
## Introduction

Meghalaya is heavily dependent on springs and groundwater with nearly all villages accessing spring water for household and irrigation use either directly from a spring or indirectly via spring- or groundwater-fed streams.
Despite high rainfall, many areas in the State face problem of water shortage. Water demand is on the rise and supply is declining possibly due to climate change, land use changes including increased diversion, pumping and groundwater exploitation, pollution of surface and ground waters, and degradation of natural recharge areas – mainly deforestation associated with mining of quarry stone, lime, coal and river sand, and loss of forest cover from tree cutting, fuel wood collection, anthropogenic fire, and rotational agriculture.

The institutional response has been focused on spring development from the supply-side (e.g. tanks and pipes); however, little has been done in terms of identification of source/recharge areas and targeted aquifer protection. But this is recognized as a problem so there is a widespread interest to mainstream hydrogeology and other scientific approaches. This includes mapping and monitoring of water resources, building stakeholder awareness and capacity, institutionalizing hydrogeology training, creating manuals and other materials, and codifying progressive groundwater management in current efforts to draft state water laws and policies.

Several governmental and civil organizations have shown interest to lead and support these efforts including the Soil and Water Conservation Department, the Water Resources Department, MeWDA, GIZ, ARGHYAM, Meghalaya Water Foundation, Meghalaya Institute of Governance and others. Meghalaya Institute of Natural Resource, under the Meghalaya Basin Development Authority has already taken initiative by conducting training programmes for the stakeholders and initiating mapping of springs. A detailed project report (DPR) for rejuvenating for dried-up springs is also being developed for accessing funds from National Adaptation Fund for climate changes (NAFCC).

Springs are essential to water security, providing necessities like drinking water & feeding rivers. Nearly all 6800+ villages in Meghalaya depend on springs or groundwater. Though no exercise for counting the springs in the state has been undertaken so far but according to the estimates the number of springs in the state may be over 50,000. Spring discharge appears to be decreasing due to groundwater exploitation, ecological degradation and possibly due to climate change. A Statewide water security initiative is being enacted to protect springs and better manage groundwater. The initiative will includes source area identification, protection and management at the village level through government support and capacity building. This includes building awareness and technical skill through dissemination and training of hydrogeology, ecological restoration and other best practices at all stakeholder levels, particularly of government decision makers, field staff, village durbars and para-professionals.

## Spring Sheds

Springs are a "window" into the groundwater flows which emerge to the surface as a spring. The underground flows within a land area that contribute water to a spring vent or outlet comprise the spring shed. Cool in the summer and warm in the winter, the springs are among the most sought-after of all the state's natural and scenic resources. As rainwater enters and recharges the aquifer, pressure is exerted on the water already in the aquifer. This pressure causes the water to move through cracks and tunnels in the aquifer. Sometimes this water flows out naturally to the land surface at places called springs. When the openings are large, spring flow may become the source of rivers.
A spring may be the result of karst topography where surface water has infiltrated the Earth's surface (recharge area), becoming part of the area ground water. The ground water then travels through a network of cracks and fissure-openings ranging from inter granular spaces to large caves. The water eventually emerges from below the surface, in the form of a karst spring.
The forcing of the spring to the surface can be the result of a confined aquifer in which the recharge area of the spring water table rests at a higher elevation than that of the outlet. Spring water which forced to the surface by elevated sources is artesian wells. This is possible even if the outlet is in the form of a 300-foot-deep (91 m) cave. In this case the cave is used like a hosepipe by the higher elevated recharge area of ground water to exit through the lower elevation opening. Non-artesian springs may simply flow from a higher elevation through the earth to a lower elevation and exit in the form of a spring, using the ground like a drainage pipe.
Still other springs are the result of pressure from an underground source in the earth, in the form of volcanic activity. The result can be water at elevated temperature such as a hot spring. The action of the ground water continually dissolves permeable bedrock such as limestone and dolomite, creating vast cave systems.


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# Types of springs:

It is necessary to identify the type of spring in order to understand how they behave over time and space. Following are the types of spring:

• Depression spring: Depression spring is a type of spring which formed at topographic lows. It formed when water table reaches the surface due to topographic undulations. A local flow system is created and a spring is formed at the local Discharge zone.

• Contact spring: Contact spring is a type of spring which formed at places where relatively permeable rocks overlie rocks of low permeability. A lithological contact is usually marked by a line of springs. Such springs are usually associated with perched aquifers in mountains.

