Impact Report

The Impact Assessment and Cost and Benefit Analysis of the Roadside Spring Protection in The Himalayas (RoSPro)

Dhankuta Municipality

Chattar Jorpati Rural Municipality

Koshi, Nepal

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Executive Summary

The Roadside Spring Protection in the Himalayas (RoSPro) Project is an initiative aimed at addressing the challenges of declining water availability and road infrastructure degradation in Nepal's mountainous regions. The project integrates spring protection into road development, ensuring water availability, reducing road maintenance costs, and enhancing community resilience. Each spring site has a unique design tailored to its specific location. The interventions entailed recharge measures in the springshed area, collection chambers at intake, road drainage conveyance structures, reservoir tanks for storage connected to a distribution system, and an overflow collection for agricultural purposes, and bioengineering on the slopes to protect it from erosion and landslides.

This study presents the post-intervention impact assessment and cost-benefit analysis (CBA), which evaluate the effectiveness of these interventions in Dhankuta Municipality (DM) and Chhathar Jorpati Rural Municipality (CJRM) in the Koshi region, Nepal. To collect both qualitative and quantitative data on various socio-economic aspects, spring water demand and usage, and road infrastructure, this study combined Focused Group Discussions (FGD) and Household Surveys (HHS) at each of the selected four spring sites; Chanchala Devi Spring (spring site 1), Bojhe Spring (spring site 2); both in DM, and Dojhe Dhara Pani Spring (spring site 3) and Keshari Kharka Spring (spring site 4) both in CJRM. The HHS was conducted involving a total user population from all spring sites, i.e., 47 respondents. Alongside, one FGD in each spring site was conducted with the participation of 6-10 members from the spring user group of the community. This study also employed the incremental cost-benefit analysis with applying Net Present Value (NPV) and Internal Rate of Return (IRR) as the feasibility indicator within the scope of 20 years' time horizon and assumed discount rate of 9% as deployed by the World Bank.

The result of this study showed that water availability saw dramatic improvements, with most the households' water demand fulfilment surging from 53–65% pre-intervention, to 92–97% post-intervention. Communities now benefit from extended service hours, with some water sources providing access for up to 18 hours daily. Additionally, 87% of respondents reported noticeable enhancements in water quality, reflecting infrastructural upgrades. Furthermore, residents indicate that the road Infrastructure interventions significantly reduced road erosion and improved transport functions, ensuring reliable connectivity even during adverse weather. This improvement enhanced mobility for residents, particularly in accessing markets, healthcare, and education—critical factors for community resilience and economic activity.

Also, beyond water and roads impact was noticeable, farmers experienced a 43% increase in agricultural production, driven by improved water availability. Firstly, prolonged and increased water availability into the dry season allows farmers to successfully grow a post-monsoon crop on land that was otherwise left fallow. Secondly, reduced irrigation time allowed farmers to allocate resources more efficiently, leading to expanded crop yields and diversified livelihoods. The Socio-Economic impact was equally profound: 36% of households reported income increases of up to 25%, attributed to higher agricultural productivity and time savings. By reducing daily water-fetching time by up to 78 minutes, individuals—particularly women—gained opportunities to engage in income-generating activities, education, and community initiatives, fostering broader economic and social empowerment.

The interventions proved financially robust, with all projects showing positive Net Present Values (NPV), confirming their economic feasibility. The Internal Rate of Return (IRR) ranged from 44% to

122%, surpassing typical discount rates and underscoring strong financial returns. A Benefit-Cost Ratio (BCR) of 4-8 further validated that the long-term benefits—such as increased agricultural output, reduced water-fetching burdens, and lower infrastructure maintenance costs—far outweighed initial investments.

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1. Introduction

The Nepalese Himalayas' mid- and high-altitude regions are among the most vulnerable areas in the world in terms of water sources (Shrestha et al., 2016). The natural springs indicate the groundwater reserves within the catchments, constituting a crucial element of the Himalayan water budget. (Andermann et al., 2012). Springs frequently serve as the sole accessible water source, supplying drinking, residential, and agricultural needs for individuals living in hilly, mountainous, peri-urban, and urban areas in the Himalayan region of Nepal, therefore, a lifeline for the people in the mountains. The viability of the springs defines liveability in the middle and high mountain regions of Nepal and neighbouring countries.

However, the Himalayan areas face significant concerns as the spring flow rate in the Himalayan region has dwindled and become erratic. A study in Nepal indicates a reduction in flow in 73% of springs and the desiccation of 12% of springs over the past decade (Poudel & Duex, 2017). Moreover, the report from ICIMOD (2022) estimated that more than 30% of these springs have dried up over the past 15 years. The mountain aquifers–the underground body of rock and/or sediment that holds groundwater– in the Himalayas are highly vulnerable to natural factors like rising temperatures, intense rainfall, seismic activity, and human-induced changes such as land degradation and road construction (The Water Channel, 2022). In Nepal, spring users reported that perennial springs are becoming seasonal, and seasonal springs are drying up as a result of erratic high-intensity and short-duration rainfall (The Water Channel, 2022).

In 2020, many springs are drying up in 74 per cent of the 300 municipalities and rural municipalities across the country (ICIMOD, 2022) and in Eastern Nepal, especially in the Nibuwa-Tankhuwa watershed, the depletion of spring sources become a critical concerns (Gupta, 2021). Furthermore, it shows that the rapid expansion of road networks is a major factor in the demise of natural springs in mountain areas, followed by earthquakes, climate changes, deforestation, and changes in land cover and rainfall patterns (ICIMOD, 2022). While the full impact is poorly understood, road construction visibly affects the Himalayan ecology by exposing or distorting the springs' outflow. This happens either by removing unconsolidated material or damaging the rock formations during road construction. If newly opened springs are not correctly managed, they can drain aquifers, worsening water shortages. Furthermore, spring water that seeps onto the road is causing damage and undermining the road. For instance, it can damage the road surface directly by destabilising or creating depressions on the road (The Water Channel, 2022).

Infrastructure development in mountainous regions demands a systemic balance with preserving natural water sources like springs. When a spring is exposed due to road construction, a careful measure must be taken to protect both the spring and the road as well as its surroundings. This leads to the need for integrated interventions to secure spring water availability while improving the adjacent road stretches.

The Roadside Spring Protection in the Himalayas (RoSPro) project aims to protect and develop spring water sources in Nepal's hilly and mountainous areas while improving the durability of local roads. Operating in regions where springs are vital lifelines for communities, the project addresses the dual challenges of water scarcity and infrastructure degradation. These communities rely heavily on spring water for drinking, household needs, and agriculture, yet rapid road infrastructure development and climate change have severely reduced spring discharge, exacerbating water shortages—especially during dry seasons.

The pilot intervention of RoSPro, launched in May 2024, has been implemented in four selected areas in the Dhankuta district, one of the vulnerable areas in the Eastern part of Himalayan Nepal. The selection process took place during a workshop in Dhankuta municipality, part of Dhankuta district, where a total of 34 participants representing Dhankuta Municipality, Chhathar Jorpati Rural Municipality, Dhankuta district, and various government offices at the central and provincial levels, including the Department of Local Infrastructure (DoLI), Local Infrastructure Development Programme office (LIDPO) in Itahari, Koshi Basin office, Soil and Water Conservation office in Dhankuta, and the World Wildlife Fund (WWF), actively participated in the decision-making. The selection criteria were determined and included high dependency on the source of water, decreasing discharge in spring source, impacted by road or impacting the road, the willingness of the people to engage, location accessibility and others. RoSPro's infrastructure interventions—including spring boxes, road drainage systems, groundwater recharge systems, and roadside bioengineering—have been constructed to capture and drain water sustainably.

Following the RoSPro activity blocks is monitoring the impact of the interventions and assessing the cost-benefit. Crucial to the understanding of the interventions is to monitor the intervention sites, therefore we conducted a baseline survey and a post-intervention survey to assess its impact. This impact report presents the results of the post-intervention study, including a cost-benefit analysis.

2. Methodology

The key objectives of this post-intervention study are:

- to create a better understanding of the impact of the implemented interventions
- to calculate and analyse the costs and benefits of incorporating spring protection into road development practice implemented at 4 project sites within the RoSPro project.

This research employs secondary data collected from a wide range of accessible databases and repositories, capturing information from scientific publications, institutional reports, etc., to define the type of documents or sources. A Google search engine was employed in this research to obtain related research papers, reports, and proceedings. The keywords were used including Cost-Benefit Analysis, Non-Market Price of Water Security Protection, and Environmental Valuation.

2.1. Data Collection Methods

Focus Group Discussion

Focused Group Discussions (FGDs) combined with participatory mapping were conducted in 4 RoSPro Pilot sites to gather qualitative data from the spring users. During these discussions, a group of 6-10 community members, all relying on one of the four selected springs, was assembled to share their knowledge, attitudes, local practices, perspectives, and perceptions on various topics, including water resources, road systems, climate change, local resources, and biodiversity in the area.

To ensure a diverse and representative discussion, the selection of participants was carefully structured to include individuals with varied experiences and perspectives. Gender balance was prioritized, with both male and female community members actively participating to capture a more holistic understanding of water resource usage and management. Additionally, only those who currently rely on the spring water were included, ensuring that the discussions reflected the lived experiences and concerns of the direct beneficiaries of the resource. Furthermore, participants from different age groups were involved, allowing for a broader historical perspective on the area's water sources, biodiversity, and infrastructure.

Household Survey (HHS)

The primary objective of the household survey (HHS) was to gather relevant data on the community's use of the spring as a water source, focusing on aspects such as accessibility, reliability, supply quantity, and its connection to road networks. Additionally, the survey examined the impact of spring water on roads and vice versa, as well as factors related to land use, climate, socio-cultural influences, and governance. Given the relatively small number of spring-dependent households (6-18) per site, the entire user population at each spring location was included in the survey.

A carefully structured questionnaire was developed with reflected the result of the FGD and KII. Later, it digitized using the KOBO Toolbox, an open-source platform designed for survey data collection. To conduct the survey within each community, three enumerators were engaged. One enumerator was a member of the RoSPro project team residing in Dhankuta, while the other two were from the local communities themselves. All enumerators were fluent in Nepali and well-versed in local customs and traditions. Prior to the survey, they participated in a full-day training session covering the project's background and objectives. They also conducted a pre-test of the questionnaire to refine the survey process. After the first day of household surveys, an evaluation and feedback session was held to identify and address any remaining issues or concerns.

Key Informant Interview

Key Informant Interviews (KIIs) were employed in this study to gain in-depth insights from individuals who possess extensive knowledge about a particular community or issue. These informants, often community leaders, professionals, or long-term residents, provide valuable perspectives that might not be accessible through other data collection methods. KIIs are particularly useful for understanding complex social dynamics, motivations, and beliefs, as they allow for detailed and probing discussions in a one-on-one setting. They are also an effective approach for gathering information on sensitive topics, as informants may feel more comfortable expressing their views in a private conversation rather than in a group setting.

2.2. Data Analysis

Mixed Method Impact Assessment

The study evaluated the effects of interventions on water availability, road durability, environmental conditions, and socioeconomic factors, utilising a mixed-methods approach aligned with Michael Bamberger's framework (2012). This methodology was selected to integrate qualitative and quantitative data and to address the complex interactions inherent in spring-based water projects and site-specific socio-economic and governance challenges. Furthermore, this approach aligned with the baseline report for RoSPro, which used a similar methodology and allowed for a coherent comparison between the initial findings and the post-intervention results. The quantitative data would provide standardised indicators and allow for statistical comparisons, while qualitative insights helped explain the contextual factors and perceptions underlying those numbers. This dual perspective is crucial for understanding how changes in water availability, road maintenance, and community practices affect different stakeholder groups. Three data collection methods supported the mixed methods: Household Survey, Focus Group Discussion and Key Informant interviews.

Once the survey was conducted, the quantitative findings were compared with the more in-depth views surfaced through FGDs and KIIs. Where there were discrepancies, such as when the interviewed households and focus group participants gave differing definitions of household demand fulfilment, the qualitative descriptions concerned were re-examined to establish context-specific definitions. This enabled the incorporation of such variables into the overall dataset for statistical examination. Through the integration and cross-validation of the findings in this manner, a more comprehensive and stable understanding was attained regarding how the interventions impacted the local communities along with infrastructure.

Incremental Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) is systematic method used to evaluate the feasibility of a project by comparing its costs and benefits in monetary terms and ensuring ensure that investments are both financially and socially (Ackerman & Heinzerling, 2002). This study employed the Incremental Cost-Benefit Analysis (ICBA), a refined approach to CBA that focuses on evaluating the marginal costs and benefits between different project alternatives rather than assessing the total costs and benefits of a single project.

ICBA was chosen for this study because the analysis focused on the marginal impact of investing in and assessing whether the specific alternative provides a greater return or not. Furthermore. ICBA identifies which approach is not only effective in the short term but also viable for large-scale implementation. This approach suited for the condition of RoSPro since the pilot interventions would be the cornerstone for the upscale model for future intervention.

The indicators of ICBA are as follows

Net Present Value (NPV)

Net Present Value (NPV) is an ICBA indicator that measures a project's profitability. This indicator reflects the difference between the present value of all future cash inflows (benefits) and the present value of all future cash outflows (costs). A positive NPV indicates that the project is expected to generate more value than it costs, making it a worthwhile investment. The equation of NPV is as follows.

$NP\ V = \sum Bt(1 + i)\text{-}t - \sum Ct(1 + i)\text{-}t$

where Bt are the total benefit, Ct the total costs, i the interest rate and t the time period in years.

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is an ICBA indicator to estimate the profitability of potential investments and it is often preferred to NPV. It represents the effective rate of return that the project is expected to yield. A higher IRR indicates a more profitable project. If the IRR is higher than the required rate of return or cost of capital, the project is considered financially feasible.

$$0 = NP\ V = \sum_{t=1}^{T} \left(\frac{\mathrm{Ct}}{(1 \times IRR)^t}\right) - C_0$$

where C_t is the net cash flow during period t, C_0 is the total initial investment cost, IRR is the internal rate of return and t is the time periods, in this case 10 years.

Time Horizon and Discount Rate

Time horizon in ICBA refers to the total duration over which the costs and benefits of a project are evaluated. It represents the expected operational lifespan of a project or intervention. This study applied the time horizon of 20 year for a development project in Nepal (ADB, 2018).

The discount rate is the set of interest rates that applies to an economical cost benefit analysis which decided by the government of the country hosting the project. This research utilized the discount rate for a development project in Nepal at the level of 9% following the Asian Development Bank standard (ADB, 2018).

2.3. Study Area

Dhankuta District is located in the Koshi Province in eastern Nepal. As per the population census 2078 B.S. (2021 A.D), the district's population is 150,599 with an annual population change of -0.78% (2011-2021 A.D.) and covers an approximate area of 891 square kilometres. Geographically, it is situated between 26°53' to 27°19' north latitude and 87°8' to 88°33' east longitude and is located at 243 to 629 meters of elevation above sea level. The location of Dhankuta District on the map can be seen in Figure 1. Nibuwa-Tankhuwa Watershed (NTW), which is rich in natural resources and supports over 80 species of flora and fauna, falls in Dhankuta District. It also provides essential ecosystem services which shape the well-being of the people living in the watershed and downstream, including water for drinking and irrigation, fuelwood and other ecosystem services and contributes to local development (Gupta, 2021).

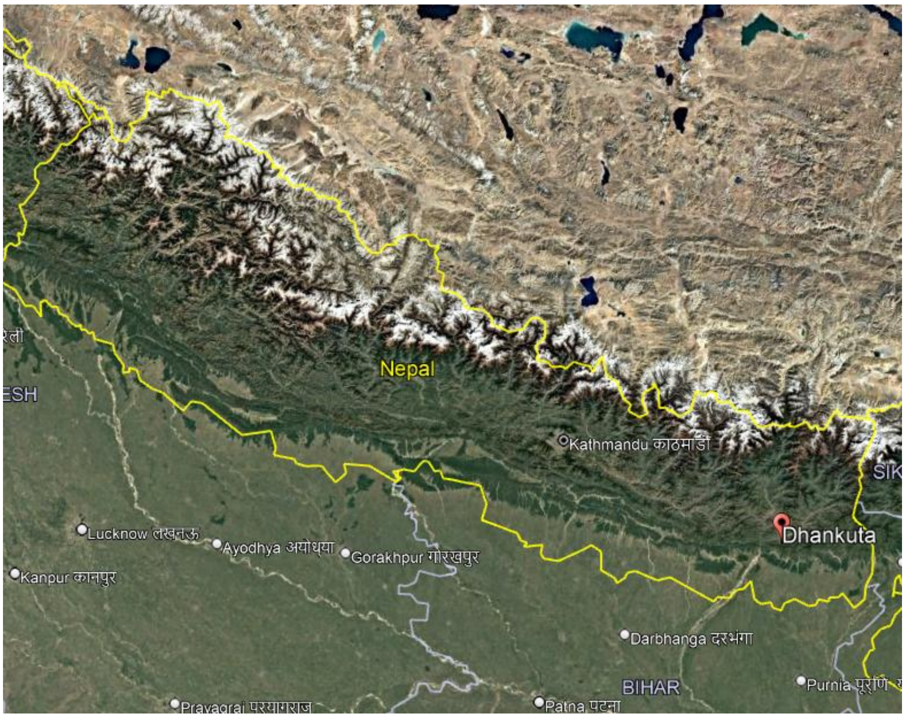

Figure 1 Dhankuta District in Nepal Map (Google Earth, n.d.)

Dhankuta District is highly dependent on natural springs and streams for various purposes, such as drinking, domestic usage, livestock and agriculture. However, the residents of Dhankuta district are currently facing a significant challenge in managing water due to the continuous drying condition of the natural springs because of both natural and human-induced factors. The data collection for this impact assessment and cost-benefit analysis was carried out in December 2024 in Dhankuta Municipality (DM) and Chhathar Jorpati Rural Municipality (CJRM), both parts of Dhankuta District. The location of DM and CJRM on the map can be seen in Figure 2. The study concentrated on four specifically chosen spring sites, with two located in ward number 1 of DM and the other two situated in ward number 2 of CJRM. The spring sites within DM include Chanchala Devi Spring (referred to as spring site 1) and Bojhe Spring (spring site 2). Meanwhile, the spring sites in CJRM are identified as Keshari Kharka Spring (spring site 3) and Dhoje Dhara Pani (spring site 4). For a visual representation, these four spring locations are illustrated in Figure 3.

