# 6.1 MULTI USE WATER SERVICES: ECONOMIC COST-BENEFIT ANALYSIS UNDER RURAL VILLAGE WATER RESOURCES MANAGEMENT PROJECT (RVWRMP) SCHEMES IN FAR WEST NEPAL

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## INTRODUCTION AND BACKGROUND

Efficient and optimum use of water resources and effectiveness of investment are important aspects for the investment on water resource management projects. This study focuses on the economic costs and benefits among standalone drinking water systems and multiple use water systems of the selected gravity flow technology implemented by Rural Village Water Resource Management Project (RVWRMP) in rural hills of Far West of Nepal. Through this cost-benefit analysis, it gets insight on the indicators and their economic value in monetary terms. World Health Organization, World Bank, Asian Development Bank, etc. have conducted many studies using cost-benefit analysis for standalone Water, Sanitation and Hygiene (WASH) projects, but there are rare documents that combines two types of projects (drinking water and irrigation) in a single study. So, this study combines both types of water use schemes. The Rural Village Water Resource Management Project (RVWRMP) has been working in the most remote and least developed areas of Nepal. It focuses on hill and mountain Village Development Committees (VDCs) of 10 districts (8 districts in Far-west region,

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now Province No.7-Achham, Baitadi, Bajhang, Bajura, Dadeldhura, Darchula, Doti and Kailali; and 2 districts in Mid-Western region, now Province No. 6 -Dailekh and Humla). The first phase of the project started in 2006 and continued to the second phase up to 2016. The third phase is ongoing from 2016 to 2021 as a completion phase (RVWRMP I, 2010; RVWRMP II, 2016; RVWRMP III, 2016).

The entry point of RVWRMP at the community level is the water use master plan (WUMP) of the working VDCs. This supports the planning and prioritisation of the drinking water supply, irrigation, improved water mills, micro-hydro and multi-use water system schemes. Sanitation and hygiene, livelihoods, cooperative development and improved cooking stoves, along with capacity building activities, are major components of the schemes. (White et al., 2017; RVWRMP II, 2015; Rautanen et al., 2014).

## LITERATURE REVIEW

### Cost-Benefit Analysis for Water Services

Water scarcity has reached, or is likely to reach, crisis proportions worldwide. Multiple uses of water are rising, increasing the draft on the limited potential. (Shah, 2005).

Cost-benefit analysis is a major tool to identify the areas for investment to optimize the resources with greater benefits. Furthermore, cost-benefit analysis can play an important role in legislative and regulatory policy debates on protecting and improving health, safety and the natural environment. The range of costs and benefits considered can vary widely. At one extreme a narrow private sector CBA (sometimes called a financial estimate) would use market prices and look only for costs supported by a small predefined group of stakeholders, usually the owners of the assets, or the project's developers, and the benefits accruing to them. On the other extreme, national, social or economic CBA would aim to assess all costs supported and benefits accruing to society at large, regardless of how they are distributed. Moreover, this economic CBA would use accounting (or shadow) prices to correct or complement market prices if they are lacking or do not reflect true economic scarcity. Moving from financial estimates to economic CBA is more easily said than done. (Gutman, 2002).

Many studies have been conducted on cost-benefit analysis on the use of water resources. However, most of them are on standalone systems.

The World Health Organisation (WHO) revealed that the cost-benefit ratio of water, sanitation and hygiene interventions is high when all benefits are included, standing at between US$ 5 and US$ 11 economic benefit per US$ 1 investment for most developing world sub-regions and for most intervention. (Hutton, 2004). For the evaluation of the Cost and Benefit of Water and Sanitation Improvements at the Global level, three dimensions have been considered; i. Direct economic benefits of avoiding diarrhoeal diseases, ii. Indirect economic benefits related health improvement, and iii. Non-health benefits related to water and sanitation improvement. The value of life has been analysed by using a human capital approach and sensitivity analysis for different discounted rates.

