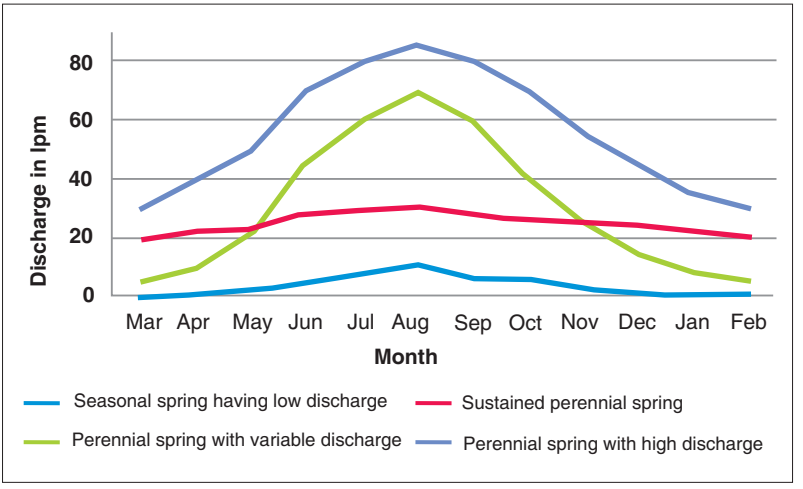
Porosity is an indicator of how much groundwater the rock will store.

Permeability is the interconnectivity of the pore spaces within a rock which controls the flow of groundwater through it. Any porous rock will only store groundwater, but it is the permeability that actually makes the water available to us and is also called transmissivity

Storativity: It is the quantity of water taken into or out of the aquifer. It will define the size of the aquifer.



Understanding the Aquifers from the Spring Discharge Hydrograph



Seasonal spring having low discharge:

These springs have low discharge even during the monsoons and are mostly connected to water ponding. Their aquifer storage is quite limited and local, hence, sustainability of discharge is not ensured. Some depression springs shows this kind of behavior. Since the volume of the aquifer is limited, undertaking artificial recharge works will not result in any visible improvement during the lean season.

Perennial spring with variable discharge

These springs are the most common in the mid-Himalayas and have high discharge during the monsoons but it reduces significantly during the dry season. Moderate aquifer storage with high transmissivity is indicated. The lean period discharge of these springs has been reducing over the years, indicating inadequate natural recharge during the monsoons. Some of these springs may become seasonal with changes in land-use, precipitation patterns and other factors. Implementation of artificial groundwater recharge works will result in significant improvement in the lean period discharge.

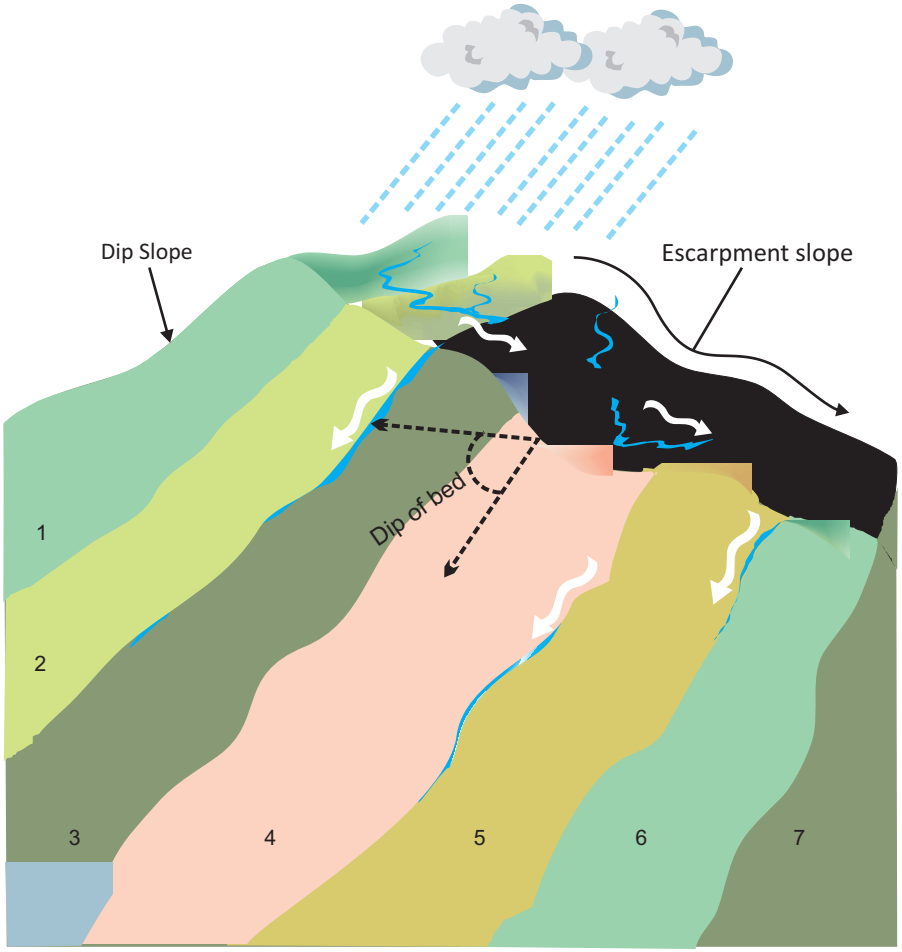
Sustained perennial springs

These perennial springs have moderate to high discharge throughout the year and are considered to be very useful. The aquifers hold significant storage but show limited transmissivity leading to a 'sustained discharge' at the spring. These aquifers are characterized by a significant distance between the recharge zone and the spring. Recharge works are likely to lead to a limited increment in spring discharge across all seasons but increases will certainly remain limited.

Perennial springs with high discharge

These springs have high discharge during the rainy season and moderate discharge during the lean season and are useful for rural water supply. The aquifers feeding such springs are characterized by high storativity and transmissivity. Implementation of artificial groundwater recharge, which needs to be carried out at a considerable scale, will result in visible improvement in the lean period discharge.

Dip direction and bedding of the rocks



1,2,3,4,5,6, 7 is the bedding of the rocks

Dip slope: The slope which conforms approximately to the dip of the underlying rock is called the dip slope. The dip slope is generally parallel to the bedding of the rocks.

Escarpment slope: The slope conforming approximately to opposite direction to the dip of the underlying rock is called escarpment slope.

Types of springs

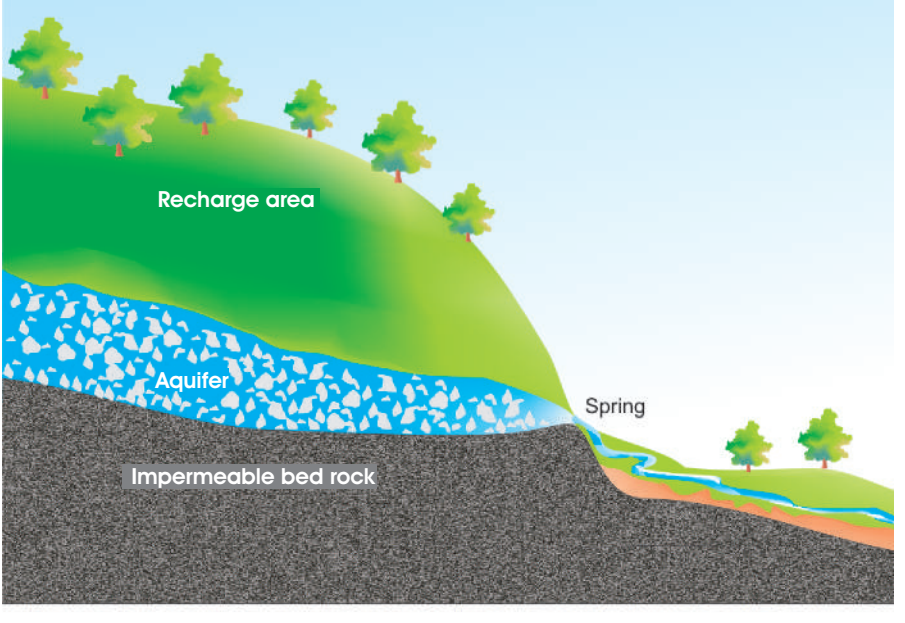
Three types of springs are commonly found in Sikkim. These are 1. Depression Springs, 2. Fracture Springs and 3. Contact Springs.