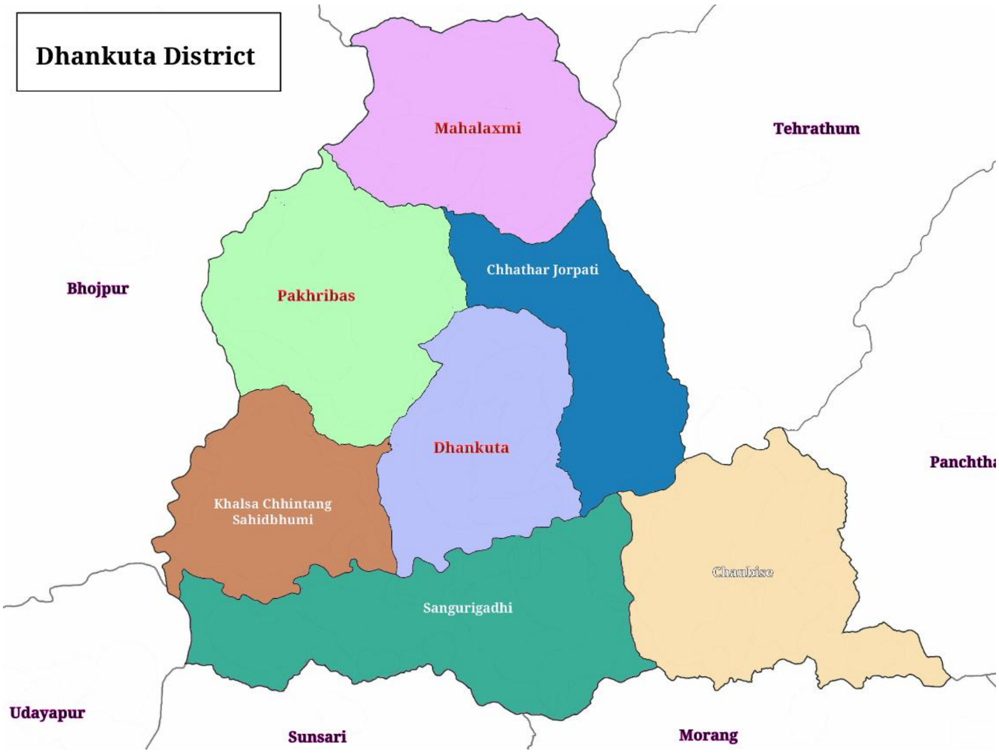

Figure 2 Dhankuta Municipality and Chhathar Jorpati on Dhankuta District Map (LGCDP Nepal, 2014)

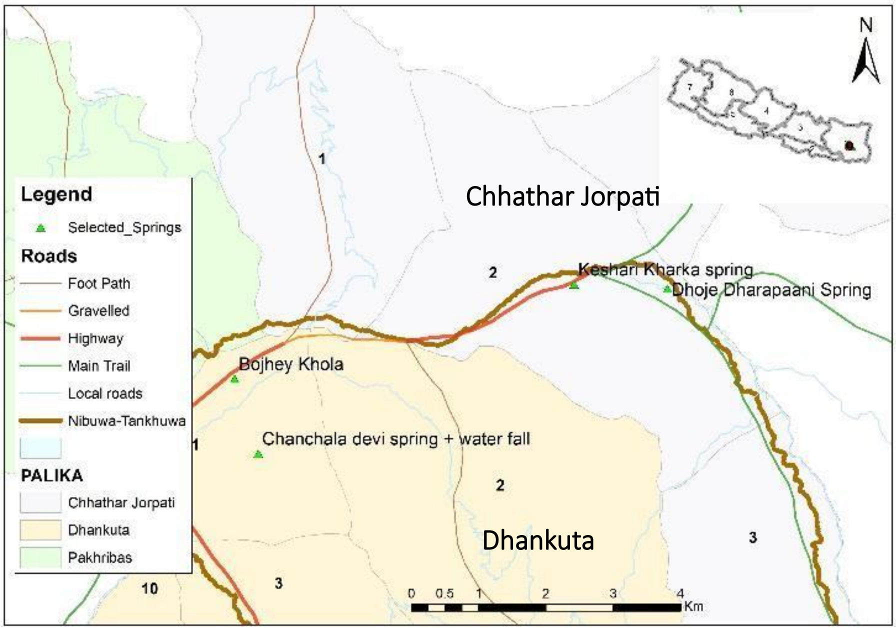

Figure 3 Location of the four spring locations in DM and CJRM map (RoSPro data, 2024).

A baseline study was conducted in October–November 2023 to establish key reference points on household water access, road infrastructure condition and functionality, agriculture and land-use, and socio-economic aspects. Following the implementation of the interventions, a comprehensive data collection process was carried out in December 2024 – January 2025 to assess changes and measure the impact across multiple dimensions. The following chapters discuss the intervention's impact and provide a transition to the different impact areas. The findings in this section are derived from multiple data collection methods, including Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and Household Surveys (HHS). The data were analysed using a combination of Excel-based quantitative analysis and qualitative interpretation. To provide a structured and logical flow, each chapter present findings on different thematic areas. The upcoming chapters will cover the following:

1. Demographics and Socio-Economic Context
2. Spring Source and Water Usage
3. Additional Water Sources
4. Impact on Agriculture
5. Impact on Road Usage and Road Adjacent Environment
6. Impact on Socio-Economic and Livelihood
7. Incremental Cost Benefit Analysis

3. Demographic and Socio-Economy Context

The household survey was conducted among user communities with diverse gender, age, ethnicity, education level, and sources of income. The respondents are 77% female, and 23% male. The higher proportion of female respondents is attributed to the fact that women are more actively engaged in household water collection and management, making them more available and willing to participate in the survey. Furthermore, most respondents fall within the elderly age group (51-70 years), making up 43% of the surveyed population. This is followed by the middle-aged group (30-50 years) at 36%, while the young age group (15-30 years) represents 21%.

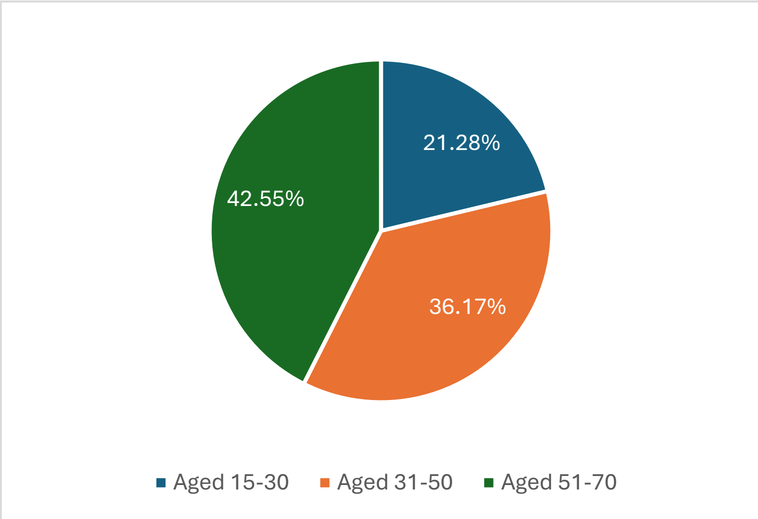

Figure 4: Age Distribution of User Communities

As compared to the baseline data there is a slight increase in representation of the 51–70-year-old age-group, with reduced representation of the middle-age group. There are two plausible explanations which we expect both contribute a share. A first reason can be that middle-aged individuals were not around due to being involved in paid work. And secondly, we visited a household which normally consists of multiple people and it's normal that you can find different household members at home at different times.

The ethnicity of the respondent is diverse, as shown in Figure 5. The Magar ethnic group is the largest among respondents followed by Chhetri, Sherpa, and Limbu ethnic groups, respectively. Meanwhile, the Brahmin, Dalit, Tamang, and Gurung groups are less represented.

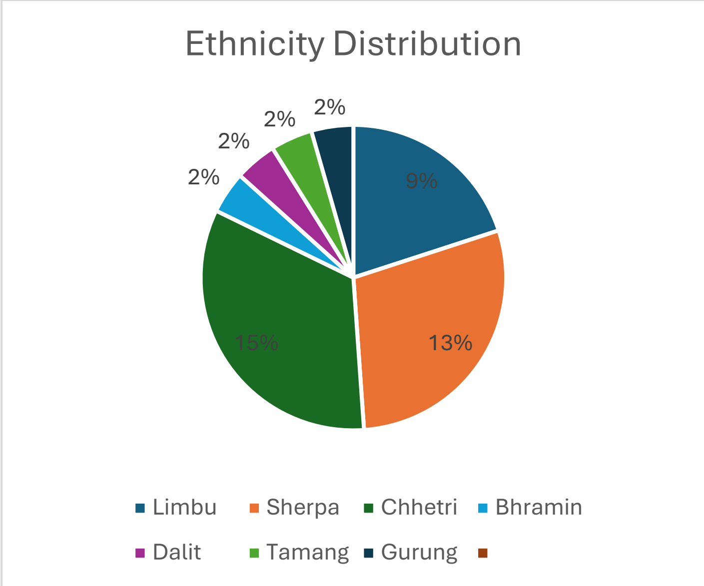

Figure 5: Ethnicity of User Communities.

The level of education among the respondents ranges from non-literate to graduate, as shown in Figure 6. Majority of the surveyed respondent, with 38% are classified as 'just literate', followed by 21% of user communities who are categorised as 'non-literate'. In addition, the middle education level groups make up a significant portion, with 15% having completed primary school, 9% lower secondary, and 9% secondary education. On the other hand, only very few of respondents have attained higher education, with 6% completed higher secondary school and only 2% reached graduate level and above.

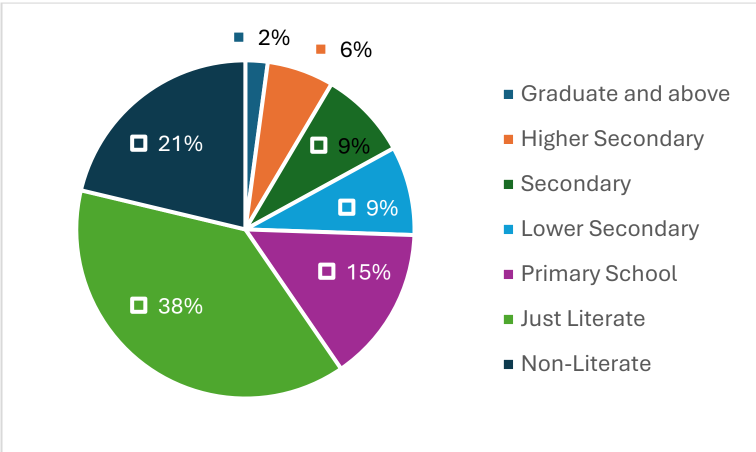

Figure 6: Level of Education of User Communities

The major sources of income among respondent vary from crop cultivation, livestock, business, remittance, government services, and labour, as shown in Figure 7. The majority of respondents rely on crop cultivation as their primary income source (62%), followed by livestock (21%). The remaining user communities depend on business (9%), remittance (4%), government services (2%), and labour (2%).

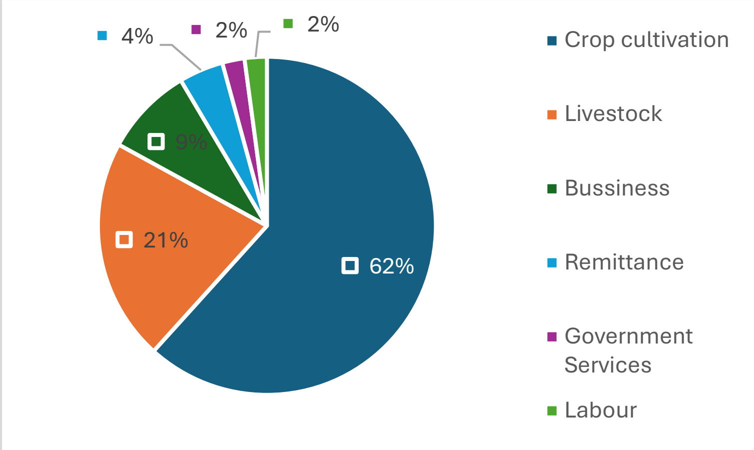

Figure 7: Major Source of Income among User Communities

During the baseline survey, 55 households (HHs) were surveyed. These included actual users, potential future users, and households that previously relied on the project's spring but had already switched to an alternative nearby spring by the time of the baseline survey. In contrast, the impact survey only includes actual users whose households are directly connected to the pipeline. The Table 1 below provides details on the number of households that have increased at each spring site.

Table 1: Change in number of households

Spring Source	Spring code	Baseline survey			Impact survey	
		Actual Users (HH)	Past Users (HH)	Future possible users (HH)	Total HH surveyed	No. of HH increased in each site.
Chanchala Devi	SPRO 1	8	3	1	6	1
Bojhe	SPRO2	11	3	-	13	2
Keshari Kharkha	SPRO3	10	-	2	10	-
Dhoje Dhara Pani	SPRO4	16	-	-	18	2

The changes and decreases in household (HH) numbers across different sites attributed to several factors. At Chanchala Devi Spring site, 12 households were surveyed during the baseline study. Among these, three households were already sourcing water from another nearby spring and did not rely on Chanchala Spring due to insufficient water supply that failed to reach their homes. Even after the intervention, some households chose not to participate in the labour construction or refused to pay the mandatory 10% community contribution for the project. Consequently, the number of user households at this site declined significantly. Despite this reduction, the User Committee (UC) has indicated plans to extend pipeline connections to financially disadvantaged households and those in need, aiming to increase access to water in the future to more people.

Similarly, at Bojhe, three households had already transitioned to another spring before the baseline survey, reducing the initial user count. However, following the intervention, two additional households joined the user group. In Keshari Kharkha, two households were identified as potential future users during the baseline survey. One of these households was still in the process of constructing their home during both surveys and had not yet begun using water from the spring. Another household, associated with the CJRM office quarter, now receives water through a metered tap system. As a result, the impact survey recorded a decrease of two households compared to the baseline survey.

4. Spring source and water usage

Before moving to the post-intervention specific results, we will take a moment to explain the interventions at each spring site, as each site has a unique design tailored to its specific location.

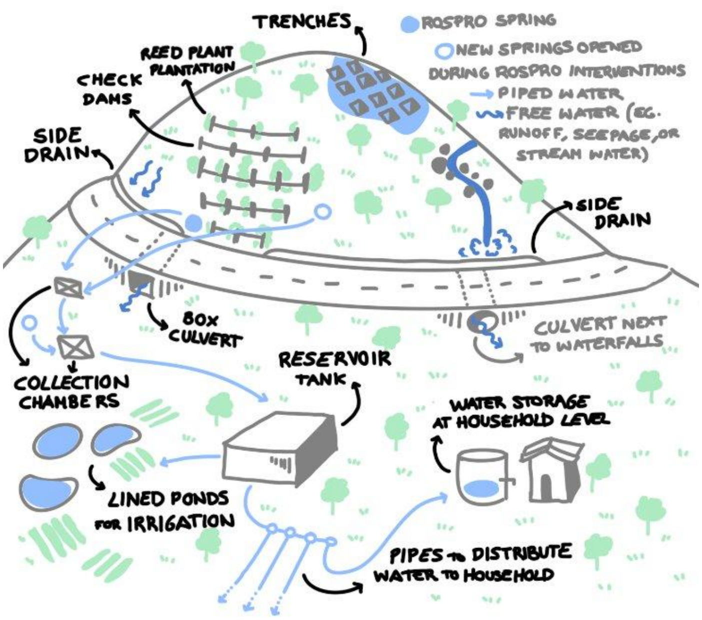

Figure 8: Intervention in Chanchala devi spring site.

At the Chanchala Devi Spring Site (SPRO1), water from one newly opened spring and two existing springs is collected in a small intake located below the roadside near a box culvert. From there, the water flows into a collection chamber before transported to a reservoir tank via a pipe system. The water is then distributed to individual households through a network of pipelines. To prevent road runoff from contaminating the spring source, a well-structured drainage system has been implemented. Road water is efficiently managed and directed away using a combination of U-shaped, V-shaped, and earthen drains, which channel the water into the box culvert and eventually into nearby rivers. Additionally, measures have been taken to protect the spring source from erosion and landslides. Series of check dams, and plantation activities have been carried out above the spring source to enhance slope stability, prevent soil degradation and to protect spring water source from debris. Furthermore, three irrigation ponds have been constructed to collect overflow water from the reservoir tank, which farmers use for irrigation purposes.

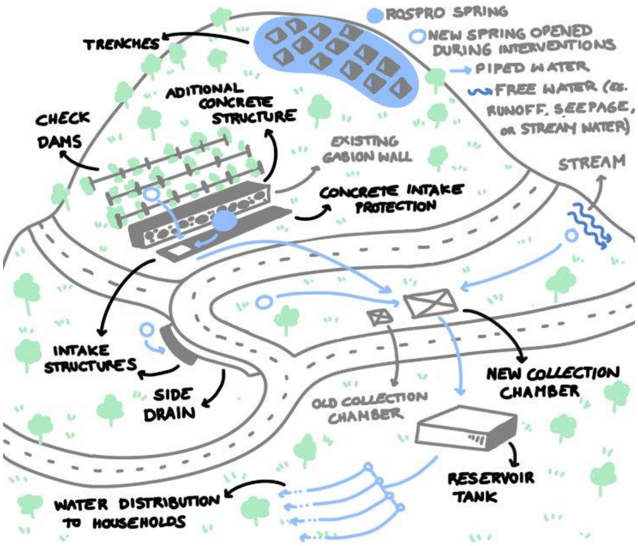

Figure 9: Interventions in Bojhe spring site.