Another study has been conducted by IWMI in 2015. According to the study, Multiple Use Water Systems (MUS) are more resilient than single-use water supply systems in the context of Nepal: 87.5% of the MUS surveyed are still fully functional or need minor repair versus 56.8% of the single-use domestic supply systems surveyed in the NMIP and DWSS study. However, the MUS surveyed did show a high level of resilience in a context where MUS does not have yet its institutional niche and where it might be therefore more difficult for MUS water users to leverage external funds for repair, maintenance and upgrade. For the systems surveyed, the payback period is less than a year (8 months and a half) and the cost benefit ratio is 11 (excluding non-monetary benefits reported by water users such as enhanced nutrition and improved health, better sanitation and time saved). (IWMI, 2015).

Water is vital for human life, and it has multiple uses including domestic as well irrigation and other uses. Most of the systems are standalone systems, for example: drinking water supply, irrigation, hydro-power or recreational use. There are various cost-benefit analyses being undertaken of such systems. However, the approaches and methodologies of cost-benefit analysis are different among such studies. For example, in the above two studies, WHO has included health and economic benefits but IWMI has only calculated the marketable production. For this reason it is not possible to make comparisons between the economic benefits from standalone drinking water systems and multiple use water systems. Hence, this study compares and identifies the appropriate approach for investments.

Climate change has affected natural resources. In particular, depletion of fresh water resources is a global threat. Nepal is one of the high-risk countries for climate change. On the other hand, most organizations, including the Government of Nepal, have departments and projects for standalone systems (irrigation, drinking water supply, orhydro power energy). In this context, it is difficult to find strategies to cope with climate change's effects through optimizing water resources.

**Opportunities for integrated water management in the Nepalese context**

The Water Resources Strategy (WRS) of Nepal, 2002, aims to improve the living standard of Nepalese people in a sustainable manner. IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. (National Water Plan, 2005).

Further, the Water Resource Act 1992 has segregated the priority of different uses of water in the following way:

1) Drinking water and domestic use, 2) Irrigation, 3) Agricultural use such as animal husbandry, fisheries, 4) Hydroelectricity, 5) Cottage industry (e.g. water mill or grinder), industrial enterprises and mining, 6) Navigation, 7) Recreational use, and 8) Other uses.

Furthermore, the new Constitution of Nepal (2015) has expressed the commitment of the state for the development of water resources (Article 51). It states "the state shall pursue a policy of prioritizing national investment in water resources based on people's participation and making a multi-utility development of water resource". However, there are many laws and related acts are yet to be developed to unfold the statements of the Constitution into practices.

**Multiple –Use Water System (MUS)**

A multiple-use water system (MUS) is an improved approach to water resource management, which taps and stores water and distributes it to farm households in small communities to meet both domestic and agricultural needs (iDE Nepal, 2015). It is a community-managed system that caters mainly to small landowners and marginal households in rural  areas and helps to alleviate poverty and increase food security for poor and marginalized groups. The first priority is to provide drinking water and water for domestic use to the community; any excess water is used for agriculture and irrigation. (ICIMOD, 2013).

We consider here that MUS does not include the mega projects of water management. It only considers the small scale community-managed water resource schemes that are designed in such a way which can be used for two or more functions or services. In a real sense, MUS can unfold the concept of integrated water management (IWRM) at the community level.

**Water Use Master Plan (WUMP) as a Participatory Planning Approach**

The WUMP is a participatory and inclusive approach for integrated planning and management of water resources (described in Figure 1). Taking Integrated Water Resource Management (IWRM) as the foundation, it assesses the total water budget and its potential uses, focusing on a unit area. The WUMP encompasses capacity development of local communities and local institutions to improve the planning for equitable and efficient use of water to improve water supply and livelihoods. This is particularly important within a smaller unit of a watershed like a Village Development Committee (VDC) or one or two wards, for management at community level. (http://wumpdata.com/wumpdata/).