• Fracture spring: Fracture spring is a type of spring which occurs due to existence of jointed or permeable fracture zones in low permeability rocks. The movement of groundwater in this type of spring is mainly through fractures that may tap shallow as well as deep aquifers. Springs are formed where these fractures intersect the land surface.

• Fault spring: Fault spring is a type of spring that occurs through faulting which give rise to conditions favorable for spring formation as groundwater under hydrostatic pressure (such as in confined aquifers). An impermeable rock unit may be brought in contact with an unconfined aquifer due to faulting.

• Karst spring: Springs which are found in limestone belt region are known as karst spring. Spring in limestone terrains can be interconnected to topographic depressions caused by sink holes – depressions in the ground surface cause due to the dissolving of limestone below. Large quantities of water move through the cavities, channels, conduits and other openings developed in limestone.

# Spring sheds and Climate Change

The state of Meghalaya is highly prone to the effects of climate change because of its geo-ecological fragility, humid monsoon climate, and socio-economic profile. Since 2005-2006, there has been an observed trend of declining annual rainfalls in Meghalaya; this is attributed by experts to a combination of climate change and deforestation. However, climate models predict 2-3.5 ⊠ C temperature increase and a 250-500 mm increase in precipitation. Furthermore, the rainfall variability and occurrence of extreme events has increased and is expected to further increase, with monsoon rains already having increased drastically since 2001 and shifted towards the "post-monsoon" period, this has over the last twenty years led to an increased frequency and magnitude of floods. At the same time, the occurrence of dry spells has increased in Meghalaya. Thus, in the future climate change will further increase the frequency and magnitude of floods and droughts. The increased uncertainty, variability and unpredictability is affecting the hydrological system and thereby both reducing the availability of water as well as increasing the destructive forces of water.
The following water related negative impacts of climate change in Meghalaya can be noted: in increased destruction of grain crops by heavy rainfalls and hail storms, increased soil erosion and loss of soil fertility as a result of increased intensity rainfalls, displacement of people by floods, shortages of drinking water during winter months, destruction of forests have been destroyed due to extreme climatic events. Hence the hydrological changes threaten the livelihoods and food security of the vast majority of Meghalaya's population, who are engaged in the agricultural sector and depend on natural resources.


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# Payment for Ecosystem Services (PES)

Spring sheds provide valuable ecosystem services. They are the only source of water for daily needs of people but also play an important role in the functioning of ecosystems and in supporting biodiversity. The springs which have dried due to some reason like excessive exploitation of natural resources, climate change etc need to be rejuvenated for the ecosystem benefits to the society at large. Therefore suitable payment of ecosystem services (PES) models can be devised wherein the communities who take initiative in rejuvenation works are compensated by the other people downstream who are likely to be benefitted. Ecosystems provide society with a wide range of services – from reliable flows of clean water to productive soil and carbon sequestration etc. People, companies and society at large rely on these services – for raw material inputs, production processes, and climate stability. The ecosystem provides us with environmental goods such as fresh water, regulating services such as water purification, supporting services for nutrient cycling, soil formation and also cultural services (aesthetic, spiritual, educational and recreational). At present however, many of these ecosystem services are either undervalued or have no financial value at all. In response to emerging concerns, markets should emerge for ecosystem services in the State. The key characteristic of these PES deals is that the focus is on maintaining a flow of a specified ecosystem "service" in exchange for an economic incentive.

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## Law & Policy

Water policy of the State is under formulation and draft of the same has been prepared. The objective of the draft Meghalaya Water Policy is to "ensure that water is used efficiently, shared equitably, managed sustainably, governed transparently and contributing to improving the health and livelihoods of all citizens". To attain this, the proposed Policy aims at ensuring that appropriate systems and measure are in place to balance the following specific objectives: Meeting the basic water and sanitation needs so that all inhabitants of the State can live healthy lives; Effectively harnessing water resources for economic development and for ensuring the livelihoods and incomes of all inhabitants of the State; Ensuring that water resources are protected, maintained, improved and utilized sustainably, so that future generations can enjoy them. Ensuring that ecosystem integrity and land productivity is maintained and minimum ecological water requirements are met, enhancing the resilience to disasters and the impacts of climate change.