Figure 9 illustrates the layout of the Bojhe Spring Site (SPRO2). Here, water from both the existing spring and newly opened springs is collected at the intake, then directed to a collection chamber before being stored in a reservoir tank. From the reservoir, the water is distributed to households through a network of pipelines. Additionally, check dams and plantation activities have been carried out above the spring area to enhance soil stability, prevent erosion, and protect the water source.

At the Keshari Kharkha Spring Site (SPRO3) water from the spring is collected through an intake system and directed to a reservoir tank via a pipeline. From the reservoir, the water is then distributed to households through a network of pipes. To maximize water utilization, overflow water from the reservoir tank, along with rainwater collected from the CJRM office roof, is directed into a brick pond. Farmers then use this stored water by transferring it to a constructed plastic pond for irrigation purposes, ensuring efficient water management and agricultural support.

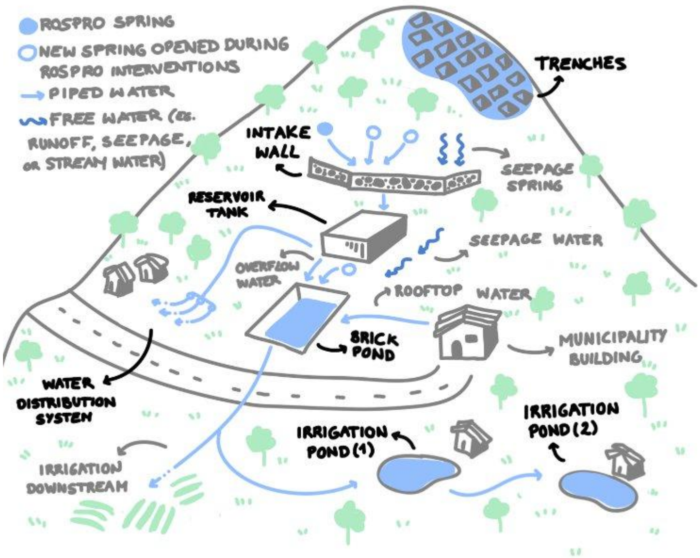

Figure 10: Interventions in Keshari Kharkha Spring Site.

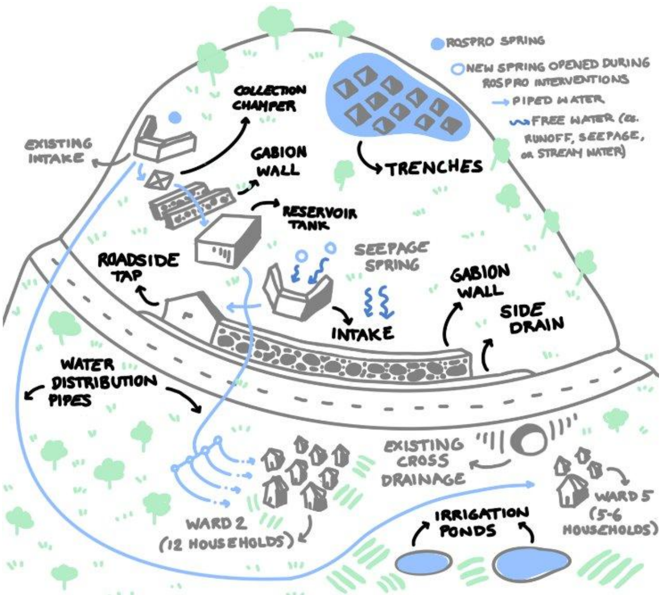

Figure 11: Interventions in Dhoje Dhara Pani Spring Site.

Lastly, in the Dhoje Dharapani Spring Site (SPRO4) –, water from the spring is collected through an intake structure and directed into a collection chamber. From there, it is stored in a reservoir tank, which then distributes water to households through a network of pipes. To enhance water utilization, the overflow water from the reservoir tank is channeled into the irrigation pond for irrigation. Additionally, seepage water from the intake structure is directed to a roadside tap, providing water for travellers, pedestrians, and farmers for washing vegetables and other uses.

Erosion control measures have also been implemented to protect the site. A layer of gabion structure has been implemented to prevent soil from sliding onto the road and to guide seepage water into the drainage system, keeping it away from accumulating on the road surface. Furthermore, to stabilize the soil near the collection chamber, three layers of gabion boxes have been installed, ensuring long-term structural integrity and minimizing erosion risks.

4.1 The Impact on Spring Water collection and Management at home

In most households, women are primarily responsible for fetching water. When they are unavailable, men and children assist with this task. Women also manage water used for agriculture, including both watering of crops and livestock. Before the intervention, residents typically had to go to the spring source and manually connect their household pipes to access water. The spring source was open, requiring individuals to wait their turn to fulfil their daily water needs. This process was not only time-consuming and tedious, but also unreliable, with inconsistent access to water.

For some households in the Chanchala Devi Spring site, fetching water required a 30-minute trip to the river, making water collection labour-intensive and time-consuming. Before the roadside spring protection interventions, on average, each households spent 60 to 90 minutes daily managing their water needs, that includes agricultural water management. Similarly, in Keshari Kharkha Spring, Dhoje Dhara Pani spring, and some households in the Chanchala Devi Spring site, each HH had to connect their HH pipes directly to the source. This method was inefficient and required daily trips to the spring site to manage water connections. On average, community members spent 30 to 60 minutes each day fetching water, purely for domestic use (drinking, cooking, washing), which was both physically demanding and time-consuming. For households in the Bojhe spring site, especially during the monsoon season, sediments and road runoff from upstream often clogged the pipes, further disrupting the water supply and requiring extra time for households to manage their daily water needs.

I) Reservoir tank II) Tap Stand

III) Pipe distribution with gate valves

Figure 12: Water Collection and Distribution in Chanchala Devi Spring Site.

Following the interventions, the user communities have implemented new water collection methods in their daily life. These new methods include the utilisation of a water tap in their own household, shared water tap, pipe connection from the collection/reservoir tank, and pipe connection from the spring source, as shown in Figure 12. Now, most respondents (60%) are collecting the water from the tap in their own household, followed by the usage of shared/communal tap and pipe connection from the collection/reservoir tank, with 23% and 17%, respectively. Compared to the baseline, where majority of the respondent (71%) were collecting water from the spring source, this result shows a significant improvement, where people shift from using a pipe connection from the spring source to having their own water tap. Now after the intervention, the time and effort, previously spent on fetching water, has been eliminated allowing community members to focus on other activities such as farming, household work, and resting. Participants during FGD shared that having water readily available at home has brought immense convenience and improved their quality of life.

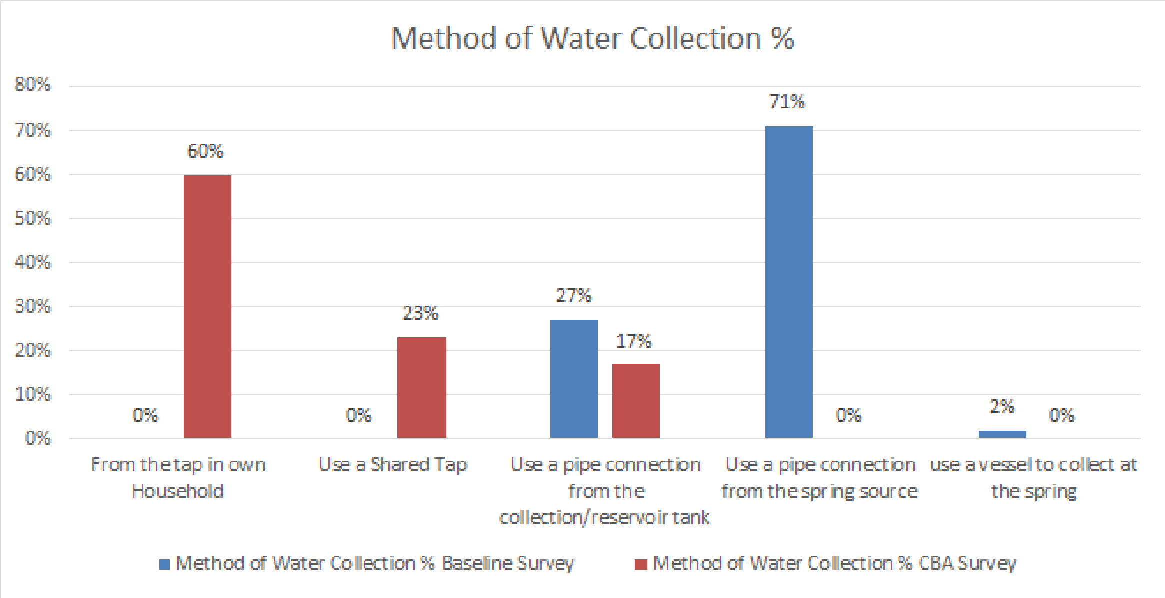

Figure 13: Change in the method of water collection

Respondents reported a significant improvement in water security following the intervention. They noted that their drinking, domestic, and agriculture water needs are now being adequately met, with a noticeable increase in water availability compared to the previous year. In terms of perception on the water security, 58% of respondents indicated that all their water needs are fulfilled, while 36% reported that only their drinking, domestic, and livestock water needs are met. A smaller portion, 6%, consists of those who do not engage in agriculture and rely solely on spring water for drinking and household purposes. Now after the project intervention, the surveyed respondents have a proper access to safe and clean water from the spring source. During the FGD Community members shared that the intervention has greatly improved their access to clean drinking water while significantly reducing the time and effort required for water collection. However, some respondents mentioned that while the intervention has improved access, they still rely on other water sources to meet their additional agricultural water demands, particularly for irrigation of crops.

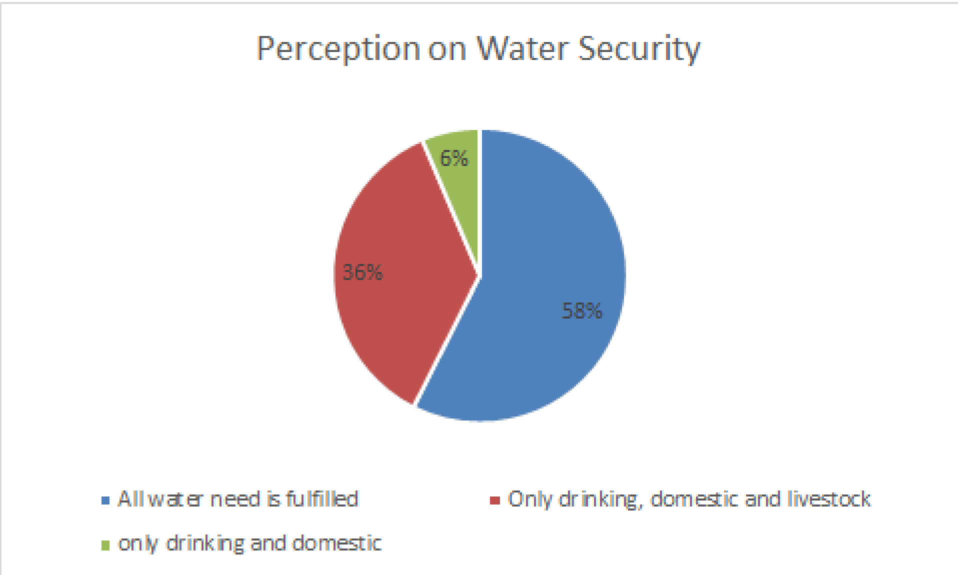

Figure 14: Perception on water security

In all 3 spring sites, except in Bojhe the farmers are now collecting the overflow water from the reservoir tank, water during rainfall and nearby rivers into the irrigation ponds for irrigation purposes. The farmers from Bojhe spring site and some of the HHs from all 3-spring site use pipe connection from their HH tap, seasonal river and spring water for irrigation purpose. The Table 2 below represent the number of irrigation ponds constructed in each spring site:

Table 2: Number of Irrigation Ponds, its source of water and HH dependent on pond water per spring site.

Spring site	Number of irrigation ponds	Source of water	Number of HH dependent on 1 pond
Chanchala Devi Spring	3	- Overflow water from reservoir tank - Rainwater - Water from nearby seasonal river, Chanchala devi waterfall.	2-3 HHs
Bojhe Spring	-		
Keshari Kharkha Spring	2	- Overflow water from reservoir tank - Rainwater harvesting from CJRM office roof into the brick pond.	1-2 HHs
Dhoje Dhara Pani Spring	3	- Overflow water from reservoir tank - Rainwater	3-4 HHs

I) Reservoir tank

II) Brick Pond

III) Plastic-lined Irrigation Pond

Figure 15: Water supply system for irrigation in Keshari Khakhra site.

In Keshari Kharkha Spring site, there is a brick pond near the spring. This pond (which also functions as recharge ponds) receives the overflow water from the reservoir tank and rainwater harvested from roofs of CJRM building through pipe connections. Farmers now take the water from the brick pond into the plastic-lined pond near their field through pipe connections for irrigation and livestock purposes. Also, the water from the brick pond is used in development activities such as construction of buildings, roads, etc. in the community.

4.2 Changes in water quantity

During the FGDs participants shared that there has been a noticeable increase in the amount of water available compared to one year ago, with the community estimating a 20–25% increase in spring water. Previously, the spring water was not properly tapped, and significant leakage in the collection chamber or pipes resulted in a substantial loss of water. These issues, combined with an inadequate system for collecting seepage water, limited the amount of water available for use in all spring sites.

Now, after the intervention, during the impact survey all the surveyed respondents (i.e. 100%) reported that the volume of water in the spring source has increased. The Table 3 below shows the perspective of the respondents of each spring site on % of volume increased in the spring source.

Table 3: Percentage increase in spring water volume after intervention.

Spring sites	% Increase in Spring water
Chanchala Devi Spring	20-25 %
Bojhe Spring	20-30 %
Keshari Kharkha Spring	20-30 %
Dhoje Dhara Pani Spring	20-40 %

The respondents reported that the major factors for this increase include:

- Opening of the new spring sources during the implementation process.
- Construction of recharge measures like ponds, trenches and toe trenches by identifying the spring recharge area through hydrogeological mapping. This has likely enhanced water retention and replenishment in the surrounding ecosystem.
- Spring source protection and management and the planting of water-conserving species around the spring area, which have helped enhance groundwater retention.
- The systematic improvements in spring water management and distribution, such as collecting spring water through intake systems, storing it in a collection chamber and reservoir tank, and distributing it evenly to households via a pipe network, have ensured better utilization of the available water.
- The higher rainfall this year (2081 BS) compared to the previous year likely contributed to the increased water flow from the spring. The rainfall and spring discharge data from all pilot sites till date from Falgun 2080 (Feb/Mar 2023) to Baisakh 2081 (Apr/May 2024) are presented in annex.

During the Focus Group Discussion (FGD), participants reported a noticeable increase in water volume compared to the situation before the intervention.

At the Chanchala Devi Spring site, prior to the intervention, community members collected water from a single spring source, which had been relocated near the road during road construction. During the intervention, this source was further shifted closer to the box culvert. After several consultations with the engineer and UC members, the UC members carefully protected and managed the newly exposed spring source. Without disturbing the natural flow, they constructed a small intake-like structure and connected it to the collection chamber. Following a period of heavy rainfall, water began flowing again from the two previously dried-up sources, and an entirely new source also emerged. By collecting all these sources to the collection chamber, the community is now receiving a significantly greater volume of water.

Similarly, at the Bojhe Spring site, community members had previously relied on seeps from upper spring sources. During the intervention, a new source emerged near the roadside drain and was connected to the collection chamber. Additionally, heavy rainfall allowed the UC members to collect seepage water from three other sources, which were also integrated into the system. As a result, the community now has access to more water than it did the previous year.

At the Keshari Kharkha Spring site, the original spring had a low flow. During the construction of intake, the source was shifted. Later, with tremendous effort through consultation with experts and UC members, we succeeded in bringing spring back. During the FGD, community members from both Keshari and Dhoje sites reported an increase in spring water volume compared to the previous year. They attributed this improvement to the construction of recharge measures like trenches and ponds, which likely enhanced groundwater recharge during the year’s heavy rainfall. Proper collection and systematic management of the spring sources have also contributed to improved water availability.

To verify the reported increase in spring discharge, two Community Resource Persons (CRPs) were appointed to measure discharge of the spring twice a month. Figure 16 shows a comparison of spring discharge for the months of Falgun (Feb/Mar) and Chaitra (Mar/Apr) in the years 2080 and 2081 BS (2023 and 2024 AD). A significant increase in discharge is observed at the Chanchala and

Bojhe sites, primarily due to the integration of multiple spring sources in addition to the original one.

The Keshari and Dhoje springs also show an increase in discharge compared to the previous year, although the increase in discharge is less compared to Chanchaladevi and Bojhe springs. This is likely because water is collected only from previous sources. The increase in discharge in both springs could be the result of the construction of recharge measures in the respective areas. Figure 17 illustrates the percentage increase in spring discharge between 2080 BS and 2081 BS. As mentioned above, the percentage increase in springs discharge at Chanchala and Bojhe exceeds 100%, whereas at Dhoje and Keshari, the increase is below 100%.

At the Dhoje site, a new spring source emerged below the reservoir tank during the intervention. The community constructed an intake structure to capture this new source, which now supplies water to several households in Ward 5. It is also connected to a tap stand used by pedestrians for drinking and by farmers for washing agricultural produce.

Table 4: Spring Discharge of month Falgun (February-March) and Chaitra (March-April) of year 2080 BS and 2081 BS.