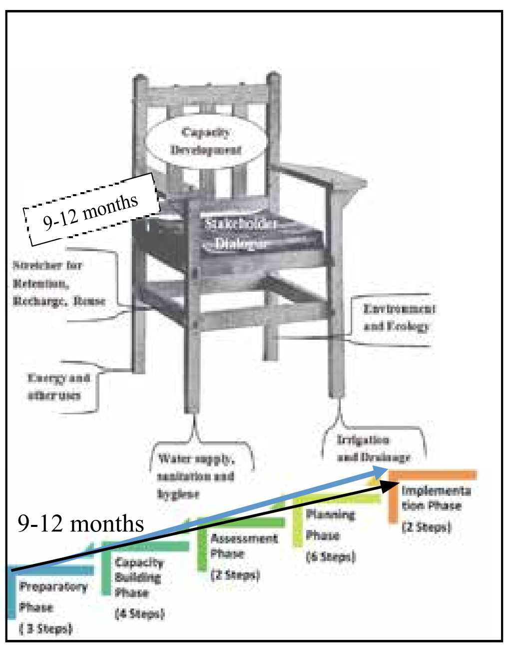


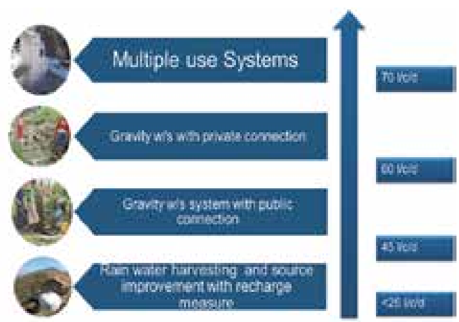

*Figure 1: WUMP chair and working steps*

Water Resource Management Project (WARM-P) / HELVETAS (a Swiss NGO) is a pioneer of WUMP in Nepal, and WUMPs have been massively used by RVWRMP in the Far and Mid-Western Development Region of Nepal. The WUMP can be considered in two ways: as an approach and as a product. The WUMP approach gives more emphasis on the participatory process of data collection, analysis, debate, prioritization and agreement, and recording the results for public display. It incorporates many issues such as the inclusion of all stakeholders (especially women and disadvantaged or vulnerable groups); and an integrated and coordinated planning for synergy with other sectors associated with water, health and livelihoods.

WUMP as a product is a plan for optimal use of water resources considering overall water resource, hygiene and sanitation, water demands and potential uses in a holistic and integrating way for sustainable development. Building Climate Resilience of Watersheds in Mountain Eco-Regions (BCRWME) project is also developing a detailed plan for scoping water uses. Hence, in any form of water use master plan, it is important to identify the best method of water management. The WUMP preparation is a process oriented approach with 5 phases and 17 steps and needs to be closely coordinated and steered by the concerned VDC authorities to ensure commitment and ownership of the plan by the local authorities, political parties and the communities. Similarly, the district development committees endorse the final WUMP and thus must be involved in its preparation and resources mobilization. However, village and district development committees at present do not have all required human resources and professionals to prepare the WUMP by themselves. External financial and human resources are necessary to facilitate, and assist them and communities in the participatory resource inventory and planning process. Realizing the importance of WUMP, the National Water Use Master Plan (WUMP) guideline was recently developed jointly by two ministries, the Ministry of Water Supply and Sanitation and the Ministry of Federal Affairs and Local Development, to facilitate the process of water resources management.

## MULTI-USE WATER SYSTEM IN WUMP

**Figure 2: Scheme identification according to source yield per-capita**




The Multi-Use Water System (MUS) has been introduced in RVWRMP as a means to maximise benefits for communities. Analysis of water source yield/supply and water demand for domestic uses to the communities is important while designing the MUS. All water sources around the micro-watershed (focus to administrative boundary of VDCs) are carefully measured and analysed, and recommendations are made regarding their best potential uses, as Figure 2, during WUMP preparation process.