1. Depression springs

- These springs occur where there is a sharp change in slope. The water table cuts the surface due to this sudden change in topography. The spring originates from the point where the water table cuts the surface. The spring is located below the sudden change in slope
- The catchment of the depression spring has loose boulder, sediment and weathered material
- These springs do not occur in cluster, but occur alone
- Discharge of these springs fluctuates widely based on rainfall pattern

Recharge area

Recharge area will be just above the spring



2. Fracture springs

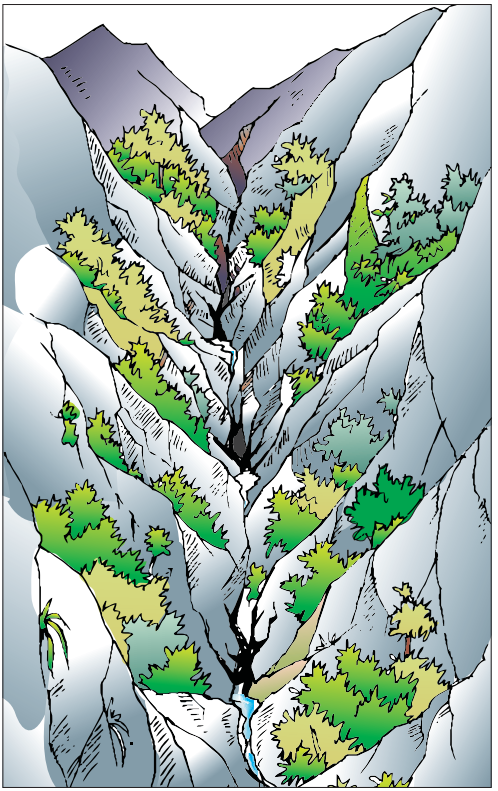
These springs can be identified as follows:

- Fracture springs originate along a fracture which cuts across an aquifer forming rock
- The fracture acts as a channel for groundwater to move out of the aquifer forming a spring
- A series of springs often emerge down slope along the fracture
- The rock type is the same on both sides of the fracture

Recharge area

Thumb rule for the identification of recharge area in fracture springs is as follows:

- Recharge area of the fracture springs will be along the fractures above the springs
- Dip slope in the catchment area above the springs
- Escarpment slope of the rocks above the springs



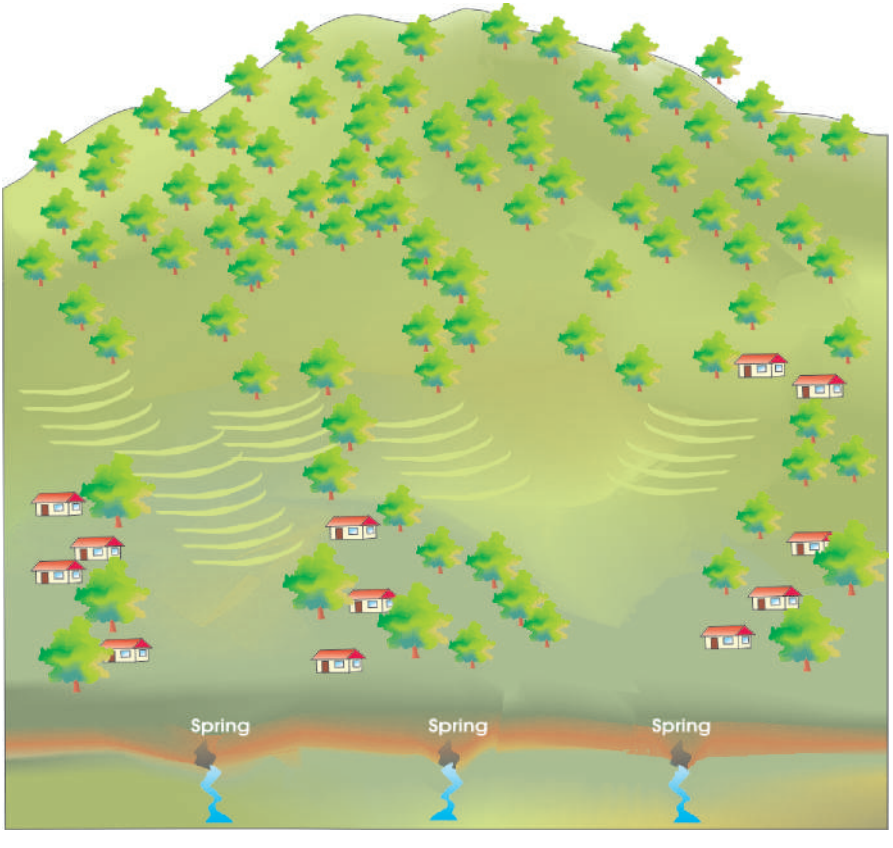
3. Contact springs

- A series of springs emerging at the contact of two different rock types are termed as contact springs
- The rocks above the springs and below the springs will differ in nature. Rocks which are below the springs basically will be impermeable rock and above the springs will be permeable rocks. So the springs emerge from the contact point of these two rocks

Recharge area

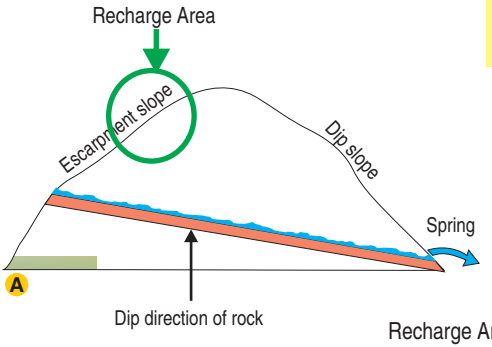
Thumb rule for the identification of recharge area in contact springs is as follows:

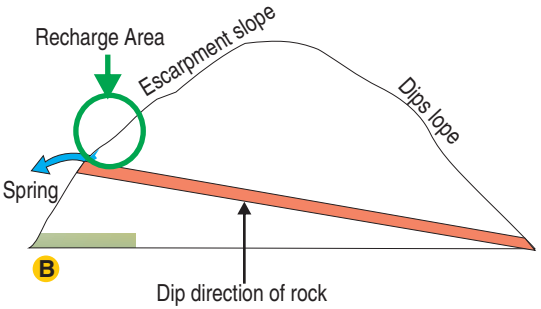
- Recharge area in case of contact springs mostly will be in the dip slope of the rocks above the springs or escarpment slope of the rocks above the springs
- Along the fractures above the springs (if any)



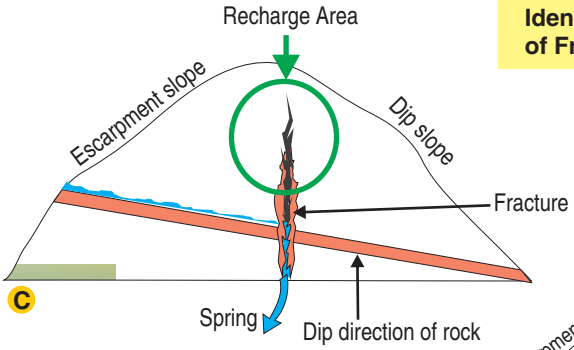
Common examples of recharge area

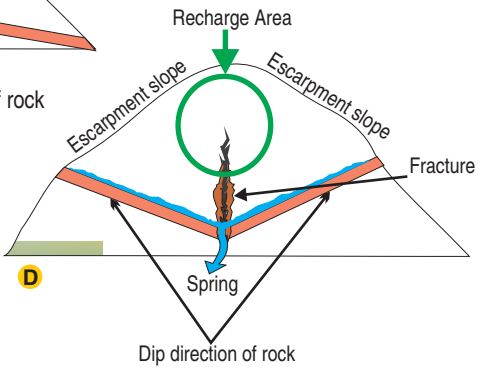
Identifying the recharge area of Depression and Contact springs