Year →	**2080 B.S**				**2081 B.S**			
	Falgun		**Chaitra**		**Falgun**		**Chaitra**	
	1	**15**	**1**	**15**	**1**	**15**	**1**	**15**
Chanchala Devi Spring discharge (LPM)*	0.774	1.698	0.461	0.379	6.293	5.88	4.209	3.829
Bojhe Spring discharge (LPM)*	3.533	2.477	1.784	2.759	8.108	7.258	8.755	8.551
Keshari Kharkha Spring discharge (LPM)	4.523	4.230	4.369	4.255	5.978	5.745	5.711	5.649
Dhoje Dhara Pani Spring discharge (LPM)	11.321	11.612	11.146	10.909	12.784	13.44	13.851	13.294

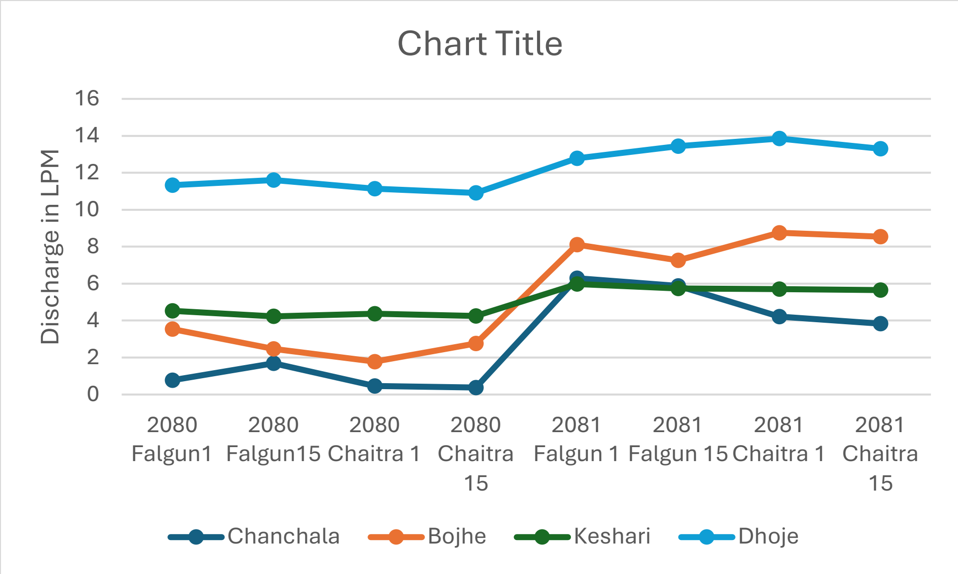

Figure 16: Change in spring discharge over the time in all 4 spring sites.

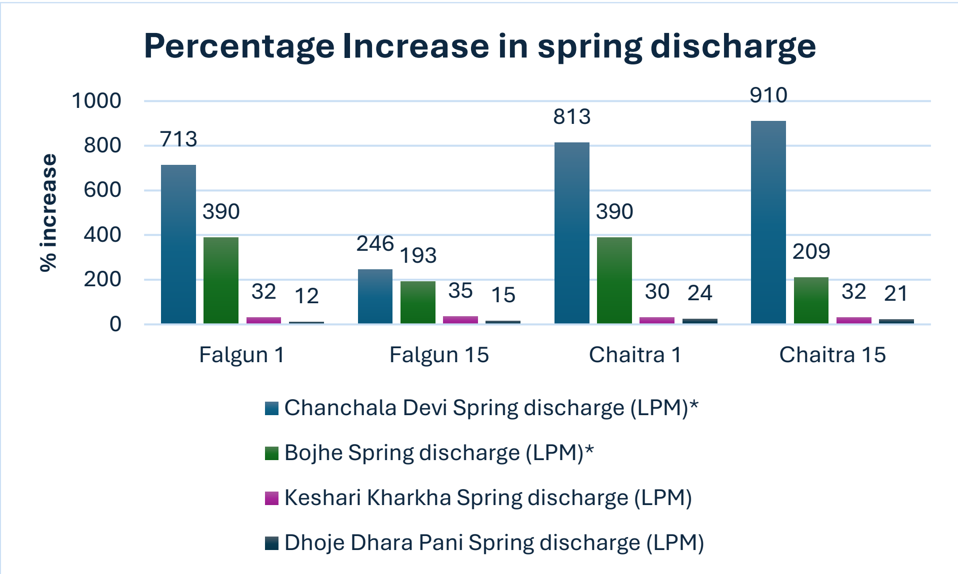

Figure 17: Percentage increase in spring discharge in all 4-spring site.

4.3 Change in Spring Water Quality

During the FGDs the participants shared that in the past the spring sources were not protected/conserved and only covered the spring sources with iron sheets. During the monsoon season, water in the open spring source were often contaminated with sediments and runoff, turning it reddish and unfit for drinking. Additionally, the open spring source were exposed to contamination from domestic and forest animals, further compromising water quality. the Figure 18 represents the change in spring water quality after the intervention, where 87% of the surveyed respondent perceives an improvement in spring water quality.

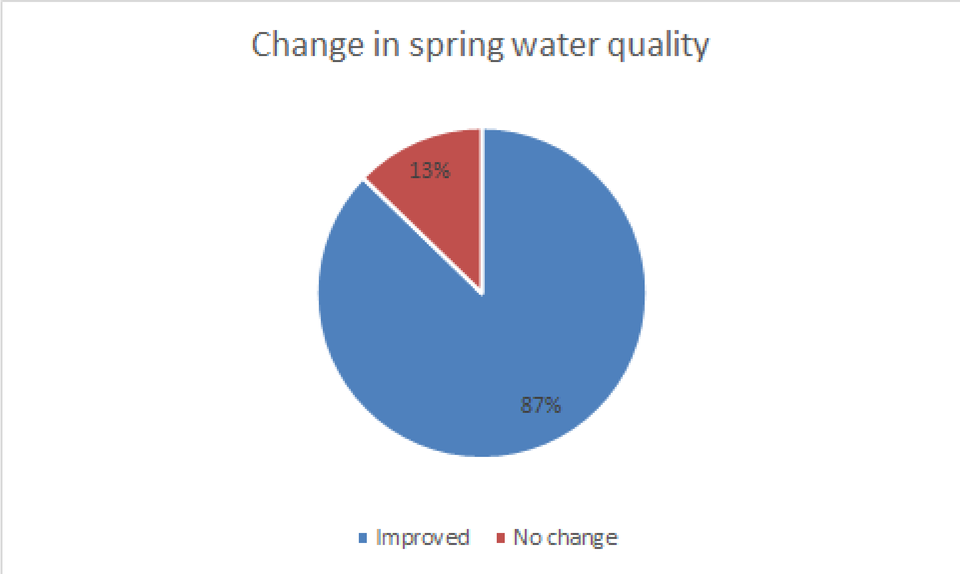

Figure 18: Change in spring water quality.

The reasons for the improvement in the quality of spring water are as below:

- Construction of spring protection measures like masonry wall to prevent the upstream runoff from entering the spring source, drain to divert the road runoff and implementation of bio engineering measures such as live check dam, plantation etc just upstream of the spring sources.
- Systematic tapping of spring water through intake systems, channelling it into a collection chamber and storing the water in reservoir tank, and distributing it directly to households via a pipe network. This has ensured a consistent supply of clean, and reliable water to each HHs.

Among the surveyed respondent, 79% of the total respondent report that they have been using the spring water directly without any treatment. They shared that after the intervention; they have experienced a notable visible change in the spring water quality. They mentioned the reason to be the systematic spring water tapping, collection and distribution after the intervention. During the FGD community people shared that after the intervention, they are now directly drinking spring water. However, during the colder months, boiling is more common. While some households still use filtration before drinking. Below Figure 19 represent the change among the surveyed HH regarding the treatment practice they do at their home.

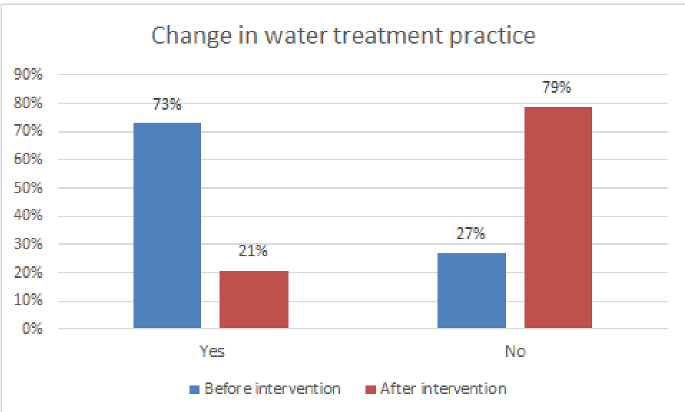

Figure 19: Change in water treatment practice after intervention.

Result from the Household surveys and focus group discussions (FGDs) strongly reflect the laboratory findings, indicating improved spring water quality after the intervention. These perceptions are consistent with laboratory test results, which showed that turbidity dropped to 0 NTU across all four springs post-intervention as shown in Table 5. Three of the four springs—Chanchala Devi, Bojhe, and Dhoje Dhara Pani—were also free of *E. coli*, reinforcing the community's increased trust in water safety. During FGDs, participants shared that they now drink spring water directly, though some households still boil water in colder months or use filters as a precaution. In Keshari Kharkha *E. coli* remained present due to upstream agricultural. This highlights the need for continued monitoring and possible localized improvements. The result of test before and after the intervention is shown in the annex 4. After the laboratory test result the community from Keshari Spring site was informed and were suggested some of the practical and community-appropriate preventive and treatment methods such as:

1. Household-Level Treatment Methods
    - ➢ Boiling
    - ➢ Gravity-Based Water Filters
    - ➢ Chlorination by using Chlorine Tablets or Liquid Bleach in the stored drinking water.
    - ➢ Placing the water in transparent PET (Polyethylene Terephthalate) bottles and expose to direct sunlight for 6 hours.
2. Community/Source-Level Preventive Measures
    - ➢ Preventing entrance of any livestock and open defecation near the spring source.
    - ➢ Planting grass or shrubs around the spring area that helps to filter the runoff and reduce faecal contamination.
    - ➢ Preventing agricultural runoff from directly entering the spring catchment.

Table 5: Water Quality Test Report Result of Before and After Intervention

SN	Spring Site	Observed Value	Category				
			Physical				Microbiological
			Turbidity	Temperature	pH	Electrical Conductivity (µs/cm)	Faecal coliform E. coli (CFU/100 ml)
1	Chanchala Devi	Before Intervention	0.5	25	6.9	75	5
		After Intervention	0	25	7.1	78	0
2	Bojhe	Before Intervention	0	25	7.2	47	0
		After Intervention	0	25	7.4	60	0
3	Keshari Kharkha	Before Intervention	0.2	25	6.6	108	16
		After Intervention	0	25	7.2	104	16
4	Dhoje Dhara Pani	Before Intervention	0.3	25	6.8	54	0
		After Intervention	0	25	6.9	88	0

NDWQS 2079 BS	**5**	**-**	**6.5-8.5***	**1500**	**0**

4.4 Dependability and reliability of spring water

Figure 20 illustrates the level of dependence on the spring water, revealing that the majority of the surveyed HHs (89%) are very dependent on spring water source. The remaining households fall into the quite dependent (2%) and moderately dependent (9%) categories. These groups include households that are using shared water tap and the HHs using metered tap water or water from seasonal springs for drinking, as these sources are located close and are easily accessible. When compared to the baseline survey, there has been a 13% increase in the reliance on spring water among the surveyed households. This increase suggests that the spring water remains the primary and most reliable source for the majority of households. And we assumed that due to the higher quantity and quality of water available, there is a greater preference of the households to use this particular spring, in combination with the new constructed infrastructures easing the access e.g. taps at or near the home. It is, therefore, expected that households use more water from one spring source and no longer need to get water from other sources which takes more time and effort to access.

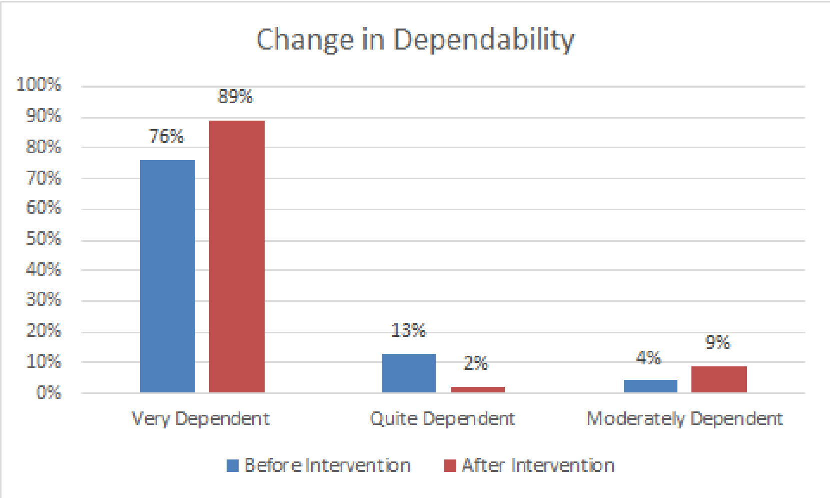

Figure 20: Change in spring water dependability before and after intervention.

After the intervention, the majority of surveyed respondents perceived that spring water is more reliable compared to the previous year, largely due to a 20-40% increase in water quantity. 68% of respondents consider the spring water to be usually reliable, acknowledging a decrease in water quantity during the dry season, while 32% view it as reliable. This represents a significant improvement from the baseline survey, where only 49% of respondents found the spring water to be usually reliable. Table 6 shows the data on the spring water reliability before and after intervention. With increased water availability, households now have better access to clean and sufficient water, enhancing the overall reliability of spring water for daily use.

Table 6: Spring water reliability before and after intervention.

Spring water Reliability	Before Intervention	After Intervention
Usually Reliable	49%	68%
Reliable	47%	32%
Rarely Reliable	4%	0%

4.5 Impact on Water Service Hours and Water Demand Fulfilment

The intervention has led to significant improvements in the water service hours provided by the reservoir tanks and collection chambers. Here, service hours—defined as the number of hours per day that water is available from these systems—have increased considerably compared to baseline conditions.

Figure 21 below shows the comparison of the number of service hours per day, related to the opening of water from the reservoir tank.

Overall, after the intervention, service hours have improved dramatically compared to the baseline condition. Before the intervention, collection chambers/reservoir tanks were absent in Chanchala Devi and Keshari Kharkha sites. Bojhe and Dhoje had old collection chambers or reservoir tanks, which were inefficient at capturing and distributing water. The residents at Chanchala Devi and Keshari Kharkha had to go directly to the spring outlet—a process that could take hours. Similarly, at Dhoje, every household member had to travel to the collection chamber, connect their household pipes, and wait until enough water was collected.

After the intervention, new or improved collection chambers and reservoir tanks were introduced across all sites. These additions not only capture water seepage and spring flow more effectively but also enable a more organized connection to household pipelines. As a result, the overall service hours have extended dramatically. For instance, Dhoje Dhara Pani Spring now offers 18 hours of water service per day. In contrast, Chanchala Devi and Keshari Kharkha Springs each provide 12 hours, demonstrating a marked improvement from previous conditions. Similarly, Bojhe Spring, which operated for only 1 hour per day before the intervention, now operates for 4 hours. Although still the lowest among the sites, this increase is significant, particularly considering the established rules in Bojhe that limit usage to two hours in the morning and two hours in the evening, as the reservoir tank supplies water for 18 households during each two-hour window.

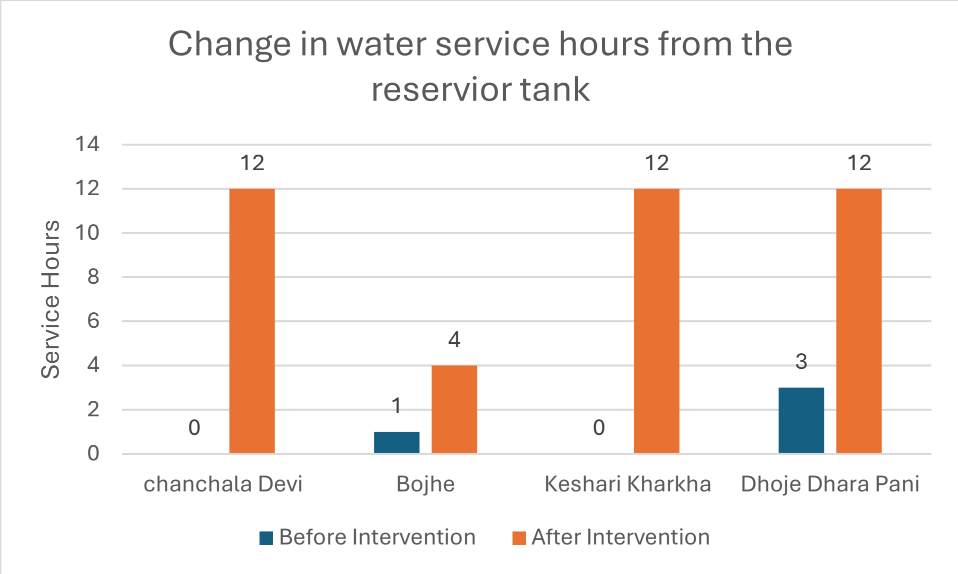

Figure 21: Number of service hours per day before and after intervention.

The improvement is also shown on the percentage of fulfilment of household water demand, as shown in Figure 22. Overall, the percentage of water demand met has increased significantly across all sites, underscoring the effectiveness of the implemented measures. This high level of improvement also indicates that the interventions have been highly effective in addressing both the supply and distribution challenges previously faced by households. Most of the spring sources in the study area now covers 92-97% of household water demand except in the Dhoje Springs where it only reaches 77%. This result emphasizes the impact of the intervention that has increased the percentage household water demand condition where it only covers around 53-65% of household water demand before the intervention. The main reason for the water demand not being fully met (100%) is that many households still supplement their water supply for irrigation/agriculture from additional sources—such as rivers, streams, or other springs.