Based on availability of water resources around the VDCs and their yield capacity, different type of MUS are explored during WUMP process (as in Figure 3) and prioritized by communities for implementation. A total of 107 VDCs have prepared a WUMP in technical and financial collaboration with RVWRMP between the years 2007-2015.

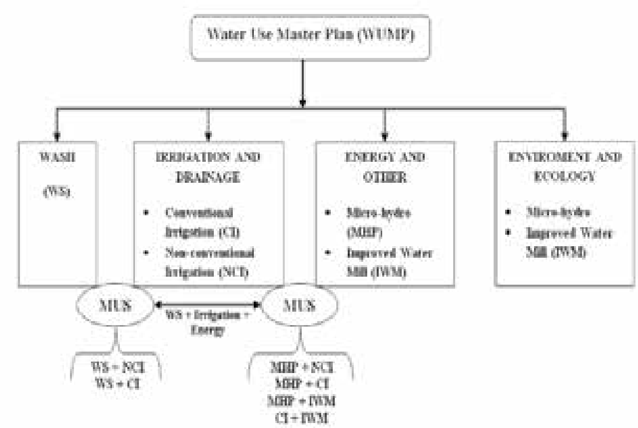



**Table 1: Identified MUS by WUMP and implemented by RVWRMP**

| MUS Type | Identified in WUMP | Implemented by RVWRMP (2007 - 2015) |
|---|---|---|
| IWM + CI | 223 | 7 |
| IWM + MHP | 14 | 1 |
| IWM + MHP + CI | 51 | 2 |
| MHP + CI | 70 | 6 |
| WS + CI | 8 | 8 |
| WS + NCI | 169 | 24 |
| MHP + CI + WS | 1 | 2 |
| IWM + NCI | 13 | 0 |
| WS + CI + IWM | 18 | 0 |
| WS + CI + IWM + MHP | 3 | 0 |
| WS + IWM | 1 | 0 |
| WS + IWM + MHP | 1 | 0 |
| WS + NCI + MHP | 2 | 0 |
| WS + NCI + IWM | 6 | 0 |
| **Total** | **580** | **50** |

580 different MUS schemes have been identified, as explained in Table 1, out of which 50 MUS schemes have been already implemented by RVWRMP from 2007 to 2015. Among RVWRMP-implemented MUS schemes, 24MUS schemes are with the combination of Drinking Water Supply (WS) + Non-Conventional Irrigation (NCI), which is the focus of this study (ref: Table 1).

## OBJECTIVES OF THE STUDY

The main objective of this study is to analyse the economic costs and benefits among standalone drinking water systems and multiple use water systems of the selected gravity flow technology implemented by Rural Village Water Resource Management Project (RVWRMP) in rural hills of Far West of Nepal.

Specific objectives of the study are:

- To analyse the economic cost benefits of standalone drinking water systems and multiple use water systems, especially using micro irrigation along with drinking water.
- To identify the key issues of the schemes relating to sustainability, climate resilience and food security perspectives.

- To guide the further research on expanded sample size and future in-depth analysis at whole scheme level, after getting feedback from the audience.

**LIMITATIONS OF THE STUDY**

- This study covers very small number of sample households, i.e. 16 households (8 households from MUS schemes and 8 households of standalone WASH schemes). Hence, it is not appropriate to multiply by total households to get the total value of the whole schemes.
- Since, all sample schemes are selected from RVWRMP, all selected standalone WASH schemes have integration of basic livelihood activities, like intervention of home gardens, in line with project basic practices. Hence, it cannot be compared with other WASH schemes that do not have such basic livelihood interventions.
- This study has not considered the detail of sustainability indicators of the schemes. However, on a few indicators of sustainability, issues have been briefly discussed during focus group discussions.
- The authors are staff of RVWRMP therefore they have very in-depth understanding of the project area. However, there is a risk that community members are influenced. The authors have aimed to bear this in mind during analysis of the qualitative data.