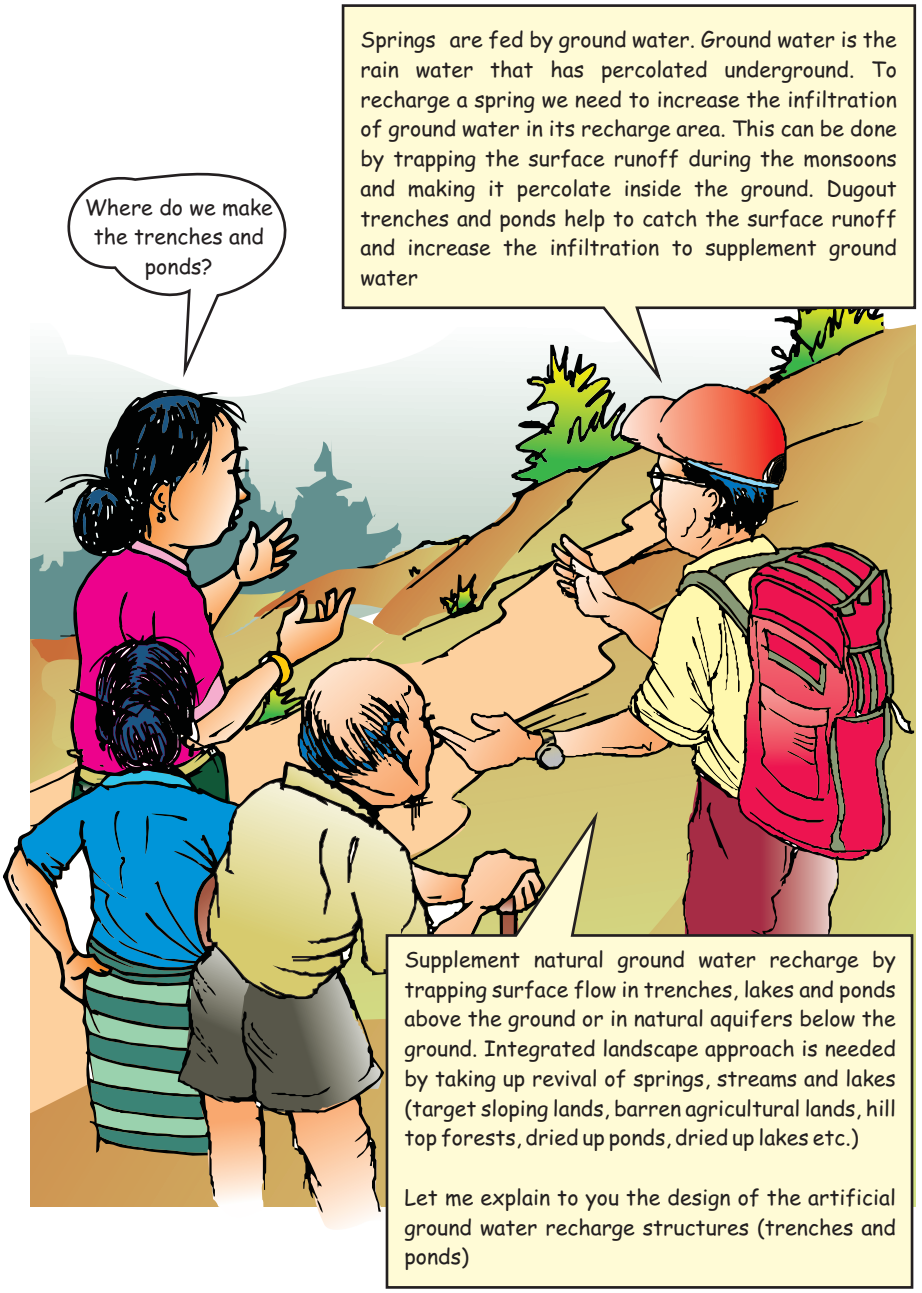


Identifying the recharge area of Fracture springs



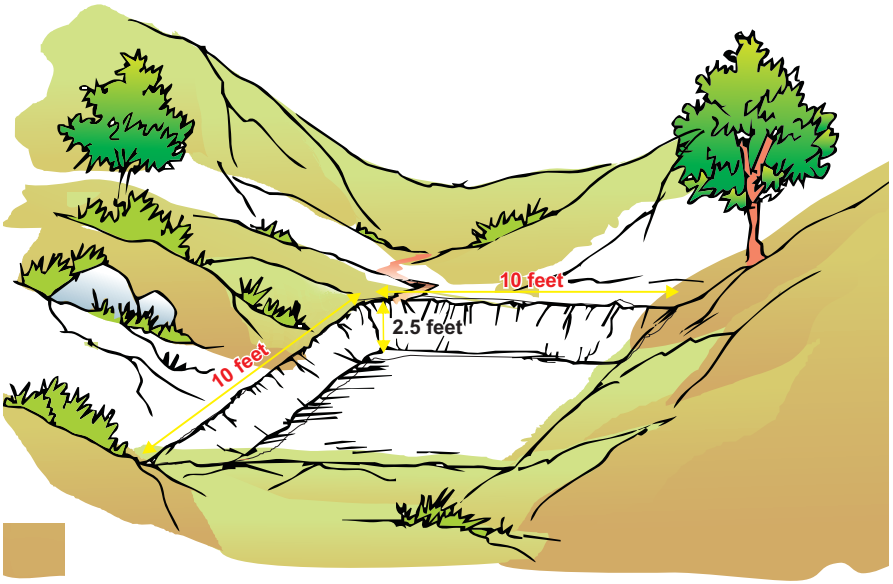


Strategy for recharging springs



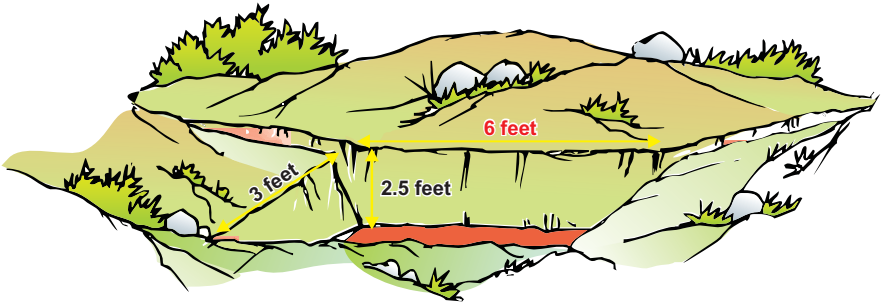
Pond

It is a rectangular dugout structure, constructed usually in a natural depression area on sloping land. The standard size is usually Length =10 feet, Breadth =10 feet and Depth = 2.5 feet with site specific modifications. The feeder channel which is connected from both sides to the pond helps to harvest additional surface flow. The walls should not be vertical but have a 45 degree slope to prevent cave in.



Trenches

It is small rectangular structure of size Length= 6 feet, Breadth= 3 feet, Depth= 2.5 feet constructed on sloping land in a staggered manner. Like in the pond it is connected by feeder channels. The slope of the walls should be not more than 45 degree.



Design of the trenches on sloping lands

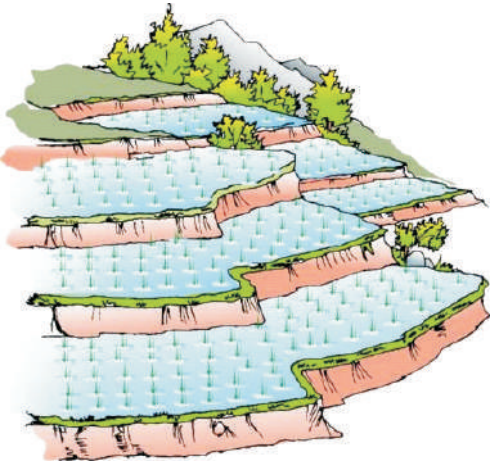
Slope	Size of the trench			Volume of trench	Total trenches per ha	Storage of water per ha*
	Length	Width	Depth			
%	m	m	m	cum	nos.	cum
<30	2.00	1.00	0.60	0.90	150	135
30-40	2.00	0.60	0.60	0.55	180	100
40-50	2.00	0.60	0.45	0.40	200	80

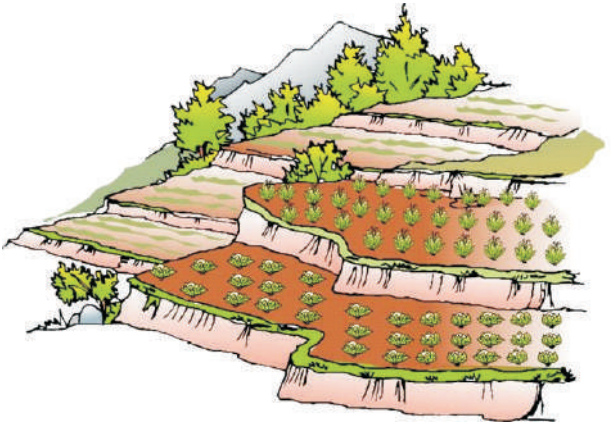
The size of the trenches and their spacing depends on the slope of the land. In higher slope areas, we need to make smaller trenches with closer spacing.

Landuse aiding in natural groundwater recharge

Paddy fields:

Paddy fields function as ponds since the surface runoff is diverted to terraces which hold the water. This helps in enhancing the percolation of rain water and recharges the springs downstream.



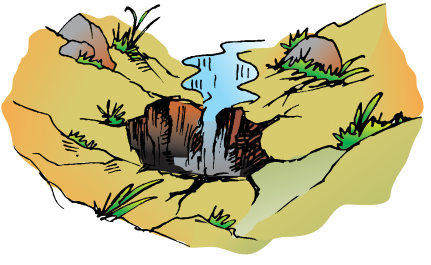


Terraced fields:

Terraced fields reduce the surface runoff as the steps help in slowing down the speed of water and increase the ground water recharge.