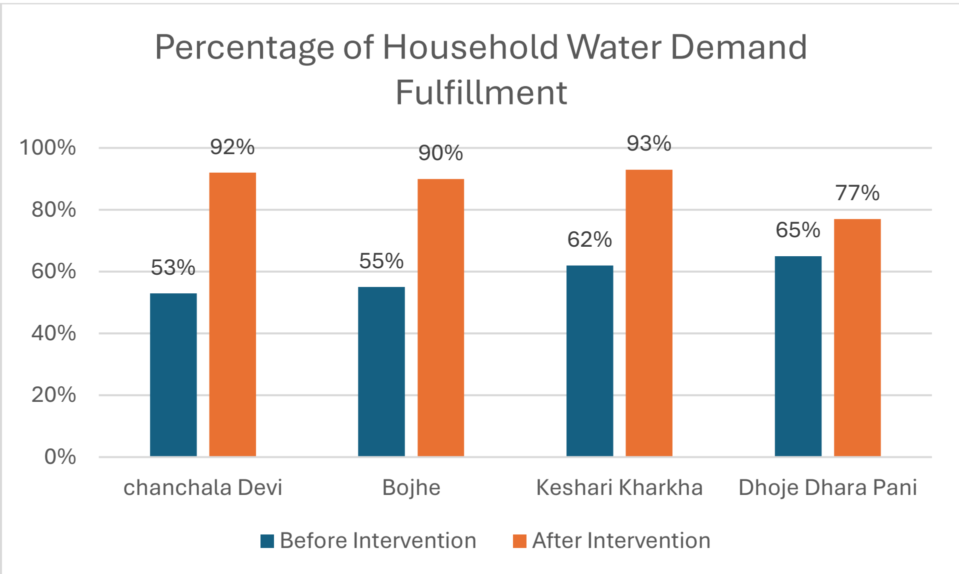

Figure 22: Percentage change in household water demand fulfilment before and after intervention

5. Additional water sources

Also, after the intervention, 38% of the surveyed households continue to use water from additional sources besides the project springs. These households rely on seasonal rivers and other springs to meet their extra agricultural needs. In addition, some households in the Keshari Kharkha site use meter water tap systems for drinking purposes, especially for running canteens in the area. The Figure 23 below represent the household using additional water sources in all 4 spring sites.

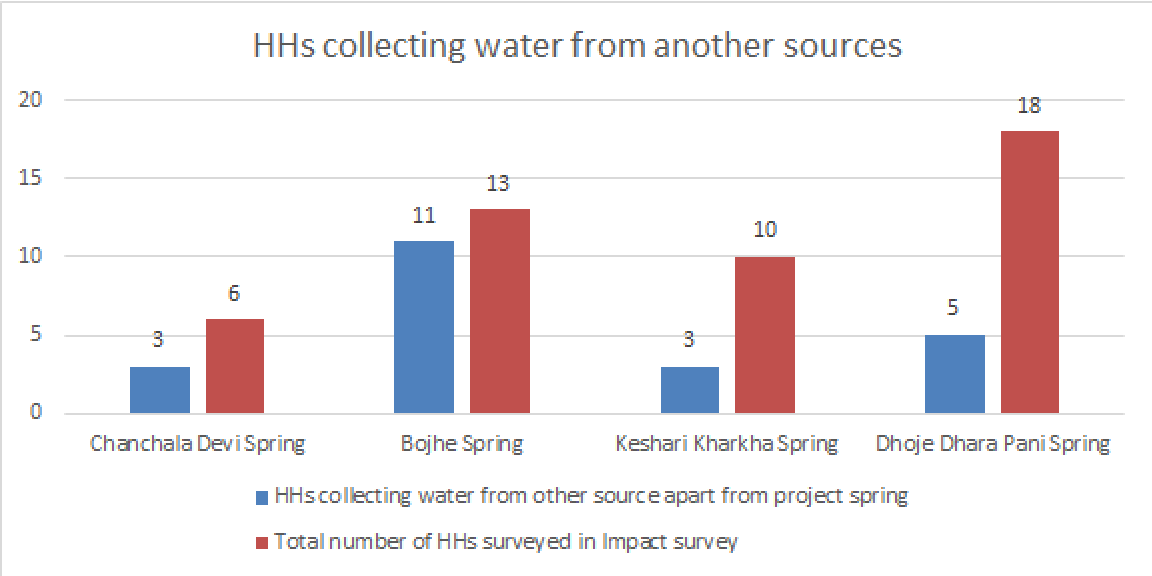

Figure 23: Water collection from other source beside the specific spring after intervention.

Majority of the households from the Chanchala Devi Spring site are collecting water from seasonal sources to meet additional irrigation needs in their fields. Surveyed respondents indicated that the water from the Chanchala Devi Spring is sufficient for drinking and domestic, and livestock. Additionally, one household also collects water from the Ghurmis spring, as it is located near their home and serves as a seasonal source during certain months.

In Bojhe, majority of surveyed respondents collects water from other water sources in addition to the Bojhe spring. Some households continue to use their previous pring sources, which they have relied on since the beginning, even before the Bojhe spring was introduced. Although the water quantity from these previous spring sources has decreased over time, they are still utilizing—particularly because they are located close to the households and are easier to access. However, these nearby spring sources are seasonal and not reliable. In addition, some households use water from the river for irrigation and occasionally for washing clothes, as the water available from the Bojhe spring alone is insufficient to meet the irrigation needs. Four households have a long-standing preference for collecting water from a seasonal spring for drinking purposes. They have relied on this source for over 15 years because, in the past, the water from Bojhe spring was not suitable for drinking. These households even purchased land specifically to access water from that seasonal spring. However, during the dry season (Falgun-Jestha), when water levels in Bojhe spring decrease significantly, these households switch to drinking water from Bojhe spring.

While in Keshari Spring site, the HHs running Canteens are also using the meter tap water for cooking, drinking and washing utensils in the canteen. They shared that the additional source likely ensures a consistent and high-quality water supply, which is critical for their business operations.

The use of metered tap water helps maintain water reliability and safety for canteen customers, complementing the primary spring water source.

6. Agriculture

91% of the total surveyed HHs are engaged in agriculture and the average land holding size is 15 ropani (0.77 ha.). Prior to the intervention, water from the spring was not sufficient for irrigation, particularly during the dry season, this posed significant challenges for agriculture. Farmers often struggled to provide sufficient water for their crops, relying on rainfall or limited access to spring water. Instances were reported where crops like peas withered and died due to the lack of water during critical growth stages forcing the farmers to grow fewer crops which often resulted in poor yields and financial losses. They frequently had to visit the spring at night to connect pipes for irrigation from the spring, nearby river, facing risks such as wild animal attacks or unsafe encounters.

While after the intervention, the improved water management system has also improved a reliable water supply for irrigation in all spring sites. The overflow water from the reservoir tank and rainwater are now stored in irrigation ponds in 3 spring sites (Chanchala, Keshari and dhoje), of 25000 liters capacity, providing a reliable source of irrigation during the dry season. While the respondents from Bojhe have connected the extra water from household pipes to sprinklers for irrigation as shown in Figure 24. This has allowed farmers to better manage water, sustain their crops, and expand their agricultural activities.

Figure 24: Plastic Pond and sprinkler used for irrigation purposes.

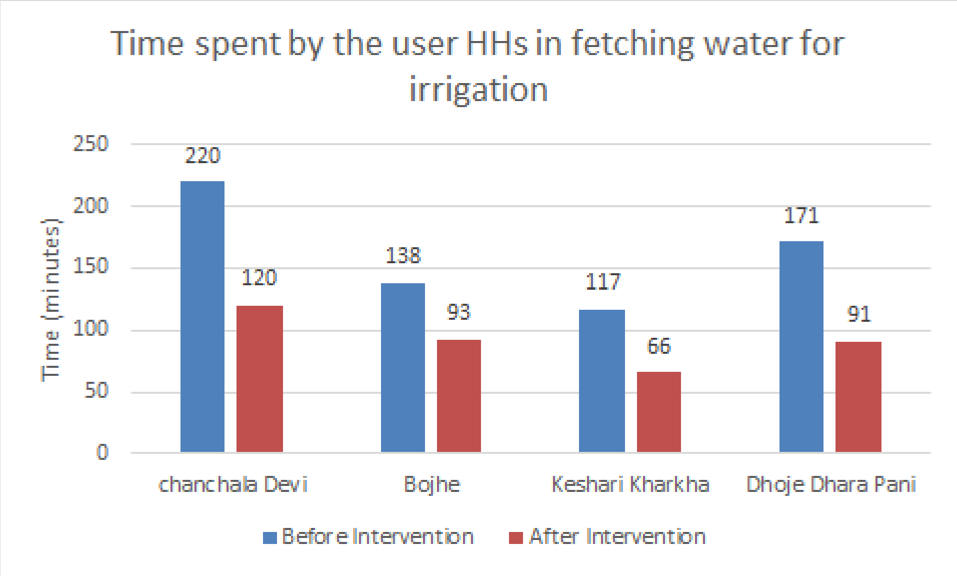

Figure 25: Change in time spent on fetching water for irrigation purposes.

The above Figure 25 represent the change on fetching water for irrigation before and after the intervention. The intervention has led to a significant reduction in the time required to fetch water for irrigation across all spring sites. The improvements in water infrastructure specifically the introduction of collection chambers, reservoir tanks, and household pipelines have made accessing water more efficient. At the same time the labour required is much less demanding, women no longer need to fetch water in containers from the spring site, rather they can take it from taps either at the home, or nearby. Thus, not only reducing time, but also physical strain on the body. On average, households now spend approximately 45–100 minutes less each day fetching water for irrigation, representing a substantial decrease of 33% to 47% in time expenditure across all sites. Which can be clearly understood by below Table 7.

Table 7: Change in time spent on fetching water for irrigation.

Spring site	Time spent before Intervention	Time spent after Intervention	Time saved in minutes	% reduction in time spent
Chanchala Devi Spring	220 minutes	120 minutes	100 minutes	45%
Bojhe Spring	138 minutes	93 minutes	45 minutes	33%
Keshari Kharkha Spring	117 minutes	66 minutes	51 minutes	44%
Dhoje Dhara Pani Spring	171 minutes	91 minutes	91 minutes	47%

This time savings is particularly significant for women, who are primarily responsible for water collection and agricultural water management. With the reduced burden, now women experience less physical strain and have more time to focus on other tasks, which provides opportunities for participation in social and economic activities. The time freed up has also allowed many community members to invest more energy into income-generating activities. Some respondents reported having additional time to cultivate more crop including off-season varieties leading to increased agricultural productivity. Others have taken advantage of the saved time to work on nearby farms for wages, supplementing their household income.

6.1 Change in total cultivation area.

The intervention has not led to a big expansion of cultivation area. It led to 6% increase in the cultivation area which is significant looking at the amount of water springs discharge. Those who have expanded did so because of more consistent and reliable water access leading to more variety of crop and increased quantity of crops grown. However, what has mainly changed is that land which was previously only cultivated in the monsoon season and left fallow after, now is also taken into production in the dry season too. So, the main difference lies in an increase in production, where crops are grown in more seasons in a year, with higher yields.

The availability of water has also enabled some households to begin cultivating off-season crops, which can provide higher market value and additional income. Compared to previous years, surveyed households are planting seasonal crops with greater frequency, benefiting from the reduced time and physical burden associated with water collection.

Additionally, the improved water supply has supported an increase in livestock numbers for 5 HHs (4 HHs from Bojhe and 1 HHs from Chanchala Devi Spring site). With more water available for drinking and cleaning purposes, households can manage and maintain larger herds, contributing to enhanced food security and increased income from livestock-related activities.

6.2. Change in Agriculture Production:

After the intervention, farmers at the Chanchala Devi and Bojhe spring sites have harvested pea, potato, maize, and millet. In contrast, farmers at the Keshari and Dhoje spring sites have only harvested pea. This is due to weather pattern difference in four pilot sites. Keshari and Dhoje experience prolonged cold weather, which delays the harvest period compared to Chanchala Devi and Bojhe. Figure 26: Average percentage increase in agricultural production. represent the percentage increase in pea production in all 4-spring site,

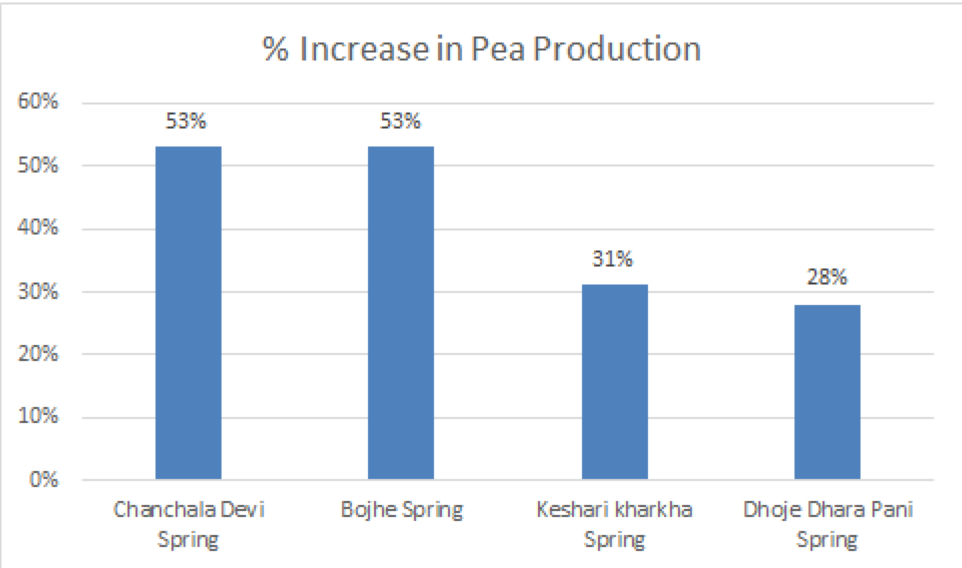

Figure 26: Average percentage increase in agricultural production.

The highest average increase in pea production was observed at Chanchala Devi and Bojhe spring sites, where both recorded a 53% increase. The ability of farmers in these areas to expand their farmland has allowed for greater crop output, reinforcing the link between irrigation improvements and higher productivity. Similarly, Keshari Kharkha and Dhoje Dhara Pani spring sites also experienced average increases in pea production, at 31% and 28%, respectively, though there was no increase in the cultivation area the improvement in water for irrigation has led to increase in the production.

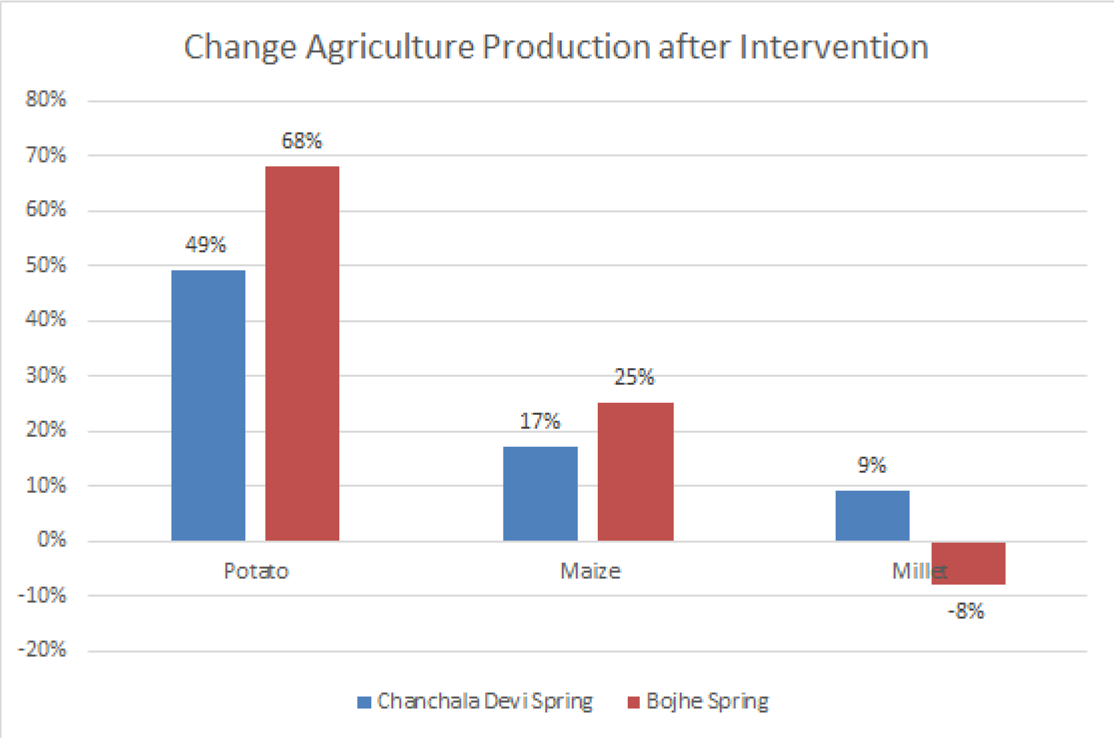

Figure 27: Change in agriculture production after intervention.

Figure 27 represent the average percentage increase and decrease in the production of potato, maize and millet. Bojhe Spring experienced the significant increase in potato production at 68% and 49% in Chanchala. Similarly, there is increase in the maize and millet as well whereas Bojhe Spring experienced an 8% decrease in millet production. Respondents from Bojhe explained that the decline in millet was due to the infestations of monkey and the low market value of millet. As a result, they have shifted to more high-value crops like pea, cauliflower, cabbage, and potatoes, growing only a small amount of millet for household purposes, such as livestock feed, liquor, and flour.

7. Road Usage and Road Adjacent-Environment

Most of the roads in the selected spring sites are feeder roads with gravel and sand surfaces, while the road leading to Bojhe spring is made of rubble soling. These roads were primarily constructed through the users' committee and the village development committee (at present there is no more village development committee. These units are transformed into municipalities), which are also responsible for their ongoing maintenance and repairs. The roads play a crucial role in enhancing infrastructure development and improving access to essential services such as healthcare, education, markets, and employment opportunities for the local community.