## Activities Spring shed Development

- Meghalaya launched the Spring shed Management Initiative on World Water Day, 2015.
- A training session was held in March on spring sensitization and methods for mapping and monitoring for field officers and Departmental heads of numerous agencies connected with natural resources in the state. This covered both the theory and practice of the importance of springs, hydrogeology, discharge measurement, water quality, field sheets, uploading of the database to the central server using the mobile application.
- Meghalaya springs program includes an ambitious plan for water and livelihoods, the Integrated Basin Development Livelihood Program. The springs conservation is a part of that.
- A Training of Trainers (TOT) for Spring Protection Initiative was organized by The Meghalaya Institute of Natural Resources (MINR), of Meghalaya Basin Development Authority (MBDA), Government of Meghalaya, in collaboration with ACWADAM, ARGHYAM, PSI, KEYSTONE, India Water Portal, w.e.f the 20th to the 25th of July, 2015. The objective of the training was to impart understanding the basic characteristics of springs and to demonstrate methods of reviving them. This programme is mainly concerned with the studies of water and the type of rocks, which in combination termed as Hydrogeology (Hydro- water, geology-rocks).
- The plan is to map or survey the entire state and gather a couple of thousand data points. This is rarely done anywhere; it is probably one of the largest springs mapping exercise in the country. The data collected will help in planning spring shed protection activities and will constitute a scaled- baseline for the program.
- The Soil and Water Conservation Department Meghalaya is working on a spring-shed development program aimed at increasing the discharge of the springs besides increasing the duration of discharge. Pilot Projects taken up so far includes Wah Shari at Khliehshnong Sohra and Catchment areas of Shillong Peak.
- The major activities in Springs shed development works includes mapping of spring discharge during lean and peak season; assessment of water quality of springs; number of households depending on springs; status of the spring shed; ownership of the springs; GPS location and interventions for rejuvenation of springs namely, Contour Trenches; Dug out pond; Check Dams and Water Harvesting Structures for ground water recharge and a forestation of the spring shed.

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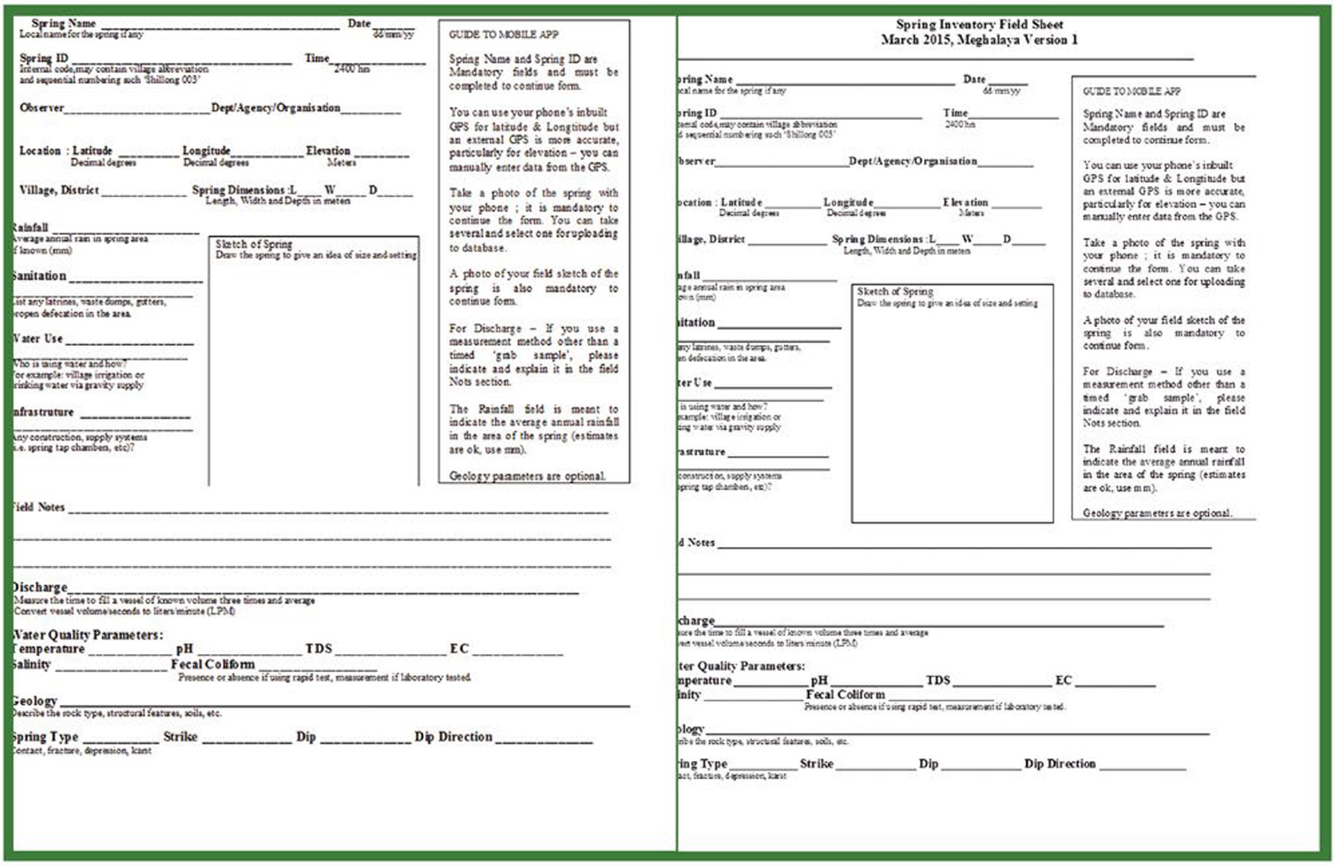
# Data Collection and Analysis