Sink hole:

It is a natural depression or hole in the ground caused by collapse of the surface which acts as a natural deep trench



Strategy for enhancing rural water security

Reduce surface runoff and increase infiltration to enhance ground water recharge

Making trenches and ponds in recharge area

Enhancing hydrological contribution of hill top forests

Reviving lakes to function as recharge structures

Expand minor irrigation network for paddy cultivation

Terracing of sloping lands

Strengthening water storage infrastructure

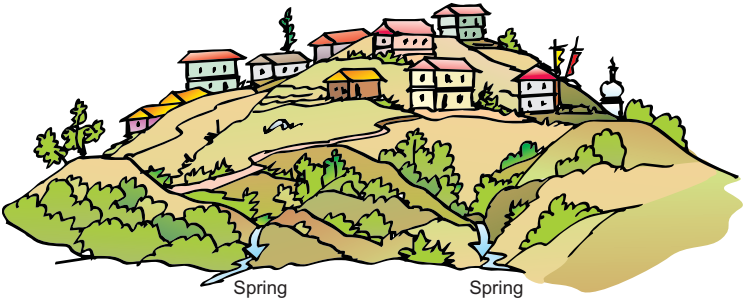
Research and documentation

Developing para professionals in geohydrology

Places where Dhara Vikas is not Feasible

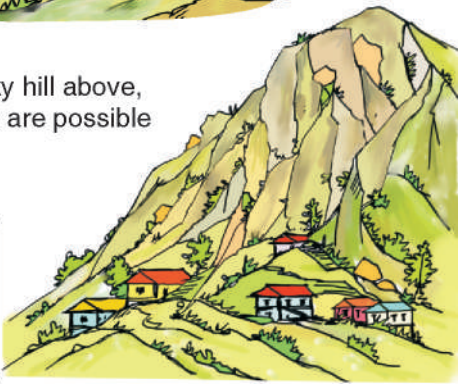
Dhara Vikas feasibility will depend on the location of the village, springs and its recharge area. Some places where Dhara Vikas initiative is not feasible.

1. Village is located on the top of the hill with no forests above the village. All the springs are located below the village



2. The land above the village is used for agriculture and no fallow land or forests are available for taking up recharge activities

3. The village has steep or rocky hill above, where no recharge activities are possible



A feasibility study need to be carried out and only if the area is found feasible, then eight step action plan can be adopted

Eight step action plan of dhara vikas

Good question my friends. We need to follow an eight step landscape based approach targeting all the water resources (springs, streams and lakes) in the village.

Step 1: Resource mapping of the village water resources (springs, streams and lakes), their location, land tenure, dependency of water users, recharge area, measurement of discharge etc

Step 2: Baseline study of the springs to measure the discharge, understand the geo-hydrology, type of spring, land tenure, dependency of water users, recharge area etc

Step 3: Prepare the Springshed Development Plan showing the spring, aquifer, recharge area, Google map etc

Step 4: Prepare the lake revival plan

Step 5: Prepare the plan to enhance the ground water recharge contribution of hill top forests

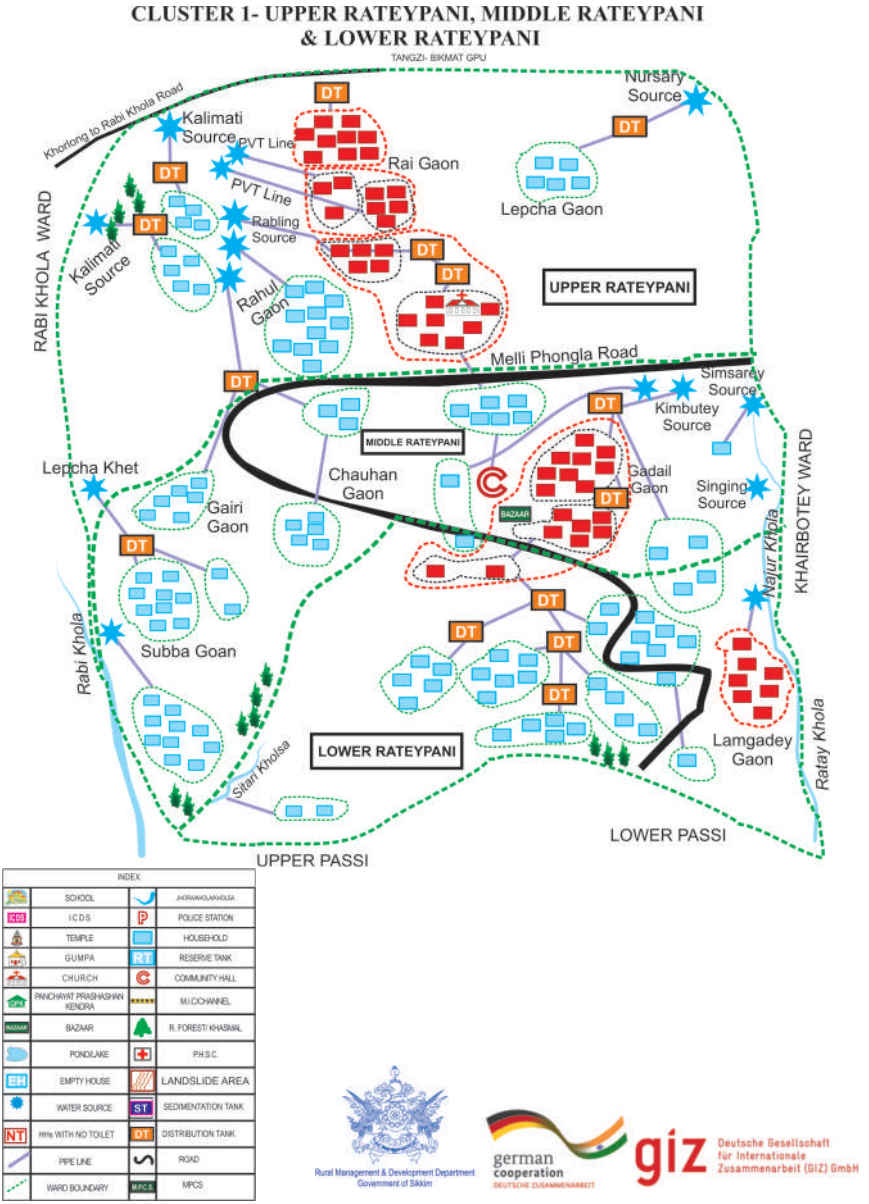
Step 6: Estimation, technical and financial sanctions

Step 7: Follow best practices in implementation

Step 8: Monitoring and evaluation

Step 1: Resource mapping of village water resources

Map all the water resources of the village, location of households, location of water tanks, water supply pipes, rivers, lakes, springs, streams, forest, cultivable land, barren land, roads and any other land mark.

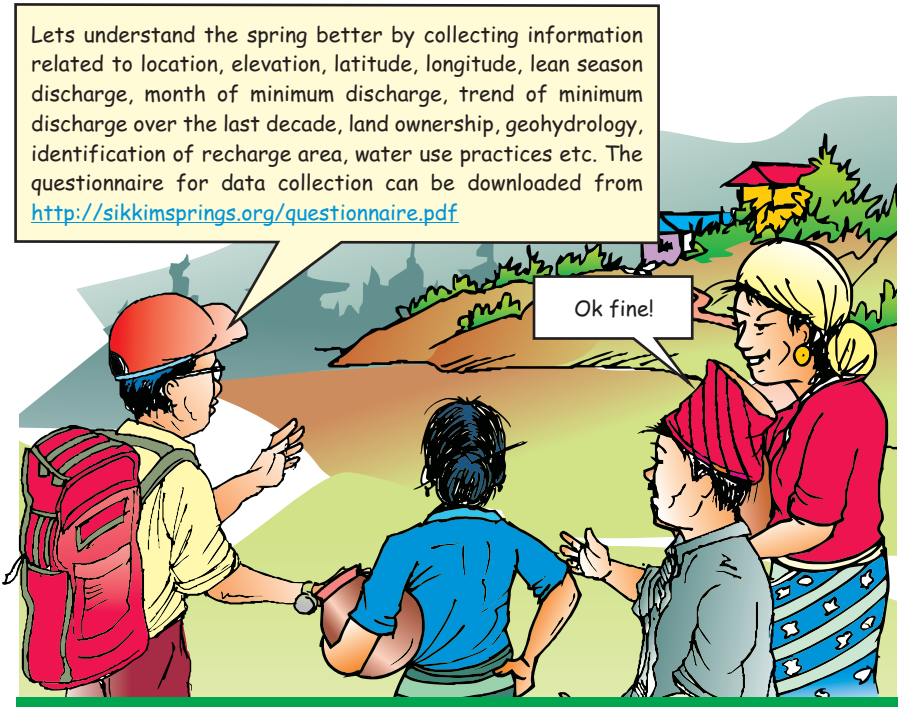


Rural Management & Development Department Government of Sikkim

german cooperation DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Step-2: Baseline study of the springs



You must have the following items with you before starting data collection. Pen, diary, questionnaire, GPS, compass, bucket and watch.