Before the intervention, there was no drainage system in the road adjoining to the spring source, thus causing damage on the road infrastructures such as damage to the road surface, water logging, erosion, sedimentation, and damage to the road embankment. The road conditions across all spring sites were poor, particularly during the monsoon season. Seepage water from upstream springs flowed along the road surface, making travel difficult, risky, and time-consuming. Although tractors, autos, and bikes were the most common vehicles on these roads, they frequently got stuck or slipped particularly during the rainy season. Pedestrians also faced challenges, as the waterlogged and damaged surfaces often caused them to slip and fall.

At the Keshari site, seepage from the spring, which overflowed from a nearby pond, caused significant waterlogging, road damage causing gully formation at downstream of the road making travel difficult. This created obstacles for both vehicles and pedestrians, including municipal staff, who often had to park their vehicles farther away and walk to their offices. The muddy road also led to hygiene issues in the office, making the working environment unpleasant and unsanitary.

In Dhoje, participants during focus group discussions (FGD) highlighted that transporting heavy agricultural produce was particularly challenging. The poor road conditions made this task time-consuming and physically exhausting. When the road was impassable, farmers had to pay more per trip i.e. NPR 1,500 more per trip to transport their produce, adding a significant financial burden to their already challenging work. (Currently farmers pay NPR 1,000, saving 1/3 of the amount)

I) Dhoje Road Condition Before Intervention Intervention

II) Dhoje Road Condition After

Figure 28: Change in Dhoje road condition after the intervention.

Following the intervention, a proper drainage system has been installed along the road adjoining the spring source, significantly reducing the frequency of the previously mentioned damages. With these road improvements, community members have experienced a noticeable positive impact on their daily travel. All surveyed respondents reported that, after the intervention, there is no longer any impact of spring water on the road. Seepage water and road runoff are now effectively managed through the constructed roadside drains and a box culvert, which directs excess water into a nearby river. Additionally, check dams and plantation work above the spring have helped control sediment from entering the road.

At the Keshari Spring site, the pond's capacity has been increased to hold more water, including rainwater harvesting from roof and overflow water from the reservoir tank, which is redirected into the irrigation pond when required. Local farmers, now, use this water for irrigation by transporting water to their irrigation ponds through pipe connections. This system not only prevents water from flowing onto the roads but also mitigates downstream impacts such as gully formation and erosion. By effectively managing overflow water, the intervention has reduced the risk of road damage and downstream land degradation, enhancing the community's ability to withstand and recover from natural disasters.

As a result, vehicles such as tractors carrying heavy construction materials, Boleros transporting agricultural goods from nearby villages, autos, and bikes can now use the road without facing the previous challenges. Additionally, transportation costs have reduced, making it more affordable and convenient for farmers.

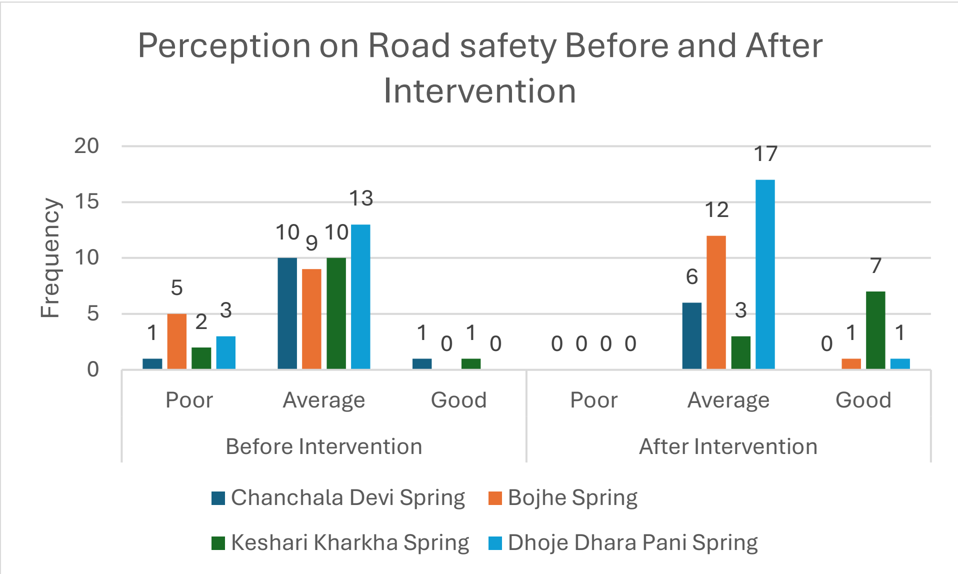

Figure 29: Perception of the respondent on the road safety before and after intervention.

Overall, most respondents rated road safety as average, indicating that the intervention has improved road conditions. Participants during FGD shared that the new road is significantly safer and of much better quality compared to the past. Previously, seepage water from upstream frequently flowed onto the road, causing severe damage to road surface, and water logging making access extremely difficult. These conditions not only disrupted daily travel but also had a major impact on education, as students faced challenges reaching school. The improved road, with proper drainage systems and gabion boxes to manage seepage water and runoff, has resolved these issues, making it easier and safer for everyone.

8. Socio-Economic and Livelihood

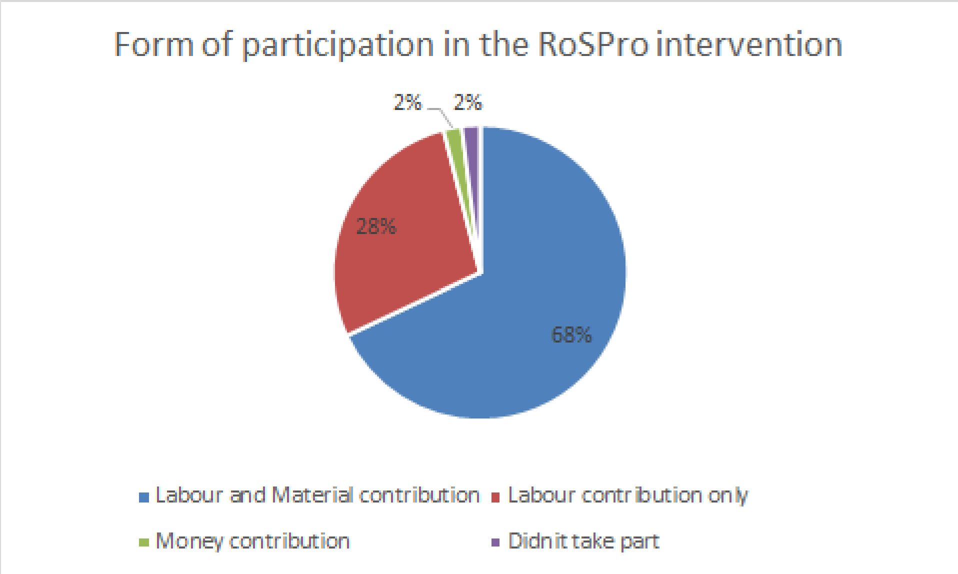

Figure 30: Participation of community members during implementation phase.

During the project implementation, the majority (68%) of the surveyed households participated in both labour and material contributions (spades, shovels, local timber, hammer, head straps etc), reflecting strong community involvement. An additional 28% of households contributed only labour, further demonstrating active participation. However, one household from the Keshari Spring site contributed money instead, due to the unavailability of family members during the implementation phase. The very high participation highlights both the widespread community support for the project and the community's commitment to improving local infrastructure and shared resources.

Table 8: Number of Labour engaged during implementation phase.

Spring site	Number of labours engaged		Number of days	Wage per day (NPR)	
	Skilled Labour	Unskilled Labour		Skilled Labour	Unskilled Labour
Chanchala Devi Spring	3	9	60	1100	800
Bojhe Spring	6	12	60	1100	800
Keshari Kharkha Spring	4	6	31	1100	800
Dhoje Dhara Pani Spring	6	14	30	800	500

During the FGD, participants shared that the project has created good employment opportunities for them. All the labour needed for the construction was managed from their own community. This was beneficial because it used local resources and gave them a chance to earn. Before this, most of them were only involved in agriculture work. But through this project, they got the opportunity to work in construction too. Participants highlighted that engagement of the local community members not only provided immediate income but also promote a sense of community involvement and ownership toward the project.

The above Table 8 shows the number of skilled and unskilled labour engaged in the project implementation and the respective per day wages. In all spring site except Dhoje spring both the skilled and unskilled labours were paid as per the municipality norms which is NPR 1100 per day for skilled labour and NPR 800 per day for unskilled labour. However, in Dhoje site, with clear communication and discussion among the community members and considering the 10% contribution through community participation, the skilled labour was paid NPR 800 per day and unskilled labour was paid NPR 500 per day.

Additionally, the working conditions were managed with flexibility and inclusivity in mind, allowing community members to participate based on their availability and personal schedules. The committee's practice planning of labour requirements a day in advance to ensure efficient resource use and accommodated varying levels of participation also making it easier for them to balance other household responsibilities while earning an income.

8.1 Impact on the HHs Income

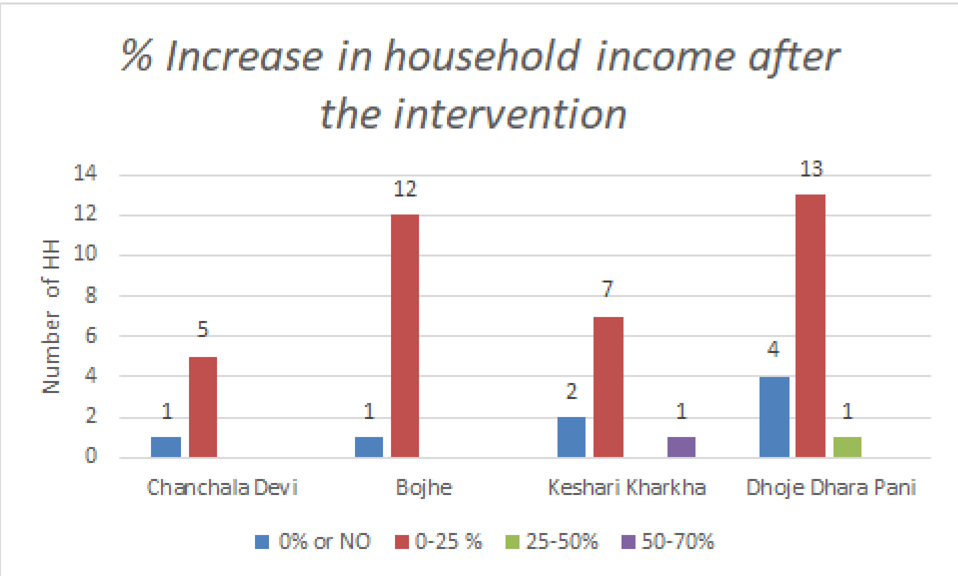

Figure 31: Percentage increase in household income of the community members after the intervention

After the intervention, a significant number of surveyed households reported an increase in their income across all spring sites. The majority of the surveyed households experienced up to 25% increase in income, with 37 households falling into this category. One household from Dhoje Dhara Pani reported a 25-50% increase, reflecting substantial economic benefit. Additionally, one household from Keshari Kharkha reported the increase of income by 50-70% which is way high than the average increase in the income. However, eight households (one from Chanchala Devi, one from

Bojhe, two from Keshari Kharkha, and four from Dhoje Dhara Pani) did not experience any change in their income.

This increase in household income is attributed to improved water access, which has enhanced the agricultural productivity enabling the cultivation of more seasonal and off-season crops, livestock and reduced transportation costs.

8.2 Impact on the community knowledge on water management system

Additionally, participants during the FGD shared that the project has enabled community members to develop technical, vocational, leadership skills and knowledge. Beyond technical skills, they also gained financial planning abilities, including record-keeping of material purchase bills, auditing, and documentation, as well as resource management and maintenance practices. Women were given the opportunity to work outside their traditional household roles by participating in construction activities alongside men. This not only promoted gender inclusivity but also increased their confidence and sense of contribution.

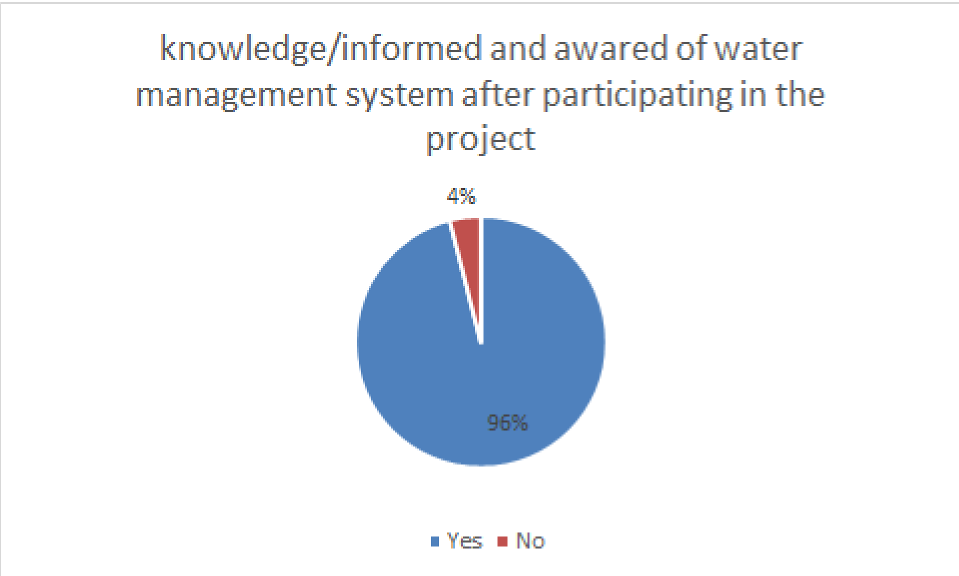

Figure 32: Surveyed respondent more aware of the knowledge on the water management system.

8.3 Impact of RoSPro on community

The intervention has had a mix of positive and negative impacts on both the community and the project area, creating meaningful changes while also presenting challenges. The positive impact includes:

- The project fostered a sense of togetherness and ownership within the community as members themselves worked on implementing the measures. This collaboration strengthened community bonds and promoted collective responsibility.
- After the intervention, there is an increase in spring water availability, which now meets the daily water demands of each household. Residents from Bojhe shared that there will be

enough water for the community's future needs as the population grows. Agricultural activities have benefited greatly from the intervention, with increased water availability leading to better irrigation and higher productivity. The improved water supply and road infrastructure have boosted agricultural productivity, enabling youth to engage in farming, explore off-season cultivation, and grow high-value crops that were previously not feasible due to water scarcity.

- The intervention has provided opportunities for skill development, including technical training in spring protection and recharge measure construction, as well as knowledge in financial management practices such as record-keeping and resource management. This new knowledge equips the community to manage future projects more effectively and sustainably. Additionally, a UC member from the Keshari Spring site, with financial support of NPR 2 lakhs (NPR 2 hundred thousand) from the Ward No. 2 office of CJRM, has successfully replicated the project approach at another spring source facing similar issues.
- The local government (CJRM) has allocated a separate budget for spring protection work (spring mapping this year, 2081 B.S) and incorporated the project's ideas into its policies ensuring project sustainability and scalability.

However, there were also some negative aspects of the intervention as listed below:

- Some households in the community expressed disagreement about contributing the required 10% of the project cost, which reduced the total number of beneficiary households compared to initial expectations.
- Although the recharge trenches construction in private land was approved by the mayor and ward chairperson, there is uncertainty about future interactions with the landowner, who might raise issues regarding the use of their land for community purposes

8.4 Impact on migration rate

Additionally, 64% of the surveyed respondents reported no change in the in-migration rate after the intervention, while 36% indicated that in-migration has increased due to the improved availability of water from the spring source. This contrasts with the baseline survey, where more people were leaving for work and education in urban centers like Dharan, Itahari, and Kathmandu, as well as foreign countries such as India, Saudi Arabia, Qatar, Malaysia, and Dubai. In Bojhe, 2-3 households had already out-migrated due to water shortages and limited job opportunities, although the intervention has since led to an increase in-migration of 1-2 HHs in the area. These findings suggest that improved water availability has a positive effect where people are more likely to stay in the rural area, however other aspects also come at play, for instance the availability of local labour for the construction of the interventions.

8.5 Future Perspective

Looking ahead, community members are concerned about the long-term sustainability of the springs. While the current supply meets their needs, they recognize the growing challenges posed by climate change, population growth, environmental degradation, and increasing migration into the area all of which are likely to raise future water demand. To address these challenges and ensure the spring's sustainability, the community has proposed several actions:

- Community members recommend ongoing maintenance of the constructed structures and regular monitoring of the spring's water levels. They also advocate for implementing strict land-use regulations near the spring source and promoting awareness campaigns on water conservation.
- The UC planned to raise a fixed amount monthly from all benefiting households to fund the repair and maintenance of the constructed measures.
- Expanding recharge areas and constructing additional recharge trenches are viewed as critical steps to improve groundwater replenishment. Also, maintaining and regularly cleaning these trenches will be essential to sustain the spring source over time.
- The community plans to work with local authorities and technical experts to explore complementary solutions, such as rainwater harvesting and alternate water storage systems.
- Prioritizing education on water conservation, protecting recharge areas, and promoting tree planting to conserve soil and water remains a key focus for the community.
- The community also intends to identify and assess other unused spring sources in the area, which could serve as supplementary water supplies in the future.

By implementing these actions, the community aims to safeguard the spring source and ensure a reliable water supply for future generations.

9. Cost Benefit Analysis

Incremental cost-benefit analysis (ICBA) in the project intervention assessment served as a critical tool in evaluating the economic feasibility of RoSPro's post-intervention outcomes. This evaluation is crucial for determining whether the intervention delivers value for money, supports the decision-making process and informs future resource allocation. This ICBA examined the Net Present Value (NPV) and Internal Rate of Return as the key indicators. NPV calculates the difference between the present value of all benefits and costs over the project's lifespan. Meanwhile, IRR represents the rate at which the project's benefit equals its cost.

Net Present Value (NPV): NPV measures the difference between the present value of all benefits and costs over the project's lifespan. It is a critical indicator of the project's profitability. A positive NPV means that the project is expected to generate more benefits than costs, making it economically viable. For example, the NPV for Chanchala Devi Spring (spring site 1) is 6,341,725.62 NPR at the end of year 20, indicating a profit valued at Euro 43,250 in today's value.