Detailed inventories of about 714 numbers of springs spread in all the 11 district of the State have been conducted. The sampling data sheet is appended with this paper for reference. The observation made after analyzing the data shows that many of the springs have dried up and in the case of the existing springs also the discharge has decreased over the years.

The main objective of this initiative is to ensure water security by mainstreaming scientific approaches to sustainable spring protection and management. The extensive springs mapping and survey is expected to provide a better knowledge and understanding of the basic charactereistics of these springs and their present condition. Action research will be done to explore whether the drying springs can be revived through a springshed development approach using geohydrological techniques.

It is proposed that every critical spring in the State will be mapped and the data collected will be used for analysis for rejuvenating the impaired springs.

Spring Inventory Field Sheet
March 2016, Meghalaya Version 1



Spring Name ________________________ Date ______
Local name for the spring if any — dd/mm/yy

Spring ID ________________________ Time ______
Internal code,may contain village abbrevation and sequential numbering such 'Shillong 003' — 2400 hrs

Observer ________________ Dept/Agency/Organisation ________

Location : Latitude ________ Longitude ________ Elevation ________
Decimal degrees — Decimal degrees — Meters

Village, District ________ Spring Dimensions :L____ W____ D____
Length, Width and Depth in meters

Rainfall ________
Average annual rain in spring area if known (mm)

Sanitation ________
List any latrines, waste dumps, gutters, or open defecation in the area.

Water Use ________
Who is using water and how? For example: village irrigation or drinking water via gravity supply

Infrastruture ________
Any construction, supply systems i.e. spring tap chambers, etc)?

Sketch of Spring
Draw the spring to give an idea of size and setting

GUIDE TO MOBILE APP

Spring Name and Spring ID are Mandatory fields and must be completed to continue form.

You can use your phone's inbuilt GPS for latitude & Longtitude but an external GPS is more accurate, particularly for elevation – you can manually enter data from the GPS.

Take a photo of the spring with your phone ; it is mandatory to continue the form. You can take several and select one for uploading to database.

A photo of your field sketch of the spring is also mandatory to continue form.

For Discharge – If you use a measurement method other than a timed 'grab sample', please indicate and explain it in the field Nots section.

The Rainfall field is meant to indicate the average annual rainfall in the area of the spring (estimates are ok, use mm).

Geology parameters are optional.

Field Notes ________________________

Discharge ________________________
Measure the time to fill a vessel of known volume three times and average
Convert vessel volume/seconds to liters/minute (LPM)

Water Quality Parameters:
Temperature ________ pH ________ TDS ________ EC ________
Salinity ________ Fecal Coliform ________
Presence or absence if using rapid test, measurement if laboratory tested.

Geology ________________________
Describe the rock type, structural features, soils, etc.

Spring Type ________ Strike ________ Dip ________ Dip Direction ________
Contact, fracture, depression, karst

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March 2015, Meghalaya Version 1

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# Conclusion

Significantly large population in Meghalaya is heavily dependent on spring water and groundwater for their household and irrigation use with an approximately 6861 number of villages dependent on these sources. That is why the Springs Initiative represents a great opportunity for contributing to water security efforts. The individual efforts of partners working in different districts demonstrate locally proven models for various typologies, and as a whole, the combined experiences of the partners provide a broad dataset and case for State level efforts including a participatory and scientific approach to springshed management.

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