GPS, Pen & Note book

Interaction with water users

Springshed map

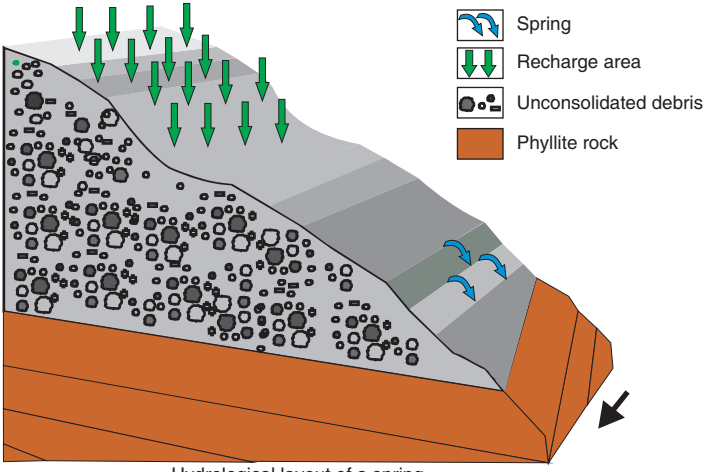
Discharge measurement

The discharge of the springs is the key indicator for monitoring of springshed development works. Thumb rule for measuring discharge is as follows:

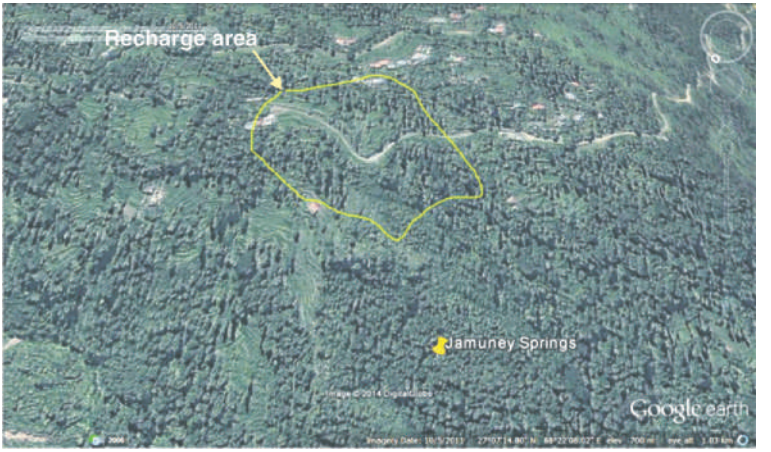
- Identify the points in the spring from where all the water can be collected
- Mark the point with permanent colour or paint to reduce confusion during future measurement
- A bucket whose volume is known to you is required to measure the discharge
- Fill the bucket with water and note the time taken to fill the bucket. Carry out this exercise at least three times to reduce error. Take the average discharge
- Take GPS coordinates of the spring
- Discharge of the springs should be measured before starting the *Dhara Vikas* works and continue monthly measurement for two to three years
- Comparing the lean period discharge of the spring before and after the work will help in the evaluation of the *Dhara Vikas* initiative.

Identify the recharge area of the spring

- Identify old rocks around and above the spring along with the soil structure
- Identify the slope of the rocks, direction of fractures and note the GPS coordinates. Underground rocks are usually visible at road cuttings or exposed by landslides. If rocks are not seen, describe the soil structure above the springs.
- Draw the hydrological layout of the spring and its recharge area. Also it will be easy to identify the recharge area physically on the ground using the Google Earth Image.

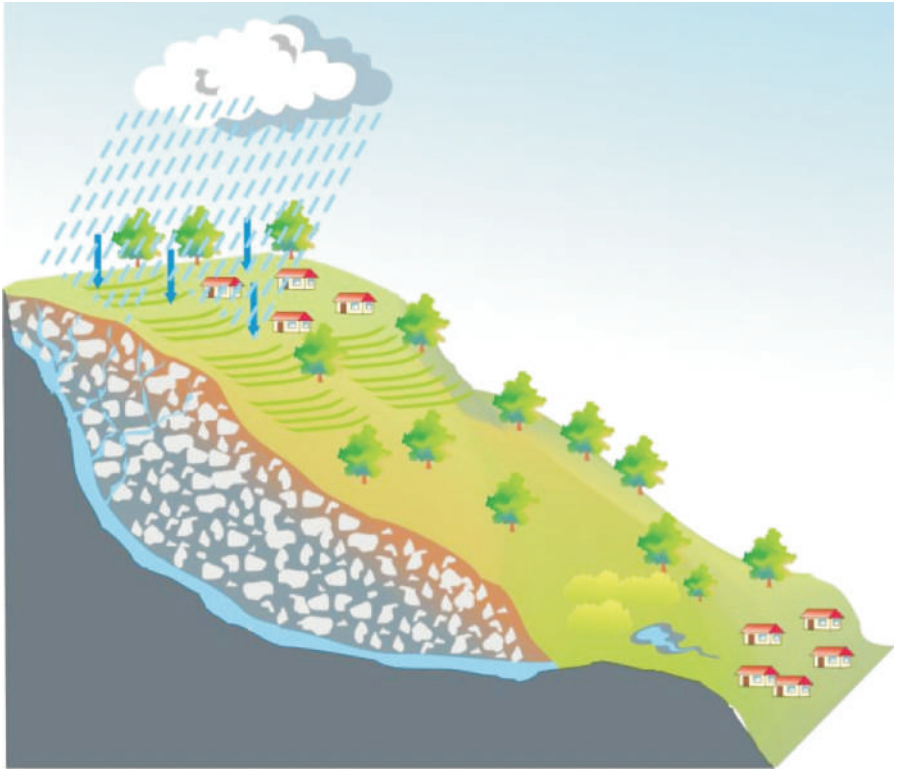


Hydrological layout of a spring



Recharge area of a spring shown using Google Earth Map

Step 3 : Prepare the springshed development plan



- Based on the field data collection, analyze the collected information on Google Earth platform
- Identify the rock type and structure
- Identify the fractures (if any)
- Identify the dip slope of rocks
- Identify the escarpment slope of rocks
- Identify the type of spring
- Identify the forest land, private land
- Analyze all the above factors which determine the spring discharge
- Now identify the recharge area of the spring
- Draw the hydrological layout of the spring and its recharge area

Step 4: Prepare the lake revival plan

Lakes have traditionally played an important role in groundwater recharge. Reviving these hill-top lakes is critical to ensure sustainability of the mountain ecosystem. Hill-top lakes act as large recharge structures that can help to revive the springs and streams originating downstream. Hill-top lakes can be recharged by diverting the nearby seasonal streams and springs into the lakes using pipes or canals. Since the volume of the lakes is large, the stored water will slowly infiltrate and help recharge the springs or stream located downstream of the lake.

- Identify the seasonal springs or streams near the lake
- Take the GPS coordinates of lake and the seasonal stream or springs, that will useful for preparation of lake revival plan
- Assess whether water from a seasonal stream or spring can be diverted into the lake or not?
- Prepare the lake revival plan

Step 5: Prepare the stream revival plan

Hill top forests are a unique feature of the mountain topography. In Sikkim, the hill-tops usually have a healthy forest cover, while the habitations are located in the mid-hills. These hill-top forests function as the recharge area of perennial streams and springs located below. The role of these hill-top forests is very crucial for ensuring rural water security in the villages below. With erratic rainfall patterns, with high intensity of rainfall concentrated in 4-5 months, less number of rainy days and longer winter droughts, the need for storing water when it is available in plenty is the need of the hour. Rainfall which is lost as surface runoff, can be actually captured by artificial rainwater harvesting structures to supplement the groundwater recharge.