**METHODOLOGY**

This research has utilised mixed-methods, and considered both quantitative and qualitative aspects. Quantitative aspectsof this study compare the direct cost and benefits, whereas qualitative aspects consider how community people manage the scarce water resources and how the adaptation allows them to cope with climate change's effects. This study has taken very small purposive sample of 8 schemes, i.e. 4 MUS schemes (especially with a composition of drinking water + micro irrigation technology) and 4 standalone WASH schemes. Focus group discussions among user committee members, individual household interviews and interviews with project's key staff have been conducted to access qualitative information during this study.

The area of the study has covered three VDCs of three districts in the following way (Table 2):

**Table 2:** Study area, sample schemes and completion year

| District / VDC | MUS Schemes | Standalone WS Schemes |
|---|---|---|
| **Darchula** | | |
| Chhapari | DandaDaha MUS (2014) | Tatopani WS (2014) |
| | | Baba WS (2013) |

| | | |
|---|---|---|
| **Doti** | | |
| ChawaraChautara | Bunnesim MUS (2015) | Pitarmath WS (2015) |
| | Chhadekhola MUS(2015) | |
| **Dadeldhura** | | |
| Rupal | Sobigada MUS (2015) | Dubid WS(2015) |

The Benefit / Cost Ratio (B/C Ratio) approach has been taken into consideration with the following formula to calculate the B/C ratio of standalone drinking water supply ($B/C_{ws}$):

$$B/C_{WS} = \left[\frac{B_0}{(1+i)^0} + \cdots + \frac{B_T}{(1+i)^T}\right] \div \left[\frac{C_0}{(1+i)^0} + \cdots + \frac{C_T}{(1+i)^T}\right]$$

Formula to calculate B/C ratio of multiple use water system (MUS), especially micro irrigation along with drinking water supply, ($B/C_{MUS}$) can be expressed as following:

$$B/C_{WS} = \left[\frac{B_0}{(1+i)^0} + \cdots + \frac{B_T}{(1+i)^T}\right] \div \left[\frac{C_0}{(1+i)^0} + \cdots + \frac{C_T}{(1+i)^T}\right]$$

Here,

$B/C_{ws}$= B/C ratio of standalone drinking water supply; $B/C_{MUS}$ = B/C ratio of multiple use water system (MUS); B = benefit calculated for the year "T", and i = discount rate

A 3% discount rate has been applied in this study as it seems justifiable to align with Global Burden of Disease specified by the Disability Adjusted Life Years (DALY) and the Quality Life Adjusted Years (QALY). (Hotton, G., 2015; Adhikari, N., 2012; WHO, 2010).

The cost and benefits have been calculated based on the revealed preference theory. The following table reflects the contributor indicators to benefits and costs.

**Table 3:** Contributor indicators on benefit and cost

| Benefit contributor indicators | Cost contributor indicators |
|---|---|
| Saving on health expenditures more than before | Share of the household on the initial scheme cost (Water, sanitation, hygiene, irrigation and Poly-house) |
| Market value of agricultural products (increased after the scheme implementation) | Value of time spent to establish the scheme as well as to maintain it (meeting, training, mobilizing, activities on farm / livelihood production and selling / marketing, etc.) |
| Increased value of land due to the facilities (as compared to the nearest land that does not have such facilities) | Transportation to take production to the market. |

| | |
|---|---|
| Value of saved time that is utilized by the household | Value of depreciation of the scheme |
| Value of changed food menu (Lunch and Supper) due to vegetable production | Major input costs (seeds / pesticides / vitamins, manure, tools &equipment, etc.) |
| Value from employment opportunities at household level | Value of opportunity cost after engaging at household level livelihood activities. |
| How households value their regular water resources from which the schemes have been built (Existence value of water resources). | |

**FINDINGS AND ANALYSIS WITH AN EMPHASIS ON RESOLVABLE CHALLENGES**

**General Notes on Benefit-CostRatio (B/C Ratio)**

There are many indicators, as mentioned in the Table 3 above, that have been converted into monetary terms. Some of the valuable indicators could not be converted into monetary terms, such as nutritional value after increased food intake, increased educational level of the children, other opportunities created after the income from vegetable sales, value ofwater optimization and climate resilience, etc. However, after the monetary value gained from the measured indicators, the B/C Ratio at the sample household level of standalone WASH scheme was found to be 4.12, and at the household level, the B/CRation of MUS (WS + MIT) was found to be 5.07.This means one rupee investment gives 0.95 paisa more return from MUS schemes than a standalone WASH scheme with livelihood intervention.