Internal Rate of Return (IRR): IRR represents the rate at which the project's benefits equal its costs. It is the discount rate that makes the NPV of all cash flows from a project equal to zero. A higher IRR indicates a more profitable project. For instance, the IRR for Bojhe spring (spring site 2) is 121%, suggesting that the project will return the investment capital faster than other springs due to higher household water demand fulfilment.

9.1 Results per spring site

The result of the incremental cost-benefit analysis of the RoSPro project is presented for each spring site, where each spring site gives unique NPV and IRR data. The CBA clearly shows that investing in roadside spring protection is a worthwhile investment, as it can deliver 4-8 times the total initial investment over a 20-year period. That means for every euro put in, the benefits—like reduced road repairs and lower maintenance costs, better water access, and saved time by communities—add up to four to eight euros over time. This is a return rate of 44% to 121% on what you spent.

The CBA calculation for Chanchala Devi Spring (spring site 1) gives the NPV number of 6.341.725,62 Nepalese Rupees (NPR) at the end of year 20. This means the project site will pass the breakeven point and will end up giving a profit, which is valued at Euro 43.250 in today's value (present value). The IRR results in 44% of the annual return.

The Bojhe spring (spring site 2) ICBA data result has the biggest NPV and IRR, at the number of 18.268.600,86 NPR and 121%, respectively, thus making the Bojhe project have the biggest NPV and IRR in all pilot spring sites. This means the project site will return the investment capital faster than the other springs. This happened since the springs give plenty of increased fulfilled household water demand benefit more than the other springs. These benefits are related to the highest monthly water consumed and the highest number of households in the user community.

Dhoje Dhara Pani spring site has an NPV and IRR, with the amount of 7.756.325,92 NPR and 46% respectively. Furthermore, the springs also have the smallest benefit of increased water demand compared to other spring sites. This relates to the perception of the user community that only perceives 11,26% of increased water demand fulfilled, which is the only spring that has the changes below 30%.

In Chhathar Jorpati Rural Municipality (CJRM), the ICBA result of Keshari Kharka Spring (spring site 3) resulted the number of NPV and IRR of 5.047.199,11 NPR and 69% respectively. This makes spring site 3 has the bigger NPV and IRR in CJRM area. This relates to the fact that the increased fulfilled household water demand in spring site 3 is up to 32% after the intervention.

The summary of the incremental cost benefit analysis could be seen in Table 9. See Annex 1 for full results from all 4 spring sites.

Table 9: Incremental cost benefit analysis

Group	Indicator	Spring Site			
		Chancala Devi	Bojhe	Dhoje	Keshari Kharka
Cost	RoSPro Investment Contribution	रु 909,211.80	रु 726,971.07	रु 704,558.56	रु 716,266.46
	Community Investment Contribution	रु 109,140.37	रु 80,774.56	रु 102,894.49	रु 112,787.32
	Municipality Investment Contribution	रु 73,051.57	रु 0.00	रु 221,491.83	रु 298,819.45
	ICIMOD Investment Contribution (on Recharge Area)	रु 393,377.00	रु 697,928.00	रु 93,707.00	रु 0.00
	Engineer Contribution	रु 30,000.00	रु 30,000.00	रु 30,000.00	रु 30,000.00
	Net Present-Valued Facility Maintenance Cost (in 20 years)	रु 414,832.35	रु 420,554.01	रु 315,661.06	रु 317,090.97
	TOTAL COST	रु 1,929,613.10	रु 1,956,227.64	रु 1,468,312.94	रु 1,474,964.20
Benefit	Net Present-Valued Impact Benefit - Total Reduced Cost of Road Maintenance - Household Fulfilled Water Demand - Time Saving for Do Other Activity	रु 8,271,338.72	रु 20,224,828.50	रु 9,224,638.86	रु 6,522,163.31
Feasibility Indicator	Net Present-Valued Cashflow Gained over 20 years (Nepali Rupees)	**रु 6,341,725.62**	**रु 18,268,600.86**	**रु 7,756,325.92**	**रु 5,047,199.11**
	Net Present-Valued Cashflow Gained over 20 years (Euro)	**€ 43,250.57**	**€ 124,591.86**	**€ 52,898.14**	**€ 34,421.90**
	Internal Rate of Return (IRR)	**44%**	**121%**	**69%**	**46%**

9.2 Environmental benefits

The Cost Benefit Analysis (CBA) highlights the significant economic and environmental advantages of implementing roadside spring protection structures in Nepal. These interventions not only provide substantial returns on investment but also contribute to sustainable water management and environmental conservation. Beyond the quantifiable benefits, there are numerous other environmental benefits that are harder to measure but equally important. The Nature-based Solutions (NbS) implemented in the project enhance ecosystem services and promote sustainable water management. The environmental benefits include:

Improved Water Quality: The construction of spring outlets and reservoir tanks helps maintain the purity of water by reducing contamination from external sources. This ensures that communities have access to clean and safe drinking water, which is essential for health and well-being.

Erosion Control: Gabion walls and check dams play a crucial role in preventing soil erosion. By stabilizing the soil, these structures reduce sedimentation in water bodies, improving water quality and reducing the risk of flooding. Additionally, these measures prevent landslides and sediment build-up on road infrastructure, thereby protecting vital transportation routes.

Enhanced Groundwater Recharge: The interventions contribute to increased water availability in spring sources, benefiting the larger recharge area landscape and vegetation. The replenishment of water supports the revival of local flora and fauna, promoting biodiversity. Furthermore, this is a long-term solution that ensures the sustainability of the spring source, providing a reliable water supply for future generations.

Climate Resilience: The integration of NbS in water management enhances the resilience of communities to climate change impacts. The region faces significant challenges due to changes in temperatures and rainfall patterns, making weather much less predictable and increasing the risk of intense rainbursts and landslides. Improved water infrastructure mitigates the effects of droughts and floods, ensuring a stable water supply. This resilience is crucial for communities to be prepared for unpredictable climatic events. Access to a reliable water source not only supports daily needs but also enables agricultural activities, which are vital for food security and livelihoods.

In summary, the implementation of roadside spring protection structures in Nepal offers a comprehensive approach to addressing both economic and environmental challenges. These Nature-based Solutions provide a sustainable pathway for water management, ecosystem conservation, and climate resilience, ensuring that communities are well-equipped to face future uncertainties.

10. Discussion

Community members highlighted the critical role of participatory planning and implementation in ensuring the success and sustainability of the project. Community members emphasized that their active involvement in decision-making and co-design processes fostered a sense of ownership and accountability, leading to better maintenance and long-term project outcomes. Rather than relying on separate capacity-building activities, the project integrated skill development directly into the implementation process. This approach enabled community members to acquire practical knowledge in areas such as water management, construction, and financial planning while contributing to project delivery. Participants reported increased confidence in managing local resources and addressing future challenges, as they were involved in every stage—from planning and design to execution and monitoring. The collaborative approach not only strengthened local expertise but also promoted social cohesion, as diverse community groups worked together toward common goals. This experience underscores the value of embedding knowledge transfer and skill development within participatory frameworks to ensure long-term project sustainability and community empowerment.

The project has generated majorly positive impacts in the four pilot sites. A key positive outcome is the increased availability of spring water, which now meets daily household demands and provides confidence in future water security as the population grows. The intervention also created opportunities for skill development in spring protection, recharge trench construction, and financial management, empowering community members and encouraging youth to stay by offering employment and agricultural prospects. However, challenges emerged, including household reluctance to contribute 10% of the project cost, which reduced the number of beneficiaries, and uncertainty about future disputes over recharge trenches on private land despite prior approval. Additionally, budget constraints and unexpected shifts in spring sources during the implementation phase posed difficulties, such as delays in project completion and the need for additional structures to tap the spring water. The project's adaptability in addressing these challenges through close collaboration between project teams, User Committee members, and municipalities reflects a commendable commitment to ensuring long-term sustainability.

Moreover, the project has significantly improved water availability while delivering important environmental co-benefits. The implementation of bioengineering measures above the spring source, such as check dams, recharge trenches, and plantations, has effectively reduced soil erosion, controlled surface runoff, and improved groundwater recharge. These interventions not only enhance water security but also contribute to long-term watershed conservation, fostering more sustainable land management practices. Additionally, the project’s integrated approach to water and infrastructure management has helped mitigate the impacts of climate change by stabilizing vulnerable areas and improving soil retention. Community-led maintenance of these structures further ensures their long-term effectiveness. These environmental co-benefits strengthen the resilience of local ecosystems and communities, promoting sustainable resource use while enhancing agricultural productivity and future water availability.

Furthermore, community members have recognized the potential risks posed by climate change, population growth, and environmental degradation, prompting proactive measures to preserve the spring water source. To sustain these efforts, the community has proposed regular monitoring of spring discharge levels, ongoing maintenance of recharge trenches, and the enforcement of strict land-use regulations near spring sources. The User Committee also plans to collect a fixed monthly contribution from beneficiary households to fund future repairs and maintenance. Collaborative efforts with local authorities and technical experts will explore complementary solutions, such as rainwater harvesting and expanding recharge areas, to further enhance water availability. Education campaigns on water conservation and protecting recharge zones remain a community priority, ensuring that residents stay engaged and informed. These collective actions, combined with structured maintenance practices, are vital to securing a sustainable water supply and preserving the benefits of the intervention for future generations.

Reflection on methodology

The Mixed-Method Impact Assessment aligns well with its objectives of incorporating qualitative and quantitative data. Data triangulation approach from Bamberger (2012) enhances the reliability and validity of findings by integrating multiple data sources, ensuring a comprehensive evaluation of socio-economic and environmental impacts. The household survey results provided statistical validation of the trends observed in FGDs and KIIs, while cross-referencing all three methods helped identify discrepancies and reinforce analytical depth. Ultimately, triangulating qualitative and quantitative data enhanced the study's accuracy, ensuring that both economic indicators and social dimensions were adequately represented (Bamberger, 2012).

The Incremental Cost-Benefit Analysis (ICBA) framework adopted for the RoSPro project aligns well with its objectives to evaluate socio-economic, infrastructural, and environmental impacts of roadside spring protection interventions. By quantifying of direct benefits (e.g., increased water availability, reduced road maintenance costs) and indirect benefits (e.g., time savings, knowledge transfer), ICBA provides an integrated analysis that has the ability to resonate with any of the different stakeholders from policymakers up to residents (Boardman et al., 2018). ICBA serves as a valuable decision-making tool because financial metrics are universally understood. Furthermore, translating outcomes into monetary terms bridges gaps in understanding across stakeholders with varying priorities—governments focus on fiscal efficiency, while communities prioritize livelihood security (Pearce et al., 2006).

The RoSPro interventions demonstrate that targeted infrastructure improvements, such as spring boxes and bioengineering, yield measurable socio-economic returns. The high Internal Rate of Return (IRR: 21–86%) underscores the economic viability of spring protection, validating investments in water security and road durability. These results align with studies in similar mountainous regions, where integrated water-infrastructure projects reduced poverty by 15–25% through improved agricultural yields and market access (World Bank, 2020). Beyond direct economic gains, the project generated indirect benefits, such as enhanced community awareness of sustainable water management. This aligns with the concept of "co-benefits" in development projects, where environmental interventions catalyze behavioral shifts toward resilience (UNEP, 2018). However, the reliance on self-reported data (e.g., perceived water quality) introduces subjectivity

While the upfront capital costs of spring protection infrastructure are significant, the long-term social welfare benefits justify the investment. For example, the near-doubling of household water demand fulfilment (53–65% to 92–97%) directly improves health outcomes and reduces time poverty, particularly for women and children (UNDP, 2021). However, the assumption of uniform impact over 20 years (e.g., static maintenance costs) may underestimate variability due to climate change or population growth. Adaptive management frameworks, as proposed by Hallegatte et al. (2017), could mitigate such risks by integrating periodic reassessments of costs and benefits.

The CBA's reliance on assumptions—such as maintenance costs (3% of total investment) and static agricultural impacts—introduces uncertainty. While these assumptions are grounded in expert judgment (e.g., water engineers), they may not fully capture on-the-ground complexities, such as fluctuating labour costs or delayed agricultural outcomes due to seasonal harvesting cycles. Similar challenges have been noted in other rural development CBAs, where data scarcity necessitates pragmatic simplifications (Flyvbjerg, 2014). To enhance robustness, future assessments could employ sensitivity analyses to test assumptions against scenarios like extreme weather or shifting demographics (Drummond et al., 2015). Additionally, the short post-intervention period limits the evaluation of long-term sustainability, a common limitation in pilot-phase studies (White & Phillips, 2012).

11. Conclusion

The RoSPro impact assessment highlights the value of CBA as a decision-making tool for multi-sectoral interventions in fragile ecosystems. While methodological constraints exist, the alignment of economic returns, as it can deliver 4-8 times the worth of the total initial investment over a 20-year period, with socio-environmental priorities (e.g. water security, gender equity) underscores the project's replicability.

The project's success in improving water access, agricultural productivity, and road infrastructure demonstrates its potential for broader application. Its integrated approach, which combines efficient water management, agricultural support, and infrastructure improvements, serves as a customizable model for communities facing similar challenges. Key achievements include the establishment of efficient water collection systems that reduce the time spent fetching water, enabling community members to engage in more productive activities. Reliable irrigation systems have also led to higher crop yields and enhanced food security.

A strong emphasis on community engagement and participatory planning has been critical to the project's sustainability and long-term impact. By involving local communities in decision-making and implementation, the project has fostered a sense of ownership and responsibility, particularly among women, who have gained confidence by participating in construction activities. Community members have acquired practical skills in construction, resource management, and financial planning, preparing them for future opportunities and ensuring the project's outcomes can be sustained independently. It has improved livelihoods, increased household incomes, and reduced transportation costs, demonstrating its tangible impact on local economies. Enhanced water access has allowed farmers to cultivate more seasonal and off-season crops, thereby increasing food security. The project has also alleviated the physical burden of water collection, particularly for women and children, while fostering community unity through active participation in implementation.

The findings emphasize the need for integrated water and infrastructure management in vulnerable regions. Future interventions should prioritize the coordination of water resource management, road infrastructure, and agricultural development through holistic, community-driven approaches. Policymakers must advocate for the integration of watershed management and water conservation strategies into local and national planning frameworks, addressing issues such as spring contamination and water scarcity. Strengthening community involvement in planning and maintenance is essential for long-term sustainability, alongside securing financial support for ongoing maintenance and expansion of water systems.

The Soil and Watershed Conservation Office highlighted challenges in managing watersheds across administrative boundaries and limited budgets hindering comprehensive solutions. Programs like water intake construction, road runoff diversion, gully and gabion treatment, and plastic pond installation have effectively reduced soil erosion, improved water availability, and minimized the risk of natural disasters. Opportunities for improvement include strengthening collaboration with external organizations, enhancing staff capacity through technical training, and advocating for policy changes to support sustainable watershed management.

To ensure the RoSPro project's long-term success, a comprehensive monitoring framework is essential. This framework should include regular reassessments of costs and benefits, consider climate change impacts, and account for population growth. Integrating a Decision Support System

(DSS) will help facilitate data-driven decision-making, allowing for flexible and responsive management.

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Annex

Annex 1: Full breakdown CBA per site

* note that years 6-14 are hidden in the tables below

Chancala Devi Spring	End of Year												
Indicator	**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**15**	**16**	**17**	**18**	**19**	**20**
Cost													
Project Investment on Construction	NPR	1,514,780.74											
Assumed annual maintenance cost	NPR/year		45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42
Total Cost	NPR/year	1,514,780.74	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42	45,443.42
Benefit (Avoided Cost & Direct Benefit)													
Reduced Cost on Road Maintenance	NPR/year		24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00	24,816.00
Increased Fullfiled Household Water Demand	NPR/year		577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00	577,080.00
Time Saving for Do Other Activity	NPR/year		304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00	304,200.00
Total Benefit	NPR/year		906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00	906,096.00
Discounted Benefit	NPR/year		831,280.73	762,642.88	699,672.36	641,901.25	588,900.23	248,757.82	228,218.18	209,374.48	192,086.68	176,226.31	161,675.52
Discounted Cost	NPR/year	1,514,780.74	41,691.21	38,248.82	35,090.66	32,193.27	29,535.11	12,475.95	11,445.82	10,500.76	9,633.72	8,838.28	8,108.51
Discounted Cash-Flow	NPR/year	- 1,514,780.74	789,589.52	724,394.06	664,581.70	609,707.98	559,365.12	236,281.87	216,772.36	198,873.73	182,452.96	167,388.04	153,567.01
NPV per life-span	NPR/year	- 1,514,780.74	- 725,191.22	- 797.16	663,784.54	1,273,492.52	1,832,857.65	5,422,671.54	5,639,443.90	5,838,317.62	6,020,770.58	6,188,158.62	6,341,725.62
NPV in final period	**NPR**	**6,341,725.62**											
IRR	**%**	**44%**											
NPV in final period (EUR)	**EUR**	**43,250.57**											
NPV in final period per household	**NPR**	**1,056,954.27**											