- Identify the recharge area in the hill top forest by using same concept used in springshed development
- Trap the surface flow in the hill top forest by making recharge structures

Augmenting the baseflow of streams by enhancing the ground water recharge contribution of hilltop forests

Identify the recharge area at landscape level

Making trenches and ponds to capture the surface runoff

Desilting and widening of existing ponds

Step 6: Estimation, technical approval and financial sanction

Procedure

- After completion of the field survey, the *Dhara Vikas* proposal has to be placed in the *Gram Sabha* for approval.
- Once approved, a technical estimate will need to be framed by experienced para-hydrogeologists posted in the *Gram Vikas Kendra.*
- Technical Sanction has to be obtained from State Institute of Rural Development (SIRD) and Financial Sanction in the *Zilla Panchayat* meeting chaired by the *Zilla Adhaksha.*
- Following this, a Sanction Intimation will be issued by the Additional District Collector (Development) and Work Commencement Order by the *Gram Vikas Adhikari.*

Preparation of Estimate

To prepare the estimates, identification of the total recharge area needs to be calculated accurately. Recharge area can be calculated using Google Earth. It is advisable to take half of the total recharge area as the targeted working area and based on this, the estimate has to be prepared.

It is advisable to assign the work on piece rate basis. The concept of piece rate basis is given below:

- One worker has to dig two number of trenches of size 6 feet x 3 feet x 2.5 feet in a day to claim one day wages

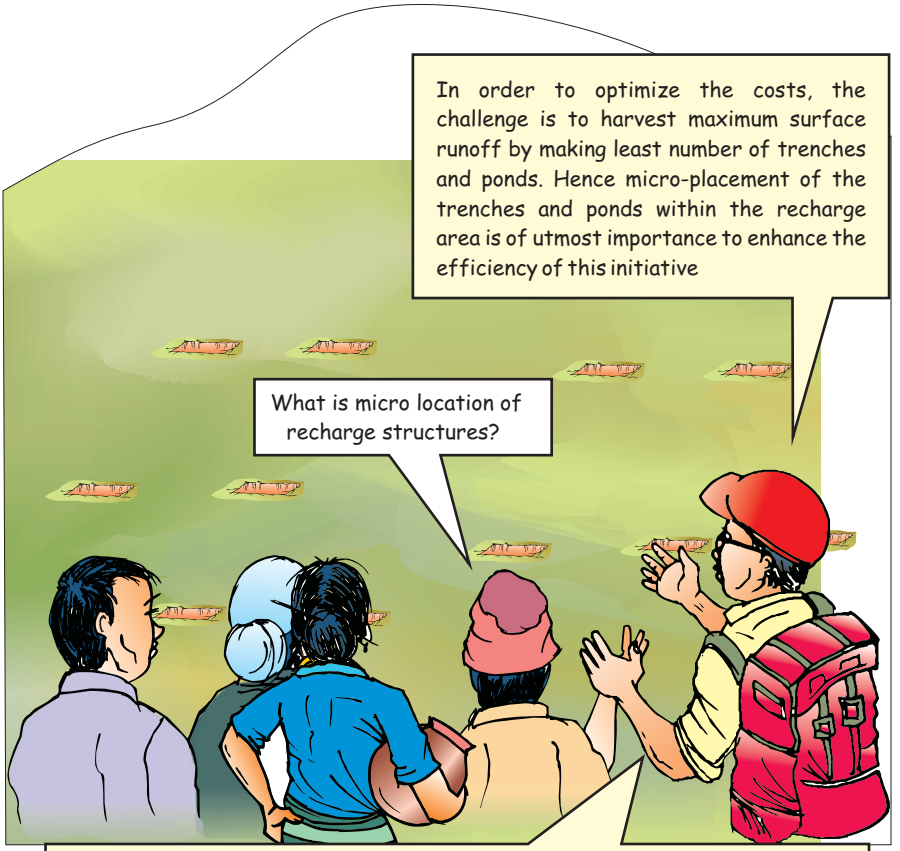
  Or
- Three workers need to dig one pond of size 10 feet x 10 feet x 2.5 feet in a day to claim one day wages

Proposal: After the *Gram Sabha* approval, the estimate is prepared by the technical officers of the *Gram Vikas Kendra* (GVK). The *Gram Vikas Adhikari* will forward this estimate to the State Institute of Rural Development (SIRD) for technical approval.

Technical Approval: State Institute of Rural Development (SIRD) is authorized to provide technical approval of *Dhara Vikas* works.

Financial Sanction: Financial Sanction is provided in the *Zilla Panchayat* meeting chaired by the *Zilla Adhaksha.* Following this a Sanction Intimation will be issued by the Additional District Collector (Development).

Step 7: Best practices in implementation

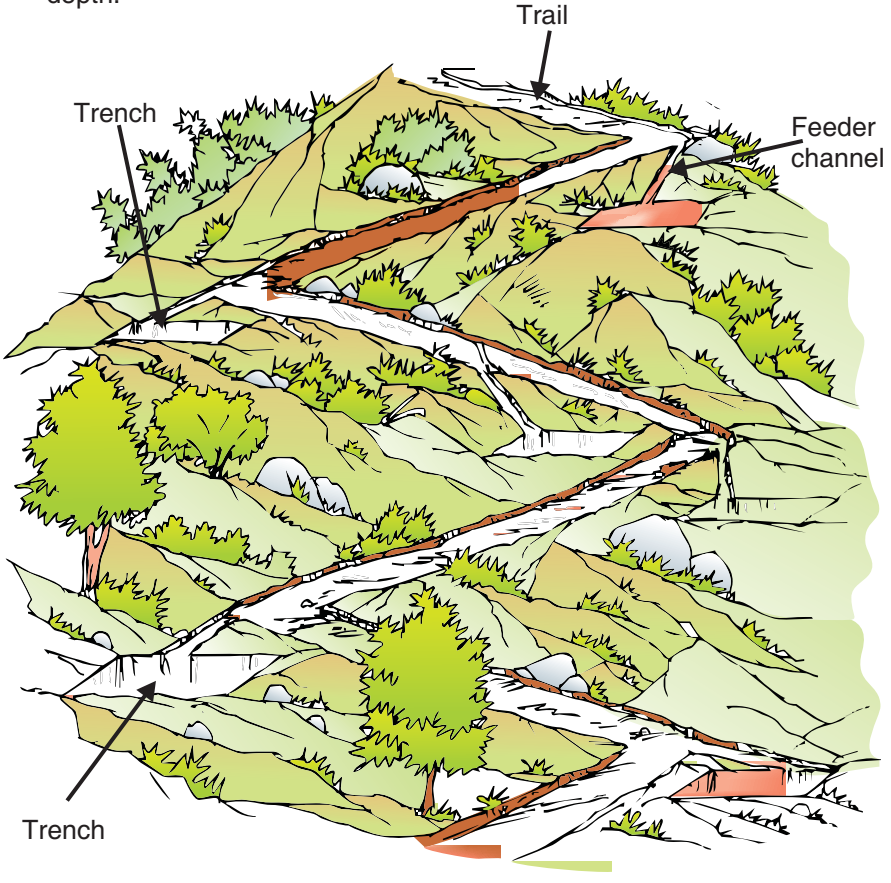


It is the exact placement of the trench and pond in the recharge area so that it captures maximum surface runoff. E.g. digging staggered trenches along the trekking trail, making dug out pond in natural depressions etc will help to accumulate more runoff. The digging of trenches and ponds is usually assigned to the workers on piece rate basis and they get the paid based on the number of trenches and pits dug. In certain locations, where daily supervision is lacking, the workers dug the trenches and pits too close to each other and in the most convenient and easy locations, instead of following a placement strategy which would have maximized the harvesting of surface runoff. In all new works, it is advisable to engage a trained and experienced supervisor from other village to assign the location of the trenches and ponds to the workers on a daily basis in order to ensure that the placement is correct

Concept for designing trenches and ponds along the trail

From past experience it is learnt that correct placement of the trenches and ponds is important to maximize the trapping of surface runoff. The following points need to be considered during implementation.