**Accountability and Ownership Issues of Water User Committees**

Legal identity and institutional development of the Water User Committee (WUC) is important for long term sustainability of water systems. (White et al, 2015). It should be ensured through registration of the WUC under the Water Resources Act (2049, Nepal), and enhancing the capacity of WUC members in different aspects before implementation of schemes. RVWRMP provides technical support to institutionalize the WUCs and ensures their registration before construction initiation. The Project also provides different types of trainings as a part of institutional development and capacity building of WUC members. WUCs are the main actors responsible for regular operation & maintenance (O&M) of the schemes, to ensure the system functionality and better services, including safe and adequate water supply to communities throughout the design period. However, in general, most of WUCs are active before and during construction of the system; but become inactive after completion of construction activities. This has a negative impact on the functionality of services and soon after the benefits of water schemes diminish and water productivity decreases.

Overall, the results of the study found average impacts of WUCs ownership towards the system. All schemes studied are fully functional, a village maintenance worker (VMW) is mobilized in each scheme, the community is paying an incentive to the VMW, and the water tariff is fixed and collected. WUC members and users are aware of various water-related issues and are empowered regarding their rights to water. Most importantly sanitation and hygiene, and livelihood opportunities have improved significantly. However, still many challenges exist regarding the scheme. This includes some problems still regarding the WUCs ownership of the water system – demonstrated by indicators such as regular WUC meetings, regular water tariff collection, equitable water distribution, transparency, ensuring the water quality, market linkages development, retaining the VMW, O&M fund mobilization, etc.

**Availability and Accessibility Dimension of Food Security**

Food availability and accessibility are major components of food security. Even if food is physically available in a region or country, it may not be accessible if households lack purchasing power. (FAO, 2016). It has been significantly observed that, due to the basic livelihood interventions even in standalone WASH schemes, households have been producing vegetables and adding them in their lunch and supper menus, at least on a seasonal basis. In contrast, in MUS schemes, households have access to vegetables the whole year round, via off-seasonal vegetable production. Hence, in the sampled households, it has been observed the varieties of crop have increased from paddy rice, oil crops and limited seasonal vegetables; to more varieties of seasonal as well off-seasonal vegetables, along with other traditional crops.

One of the direct benefits that can be seen from MUS schemes is expansion of irrigable land through the intervention of technology. The sampled four MUS schemes have converted 19.9 hectares to irrigable land. This definitely contributes to increase the national irrigable land and the quantity of food production.

**Climate Resilience Perspective**

In Nepal, changes in weather patterns and increased frequency of extreme events threaten to exacerbate existing threats to food security, as agriculture yields and production decrease and water scarcity increases (Krishnamurthy et al., 2013). A study done by Rural Water Supply & Sanitation Project, Western Nepal (RWSSP-WN) in nearly 2,400 sources between the years 2004 and 2014 in Tanahun district, showed that there is 50% reduction in average yield of point sources (springs) over ten years (RWSSP-WN 2015). Such kind of study has not been done yet at the study area but while analysing the rainfall data of Department of Hydrology & Meteorology of Dadeldhura, the annual total rainfall and rainfall days of Dadeldhura (Far-western Nepal) is decreasing as shown in figure 4. Decreasing the rainfall directly affect the recharge of springs/ground water; which are verified by the communities while in interview. It shows the value of water is increasing daily to fulfil the future demands of domestic and other uses. Shifting climate patterns are likely to have negative impact across most populations with strong impacts on vulnerable populations already facing minimal livelihood options and least able to adapt to climate stressors.