Bhoje Spring	End of Year												
Indicator	**unit**	**0**	**1**	**2**	**3**	**4**	**5**	**15**	**16**	**17**	**18**	**19**	**20**
Cost													
Project Investment on Construction	NPR	1,535,673.64											
Assumed annual maintenance cost	NPR/year		46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21
Total Cost	NPR/year	1,535,673.64	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21	46,070.21
Benefit (Avoided Cost & Direct Benefit)													
Reduced Cost on Road Maintenance	NPR/year		22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67	22,058.67
Increased Fullfiled Household Water Demand	NPR/year		1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00	1,602,000.00
Time Saving for Do Other Activity	NPR/year		591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00	591,500.00
Total Benefit	NPR/year		2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67	2,215,558.67
Discounted Benefit	NPR/year		2,032,622.63	1,864,791.41	1,710,817.80	1,569,557.62	1,439,961.12	608,255.14	558,032.24	511,956.18	469,684.57	430,903.27	395,324.10
Discounted Cost	NPR/year	1,535,673.64	42,266.25	38,776.37	35,574.65	32,637.30	29,942.47	12,648.02	11,603.69	10,645.59	9,766.60	8,960.18	8,220.35
Discounted Cash-Flow	NPR/year	- 1,535,673.64	1,990,356.39	1,826,015.03	1,675,243.15	1,536,920.32	1,410,018.64	595,607.11	546,428.54	501,310.59	459,917.97	421,943.09	387,103.76
NPV per life-span	NPR/year	- 1,535,673.64	454,682.75	2,280,697.78	3,955,940.93	5,492,861.25	6,902,879.89	15,951,896.89	16,498,325.44	16,999,636.03	17,459,554.00	17,881,497.10	18,268,600.85
NPV in final period	**NPR**	**18,268,600.85**											
IRR	**%**	**121%**											
NPV in final period (EUR)	**EUR**	**124,591.86**											
NPV in final period per household	**NPR**	**1,405,276.99**											

Dhoje Spring						**End of Year**							
Indicator	**unit**	**0**	**1**	**2**	**3**	**4**	**5**	**15**	**16**	**17**	**18**	**19**	**20**
Cost													
Project Investment on Construction	NPR	1,152,651.88											
Assumed annual maintenance cost	NPR/year		34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56
Total Cost	NPR/year	1,152,651.88	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56	34,579.56
Benefit (Avoided Cost & Direct Benefit)													
Reduced Cost on Road Maintenance	NPR/year		24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67	24,126.67
Increased Fullfiled Household Water Demand	NPR/year		378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00	378,000.00
Time Saving for Do Other Activity	NPR/year		608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00	608,400.00
Total Benefit	NPR/year		1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67	1,010,526.67
Discounted Benefit	NPR/year		927,088.69	850,540.08	780,312.00	715,882.57	656,773.00	277,428.01	254,521.11	233,505.61	214,225.33	196,537.00	180,309.17
Discounted Cost	NPR/year	1,152,651.88	31,724.36	29,104.92	26,701.76	24,497.03	22,474.34	9,493.40	8,709.54	7,990.41	7,330.65	6,725.37	6,170.06
Discounted Cash-Flow	NPR/year	- 1,152,651.88	895,364.32	821,435.16	753,610.24	691,385.54	634,298.66	267,934.61	245,811.57	225,515.20	206,894.68	189,811.63	174,139.11
NPV per life-span	NPR/year	- 1,152,651.88	- 257,287.56	564,147.60	1,317,757.84	2,009,143.38	2,643,442.04	6,714,153.73	6,959,965.29	7,185,480.49	7,392,375.17	7,582,186.81	7,756,325.92
NPV in final period	**NPR**	**7,756,325.92**											
IRR	**%**	**69%**											
NPV in final period (EUR)	**EUR**	**52,898.14**											
NPV in final period per household	**NPR**	**430,907.00**											

Keshari Kharka Spring						End of Year							
Indictor	**unit**	**0**	**1**	**2**	**3**	**4**	**5**	**15**	**16**	**17**	**18**	**19**	**20**
Cost													
Project Investment on Construction	NPR	1,157,873.25											
Assumed annual maintenance cost	NPR/year		34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20
Total Cost	NPR/year	1,157,873.25	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20	34,736.20
Benefit (Avoided Cost & Direct Benefit)													
Reduced Cost on Road Maintenance	NPR/year		20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00	20,680.00
Increased Fullfiled Household Water Demand	NPR/year		550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00	550,800.00
Time Saving for Do Other Activity	NPR/year		143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00	143,000.00
Total Benefit	NPR/year		714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00	714,480.00
Discounted Benefit	NPR/year		655,486.24	601,363.52	551,709.65	506,155.64	464,362.98	196,151.94	179,955.91	165,097.16	151,465.29	138,958.98	127,485.30
Discounted Cost	NPR/year	1,157,873.25	31,868.07	29,236.76	26,822.72	24,608.00	22,576.14	9,536.41	8,749.00	8,026.60	7,363.86	6,755.83	6,198.01
Discounted Cash-Flow	NPR/year	- 1,157,873.25	623,618.17	572,126.76	524,886.93	481,547.65	441,786.83	186,615.53	171,206.91	157,070.56	144,101.43	132,203.15	121,287.29
NPV per life-span	NPR/year	- 1,157,873.25	- 534,255.08	37,871.68	562,758.61	1,044,306.26	1,486,093.09	4,321,329.75	4,492,536.66	4,649,607.22	4,793,708.66	4,925,911.80	5,047,199.09
NPV in final period	**NPR**	**5,047,199.09**											
IRR	**%**	**46%**											
NPV in final period (EUR)	**EUR**	**34,421.90**											
NPV in final period per household	**NPR**	**504,719.91**											

Annex 2: Rainfall and Spring Discharge Data

Table 10: Rainfall Data of Dhankuta Municipality.

Months	2080	2081	2082
Baihakh	-	133.5	171
Jestha	-	112.8	
Ashar	-	563.14	
Shrawan	-	510.3	
Bhadra	-	425.4	
Ashwin	-	580	
Kartik	-	2.2	
Mangsir	-	0	
Poush	-	0	
Magh	-	0	
Falgun	0.2	41.2	
Chaitra	75.7	0	

Table 11: Rainfall Data of Chhathar Jorpati Rural Municipality:

Months	2080	2081	2082
Baihakh	-	203	142.8
Jestha	-	220.2	
Ashar	-	753.8	
Shrawan	-	517	
Bhadra	-	585.2	
Ashwin	-	654.4	
Kartik	-	0	
Mangsir	-	0	
Poush	-	0	
Magh	-	0	
Falgun	0	5	
Chaitra	171	82	

Table 12: Chanchala Devi Spring Discharge Data.

Month-Date	2080	2081	2082
Baisakh 1		3.479605645	3.722854188
Baisakh 15		3.141361257	3.718240033
Jestha 1		-	
Jestha 15		-	
Ashar 1		-	
Ashar 15		-	
Shrawan 1		-	
Shrawan 15		-	
Bhadra 1		5.741626794	
Bhadra 15		5.730659026	
Ashwin 1		5.696202532	
Ashwin15		5.710659898	
Kartik 1		5.685407454	
Kartik 15		5.690799874	
Mangsir 1		5.747126437	
Mangsir 15		5.710659898	
Poush 1		6.543075245	
Poush 15		7.255139057	
Magh 1		7.114624506	
Magh 15		6.976744186	
Falgun 1	0.7737941708	6.293706294	
Falgun 15	1.698754247	5.882352941	
Chaitra 1	0.4614201487	4.209541628	
Chaitra 15	0.3790670738	3.828972559	

Table 13: Bojhe Spring Discharge Data.

Month-Date	2080	2081	2082
Baisakh 1	-	2.310358106	8.31792976
Baisakh 15	-	3.322872439	7.610993658
Jestha 1	-	-	
Jestha 15	-	-	
Ashar 1	-	-	
Ashar 15	-	-	
Shrawan 1	-	-	
Shrawan 15	-	-	
Bhadra 1	-	8.035714286	
Bhadra 15	-	9.610250934	
Ashwin 1	-	9.605122732	
Ashwin15	-	9.63081862	
Kartik 1	-	9.533898305	
Kartik 15	-	9.814612868	
Mangsir 1	-	9.771986971	
Mangsir 15	-	9.63081862	
Poush 1	-	14.63414634	
Poush 15	-	14.35406699	
Magh 1	-	14.28571429	
Magh 15	-	13.33333333	
Falgun 1	3.532875368	8.108108108	
Falgun 15	2.477291495	7.258064516	
Chaitra 1	1.78412132	8.754863813	
Chaitra 15	2.759889604	8.551068884	

Table 14: Keshari Kharkha Spring Discharge Data.

Month-Date	2080	2081	2082
Baisakh 1	-	4.07239819	5.690799874
Baisakh 15	-	3.900325027	5.625879044
Jestha 1	-	3.284671533	
Jestha 15	-	3.269160915	
Ashar 1	-	3.747657714	
Ashar 15	-	4.991680532	
Shrawan 1	-	7.17989629	
Shrawan 15	-	7.317073171	
Bhadra 1	-	11.51631478	
Bhadra 15	-	12.84796574	
Ashwin 1	-	14.47527141	
Ashwin15	-	25.78796562	
Kartik 1	-	8.864811623	
Kartik 15	-	7.142857143	
Mangsir 1	-	7.06991359	
Mangsir 15	-	6.672845227	
Poush 1	-	6.432017152	
Poush 15	-	6.268500784	
Magh 1	-	6.058566139	
Magh 15	-	5.876591577	
Falgun 1	4.522613065	5.978080372	
Falgun 15	4.230317274	5.745292052	
Chaitra 1	4.368932039	5.710659898	
Chaitra 15	4.255319149	5.649717514	

Table 15: Dhoje Dhara Pani Spring Discharge Data.

Month-Date	2080	2081	2082
Baisakh 1	-	10.52631579	13.62088536
Baisakh 15	-	10.31518625	13.70384469
Jestha 1	-	10.84337349	
Jestha 15	-	11.25703565	
Ashar 1	-	12.56106071	
Ashar 15	-	14.07349492	
Shrawan 1	-	15.76872536	
Shrawan 15	-	18.84816754	
Bhadra 1	-	22.67002519	
Bhadra 15	-	28.66242038	
Ashwin 1	-	31.11495246	
Ashwin15	-	31.71806167	
Kartik 1	-	30.12552301	
Kartik 15	-	29.41176471	
Mangsir 1	-	27.86377709	
Mangsir 15	-	22.3325062	
Poush 1	-	20.2247191	
Poush 15	-	18.75	
Magh 1	-	14.66395112	
Magh 15	-	13.0198915	
Falgun 1	11.32075472	12.78409091	
Falgun 15	11.61290323	13.44286781	
Chaitra 1	11.14551084	13.85148134	
Chaitra 15	10.90909091	13.29394387	

Annex 3: Pictures from FGD, HHS and KII.

FGD

HHS

KII:

Annex 4: Water quality test report

Before Intervention Laboratory Test Result

Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- META-META
Sampled By:- :- META-META
Source of Sample:- Spring
Sampling Point:- Source(Chanchala Devi)
Location:- Dhankuta-1, Dhankuta
GPS:-

Sample Code:- C-657
Date of Collection:- 2080/12/05
Date of Analysis:- 2080/12/05
Date of Completion:- 2080/12/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.5	5	2130 B, APHA, 21st EDITION
2		Temp. ^{0}c	25	-	2550 B, APHA, 21st EDITION
3		pH	6.9	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	75	1500	2510 B, APHA, 21st EDITION
5	Chemical	Iron (mg/L)	<0.2	0.3 (3)	3111 B. APHA, 21st EDITION
6		Total Hardness (mg/L as $CaCO_3$)	20	500	2340 C, APHA, 21st EDITION
7	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	5	0	9222 D., APHA,21st EDITION

APHA: *American Public Health Association, Standard Methods for Examination of Water & Waste Water*
** These values show lower and upper limits.*
() Values in parentheses refer the acceptable values only when alternative is not available.
The entire test was conducted as per the National Drinking Water Quality Standard Guide Line, 2062BS
Note: 1. The above results refer only to the submitted sample and test performed.
2. This report cannot be used for any publicity or advertisement without the written consent of this lab.
3. Test report shall not be reproduced in full, without written approval of the laboratory.

Analyzed by
Shiva Kumar Poudyal
Assistant Chemist

Approved by
Ramesh Kumar Yadav
Chemist

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Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- META-META
Sampled By:- :- META-META
Source of Sample:- Spring
Sampling Point:- Source(Bojhe)
Location:- Dhankuta-1, Dhankuta
GPS:-

Sample Code:- C-658
Date of Collection:- 2080/12/05
Date of Analysis:- 2080/12/05
Date of Completion:- 2080/12/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.0	5	2130 B, APHA, 21st EDITION
2		Temp. ^{0}c	25	-	2550 B, APHA, 21st EDITION
3		pH	7.2	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	47	1500	2510 B, APHA, 21st EDITION
5	Chemical	Iron (mg/L)	<0.2	0.3 (3)	3111 B. APHA, 21st EDITION
6		Total Hardness (mg/L as $CaCO_3$)	12	500	2340 C, APHA, 21st EDITION
7	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	9222 D., APHA,21st EDITION

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** These values show lower and upper limits.*
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Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- META-META
Sampled By:- :- META-META
Source of Sample:- Spring
Sampling Point:- Source(Dhoje Dharapani)
Location:- Chhatar-2, Dhankuta
GPS:-

Sample Code:- C-660
Date of Collection:- 2080/12/05
Date of Analysis:- 2080/12/05
Date of Completion:- 2080/12/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.3	5	2130 B, APHA, 21st EDITION
2		Temp. ^0c	25	-	2550 B, APHA, 21st EDITION
3		pH	6.8	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	54	1500	2510 B, APHA, 21st EDITION
5	Chemical	Iron (mg/L)	<0.2	0.3 (3)	3111 B. APHA, 21st EDITION
6		Total Hardness (mg/L as $CaCO_3$)	16	500	2340 C, APHA, 21st EDITION
7	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	9222 D., APHA,21st EDITION

APHA: *American Public Health Association, Standard Methods for Examination of Water & Waste Water*
** These values show lower and upper limits.*
() Values in parentheses refer the acceptable values only when alternative is not available.
The entire test was conducted as per the National Drinking Water Quality Standard Guide Line, 2062BS
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Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- META-META
Sampled By:- :- META-META
Source of Sample:- Spring
Sampling Point:- Source(Keshari Kharkha)
Location:- Chhatar-2, Dhankuta
GPS:-

Sample Code:- C-659
Date of Collection:- 2080/12/05
Date of Analysis:- 2080/12/05
Date of Completion:- 2080/12/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.2	5	2130 B, APHA, 21st EDITION
2		Temp. ^0c	25	-	2550 B, APHA, 21st EDITION
3		pH	6.6	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	108	1500	2510 B, APHA, 21st EDITION
5	Chemical	Iron (mg/L)	<0.2	0.3 (3)	3111 B. APHA, 21st EDITION
6		Total Hardness (mg/L as $CaCO_3$)	32	500	2340 C, APHA, 21st EDITION
7	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	16	0	9222 D., APHA,21st EDITION

APHA: *American Public Health Association, Standard Methods for Examination of Water & Waste Water*
** These values show lower and upper limits.*
() Values in parentheses refer the acceptable values only when alternative is not available.
The entire test was conducted as per the National Drinking Water Quality Standard Guide Line, 2062BS
Note: 1. The above results refer only to the submitted sample and test performed.
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After Intervention Laboratory Test Result

Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- Meta- Meta Research
Sampled By:- :- Meta- Meta Research
Source of Sample:- Spring
Sampling Point:- Source(Dhoje)
Location:- Chhatar-2, Dhankuta
GPS:-

Sample Code:- J-651
Date of Collection:- 2082/02/06
Date of Analysis:- 2082/02/06
Date of Completion:- 2082/02/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.0	5	2130 B, APHA, 21st EDITION
2		Temp. ^{0}c	25	-	2550 B, APHA, 21st EDITION
3		pH	6.9	6.5 – 8.5 *	4500-H$^+$ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	88	1500	2510 B, APHA, 21st EDITION
6	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	9222 D., APHA,21st EDITION

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Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- Meta- Meta Research
Sampled By:- :- Meta- Meta Research
Source of Sample:- Spring
Sampling Point:- Source(Keshari)
Location:- Chhatar-2, Dhankuta
GPS:-

Sample Code:- J-652
Date of Collection:- 2082/02/06
Date of Analysis:- 2082/02/06
Date of Completion:- 2082/02/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.0	5	2130 B, APHA, 21st EDITION
2		Temp. ^{0}c	25	-	2550 B, APHA, 21st EDITION
3		pH	7.2	6.5 – 8.5 *	4500-H$^+$ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	104	1500	2510 B, APHA, 21st EDITION
6	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	16	0	9222 D., APHA,21st EDITION

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Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
Biratnagar
Water Quality Testing Laboratory
Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- Meta- Meta Research
Sampled By:- :- Meta- Meta Research
Source of Sample:- Spring
Sampling Point:- Source(Chanchaladevi)
Location:- Dhankuta-1, Dhankuta
GPS:-

Sample Code:- J-653
Date of Collection:- 2082/02/06
Date of Analysis:- 2082/02/06
Date of Completion:- 2082/02/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.0	5	2130 B, APHA, 21st EDITION
2		Temp. ^0c	25	-	2550 B, APHA, 21st EDITION
3		pH	7.1	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	78	1500	2510 B, APHA, 21st EDITION
6	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	9222 D., APHA,21st EDITION

APHA: *American Public Health Association, Standard Methods for Examination of Water & Waste Water*
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Department of Water Supply and Sewerage Management
Federal Water Supply & Sewerage Management Project
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Itahari, Sunsari

WATER QUALITY TEST REPORT

Name of Client:- Meta- Meta Research
Sampled By:- :- Meta- Meta Research
Source of Sample:- Spring
Sampling Point:- Source(Bhoje)
Location:- Dhankuta-1, Dhankuta
GPS:-

Sample Code:- J-654
Date of Collection:- 2082/02/06
Date of Analysis:- 2082/02/06
Date of Completion:- 2082/02/07

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Methods Used
1	Physical	Turbidity (NTU)	0.0	5	2130 B, APHA, 21st EDITION
2		Temp. ^0c	25	-	2550 B, APHA, 21st EDITION
3		pH	7.4	6.5 – 8.5 *	4500-H^+ B, APHA, 21st EDITION
4		Electrical Conductivity (µs/cm)	60	1500	2510 B, APHA, 21st EDITION
6	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	9222 D., APHA,21st EDITION

APHA: *American Public Health Association, Standard Methods for Examination of Water & Waste Water*
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The entire test was conducted as per the National Drinking Water Quality Standard Guide Line, 2079BS
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