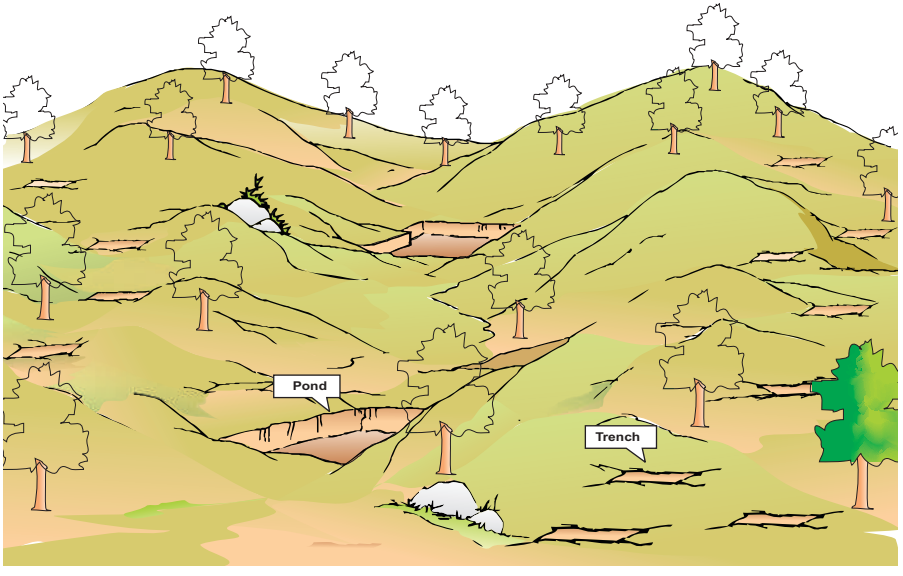
- Runoff along the trail will be always maximum, so making trenches or pond near the trekking trail and diverting all the runoff along the trail using feeder channel can help to harvest maximum runoff during rainfall.
- During rainfall, runoff mostly flows into the natural depression area or the low land. It is advisable to make ponds in the natural depression area to harvest maximum runoff.
- In higher slope (slope 35° to 45°), it is advisable to dig trenches with lesser depth.



Digging ponds in natural depression area

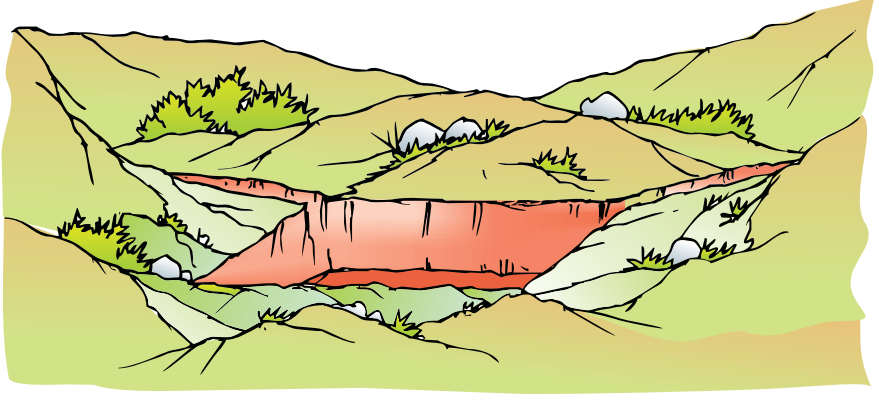
Location of pond

Digging ponds in natural depressions, will collect maximum runoff. Construction of trenches on the adjacent sloping lands in this case is not needed.



Feeder Channel

Feeder channel from both side of the trenches and ponds will collect maximum runoff and feed into the pond.

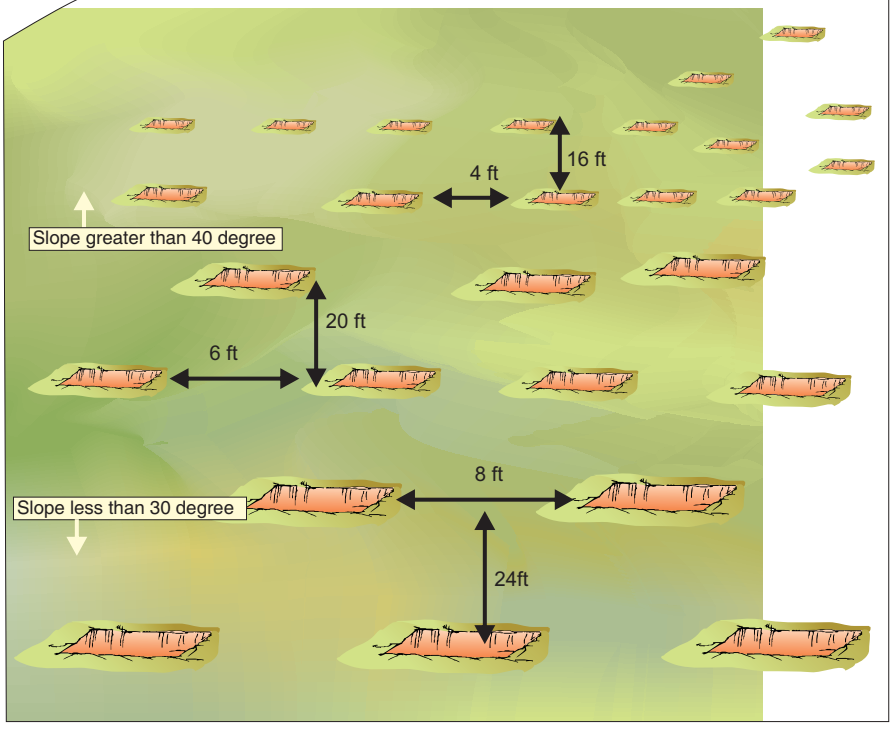


Staggered contour trenches

If the slope is less than 50 degree, and there is no trail or natural depression area, then design staggered trenches as indicated in the table below:

Design of the trenches on sloping lands

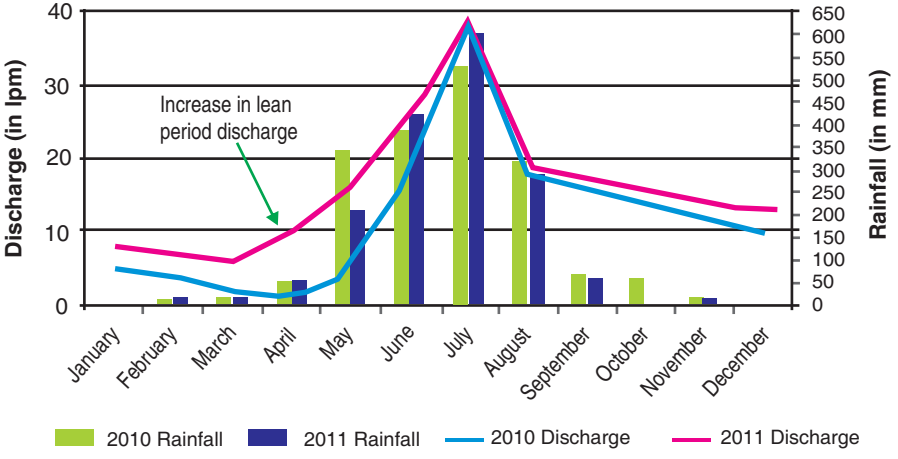
Slope	Size of the trench			Volume of trench	Total trenches per ha	Storage of water per ha*
	Length	Width	Depth			
%	m	m	m	cum	nos.	cum
<30	2.00	1.00	0.60	0.90	150	135
30-40	2.00	0.60	0.60	0.55	180	100
40-50	2.00	0.60	0.45	0.40	200	80



Step 8: Monitoring and evaluation

Hydrograph of a spring

Hydrograph of a spring, showing the impact of artificial recharge on spring discharge along with rainfall pattern.



Water storage tanks and livelihood outcomes

The night flow of the spring was tapped and stored in the water storage tanks constructed under the MGNREGA scheme. The sanitation status and personal hygiene of the villagers also improved due to this enhanced water availability. They could also now grow vegetables and by selling them in the local market, earn additional income.

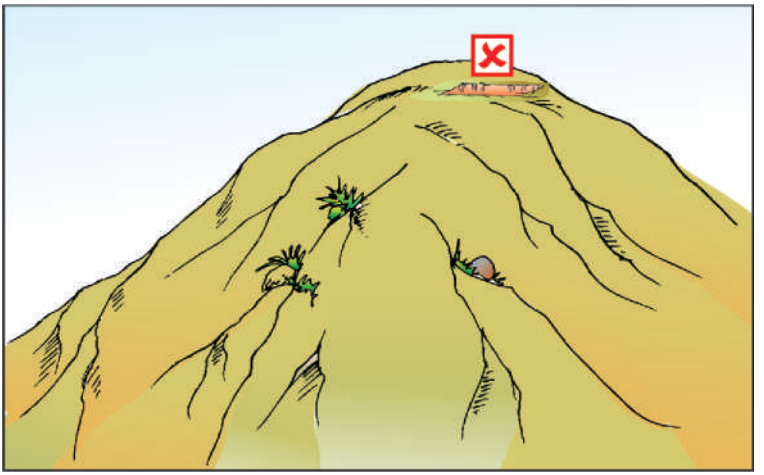
Learning from mistakes

Some of the common mistakes that need to be avoided are:

- Digging trenches on terraced fields
- Location of the trenches and ponds on ridge tops without understanding their purpose
- Forestry and horticulture plantations alone with no trenches/ ponds
- Lack of baseline information on discharge
- Concretizing of hill-top lakes to store water
- Pine *(Dhoopi)* plantations in upper catchments of drought prone areas