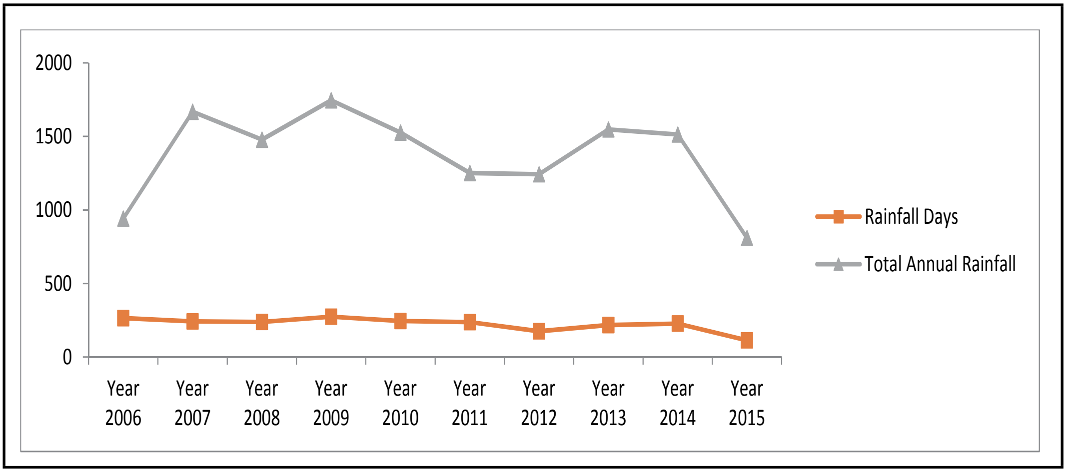



**Figure 4:** Annual rainfall and rainfall days of Dadeldhura

*Source: Department of Hydrology and Meteorology, 2016*

Overall, people interviewed in the current study were found to have limited knowledge regarding climate change effects in the study area, and they have taken very few steps towards mitigation initiatives. They report that water yields of sources are depleting, the cropping pattern changed, there is less winter rainfall, and heavy rainfall during the short monsoon period. Yet despite this, they have not developed regular source water yield monitoring mechanisms; and they also have not carried out any water source recharge initiatives yet.

With whatever water is available from the present water sources/system, communities are maximizing water productivity for domestic uses, home garden management and agriculture production for income generation. Table 4 shows the total availability of water for their productive uses. As can be seen there is considerable variation in water availability, ranging from 17,280 to 43,200 litres/day for domestic and other productive uses. Project has designed to tap maximum water from source considering the future demand and climate change effects. Excess water (more than domestic use) is used in home garden and agro-production mainly to vegetable farming and also promoting waste water for their kitchen garden management. This has consequences for the possibility to use water for productive purposes. Hence, in Dubid WS Rupal, once water is used for domestic purposes there are only 320 litres/household/day left for irrigation. On the other hand, in Danda Daha MUS in Chhapari, there are 1,550 litres/household/day available for irrigation.

| Scheme Name | HH covered | Popn. | Design Yield (lps) | Total Water Availability/day | Present Household water demand (Lit/day) | Surplus water for irrigation (Day) | Water available for irrigation/HH (lit/Day) |
|---|---|---|---|---|---|---|---|
| Danda Daha MUS, Chhapari, Darchula | 23 | 168 | 0.5 | 43,200 | 7,560 | 35,640 | 1,550 |
| Tatopani WSS, Chhapari, Darchula | 16 | 121 | 0.3 | 25,920 | 5,445 | 20,475 | 1,280 |
| Bunnesim MUS, Chamara Chautara-7, Doti | 18 | 137 | 0.34 | 29,376 | 6,165 | 23,211 | 1,290 |
| Pitarmath WSS, Chamara Chautara -7, Doti | 59 | 325 | 0.38 | 32,832 | 14,625 | 18,207 | 309 |
| Chhadekhola MuS, Chamara Chautara-7, Doti | 13 | 72 | 0.29 | 25,056 | 3,240 | 21,816 | 1,678 |
| Baba WSS, Chhapari -1, Darchula | 23 | 176 | 0.31 | 26,784 | 7,920 | 18,864 | 820 |
| Dubid WSS, Rupal - 8, DDL | 27 | 192 | 0.2 | 17,280 | 8,640 | 8,640 | 320 |
| Sobigada MUS, Rupal, Dadeldhura | 22 | 120 | 0.5 | 43,200 | 5,400 | 37,800 | 1,718 |