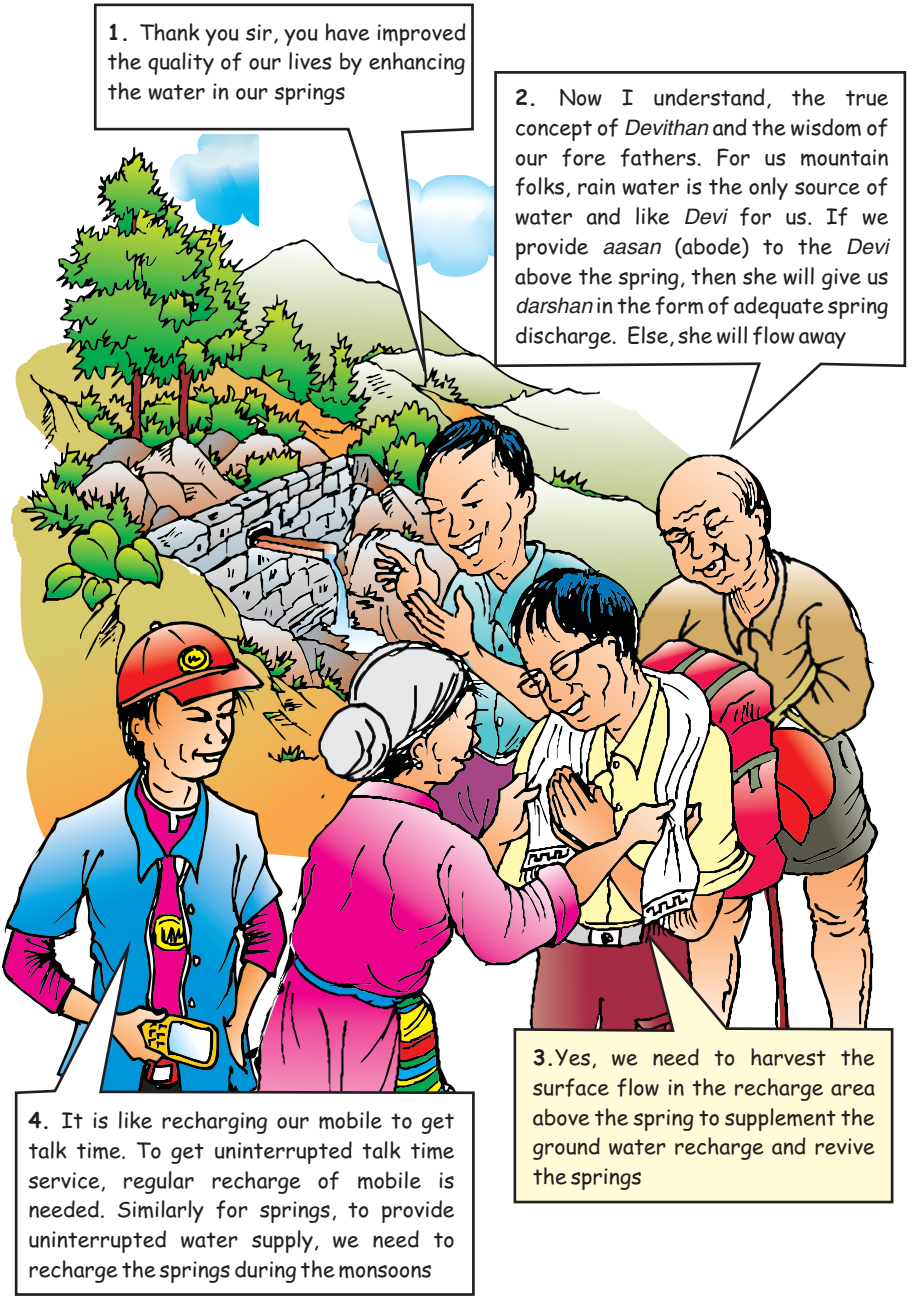
Pine *(Dhoopi)* plantations in upper catchments of drought prone areas

Concretizing of hill-top lakes to store water



Location of the trenches and ponds on ridge tops without understanding their purpose

Farewell and way forward



Partners

- ACWADAM, Pune
- ARGHYAM, Bangalore
- BARC, Mumbai
- CHIRAG, Nainital
- Deutsche Gasellschaft für Internationale Zusammenarbeit (GIZ)
- Department of Forest, Environment and Wildlife Management
- Department of Mines, Minerals and Geology
- Department of Science and Technology and Climate Change
- G. B. Pant Institute of Himalayan Environment and Development, Sikkim
- Peoples' Science Institute, Dehradun
- State Institute of Rural Development, Sikkim
- The Mountain Institute - India, Sikkim
- WWF India

Future plans

- Take up a study on the Environmental isotope fingerprinting of Sikkim springs in collaboration with the Bhabha Atomic Research Centre (BARC) to further deepen the understanding of mountain aquifers, improve our ability to identify the recharge areas with greater precision and develop the capacity of local human resource

- Implementing more landscape level initiatives following an integrated strategy of reviving springs, streams and lakes

- Preparation of Village Water Security Plans at gram panchayat level by documenting the village water budget, recharge areas and enhancing water use efficiency

- Further build the capacity of the budding para-hydrogeologists by conducting more training and exposure visits

- Better monitoring and evaluation of this initiative by partnering with institutes of excellence and Government of India agencies

- Sharing and dissemination of the lessons learnt in reviving Himalayan springs with other mountain states and countries and evolving into a centre of excellence

- Initiate impact assessment studies by independent agencies to better understand the outcome of the project

For more information please contact:

Shri Pem Norbu Sherpa,
Dhara Vikas Coordinator,
State Institute of Rural Development,
Karfectar, South Sikkim
Email: ffkaluk@gmail.com
Phone: 9733235202

Shri Nima Tashi Bhutia,
Senior Planning Coordinator,
MGNREGA Cell, RM&DD,
Gangtok,
Email: ntbhutia@gmail.com
Phone: 9733091853

References

ACWADAM, RM&DD. 2011: (Mahamuni, K. and Kulkarni, H., prin. authors). Hydrogeological Studies and Action Research for Spring Recharge and Development and Hill-Top Lake Restoration in Parts of Southern District, Sikkim State. Advanced Center for Water Resources Development and Management and Rural Management and Development, Government of Sikkim, Submitted to GIZ, India. ACWA/Hydro/2011/H-20.

Geological Survey of India. 2007: Geological and Mineral map of Sikkim, GSI, Government of India, Kolkata.

Mahamuni K, Upasani D. 2011: Springs: A Common Source of a Common Resource. Sustaining Commons: Sustaining Our Future, the Thirteenth Biennial Conference of the International Association for the Study of the Commons. IASC-2011, Digital Library of The Commons, Indiana University.

Seetharaman K. 2008: Climate change scenario over Gangtok. Letter to the editor. Meteorological center, Gangtok. Indian Meteorological Department, India. Mausam, 2008, 59(3), 361-366.

Success Stories in Mountain Ecosystem Management, South Asian Association for Regional Cooperation" by Mountain Ecology Division, SAARC Forestry Centre, Thimpu, Bhutan, March 2014. http://sfc.org.bt/images/successstories.pdf

Tambe, S., Kharel, G., Arrawatia, M.L., Kulkarni, H., Mahamuni, K. and Ganeriwala, A. 2012. Reviving Dying Springs: Climate Change Adaptation Experiments from the Sikkim Himalaya. Mountain Research and Development, 32(1):62-72. 2012.

Tambe S, Arrawatia ML, Bhutia NT, Swaroop B. 2011: Rapid, cost effective and high resolution assessment of climate-related vulnerability of rural communities of Sikkim Himalaya, India. Current Science, 2010, 101(2), 165-173.

Tambe S, Arrawatia ML, Kumar R, Bharti H, Shrestha P. 2009: Conceptualizing strategies to enhance rural water security in Sikkim, Eastern Himalaya, India. Selected technical papers from the proceedings of the workshop on integrated water resource management held on 27th Nov, 2009. Central Ground Water Board, Eastern Region, Ministry of Water Resources, Government of India. Salt Lake, Kolkata.

LIVE AS IF YOU WERE TO DIE TOMORROW,
LEARN AS IF YOU WERE TO LIVE FOREVER.

Dhara Vikas Handbook
2nd Edition, November, 2014

Website:
www.sikkimsprings.org

Concept and Content by :
Rural Management and Development Department, Government of Sikkim jointly with the Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH

Funding support:
GoI-UNDP Project on Enhancing Institutional and Community Resilience to Disasters and Climate Change under Sikkim State Disaster Management Authority, Land Revenue & Disaster Management Department, Government of Sikkim.

Illustration by peterslepcha@gmail.com