**Table 4:** Availability of Water at Sampled Schemes and Their Possible Productive Use

**Standalone versus MUS Scheme Cost**

The average cost per household for a standalone WASH scheme was found to be NPR 76,474 (i.e. an average figure of NPR 10,373 per person of the total cost, which includes support from government of Nepal and Government of Finland, district development committee and VDCs on average of NPR 7,568). The average cost for a MUS scheme was found to be NPR 102,509 (i.e. an average of NPR 14,200 per person of the total cost, which includes an average of NPR 10,458 of external support).

On the basis of this analysis of 8 schemes and 16 households, the MUS schemes require anaverage of 74.6% more investment than the standalone WASH schemes with basic livelihood interventions, but they achieve 0.95 more on a B/C Ratio.

However, as noted above, this is a very limited sample. The study should be repeated with a larger sample size, in order to be able to generalise.

## CONCLUSIONS AND RECOMMENDATIONS

### Scaling-up of Water Use Master Plan (WUMP)

As WUMP is a promising approach for planning and management of water resources (with an emphasis on MUS), scaling up such approaches is recommended - not only for easy planning, but also to ensure water resources are optimally utilized for the benefit of communities with available water resources.

**More Analysis and Actions on the Schemes' Sustainability Issues**

In the focus group discussions, the study does not find any differences between regular payment of operation and maintenance (O&M) fees or water tariffs between standalone WASH schemes and MUS schemes. In general, it is supposed that increase in income at household level would lead to an increase in the rate of regular O&M payments. However, with this small sample it could not be demonstrated. This assumption should be proven by a further study,or further action should be taken to review and revise the sustainability framework / activities.

**MUS Schemes and Market Linkages**

The most successfully operating MUS scheme among the sampled schemes was Danda Daha, which has good linkages with the nearest market. Produced crops / vegetables are directly and quickly taken down from the top of the hill to the district headquarters (Darchula) via a Gravity Goods Rope Way. In this community, almost all households are producing vegetables and selling them. However, in other MUS schemes, the market linkage is poor and very few vegetables are sold at the local market. Despite this, their vegetable consumption rate has drastically increased and their food security and nutrition has improved. However, in order to maximise the benefits, it is recommended that while designing MUS schemes, market linkages and value chain perspectives should be considered.

**Food Security and Climate Resilience Perspective**

Expansion of irrigable land, increased productivity, and diversification of crops accessible to the common rural people are core components for food security. These elements are observed to a large degree in the MUS scheme communities. Hence, when there is possibility of MUS schemes at the design period, food security and climate resilience perspectives should receive more consideration, rather than only cost comparison perspectives with other schemes.

**Leading Institution for MUS**

Although water resources have the characteristics of multiple uses, in the Nepali context, there are standalone institutions for individual use. For example, DWSS focuses on the drinking water and domestic use of water, the Department of Irrigation focuses on irrigation only, the Alternative Energy Promotion Centre focuses on renewable energy such as micro-hydropower, etc. Since, MUS schemes by definition include multiple uses of water, it is difficult to place them under one department. Hence, in the process of state restructuring of new Nepal, it is recommended that a leading institution should be selected, which leads an integrated water resource management perspective.

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