Results from a High Elevation Fog Water Supply Project in Nepal

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Abstract: Nepal is a country rich in natural water resources however the use of these resources is often prohibitively expensive or impractical for people in rural areas. There are many small settlements on ridgetops above all available water resources. Some women in Nepal spend 6-8 hours per day carrying water uphill. Many of these villages in the hills are regularly impacted by orographic cloud. The database of nine sites in clearly shows that collection of water from fog in Nepal is a viable option. One SFC operating at Naya Bazar, Ilam from February 1998 until April, 2000 has a minimum, maximum, mean monthly average collection rate of 1.4, 33.0, 10.7 l/m^2/d respectively. Similar results have been observed at Kalpokhari, Ilam. Monthly average rates of collection from 17.4 l/m^2/d to 41.8 l/m^2/d have been observed at 3 SFCs in Megma, Ilam from May 2000 to Sept 2000. Slightly lower but still significant collection rates are observed at Bhadure, Ilam and Danda Bazar, Dhankuta.

1. INTRODUCTION

Nepal is considered to be a country rich in fresh water resources, however due to many factors the distribution of water to many small villages in is still a major problem. In response to this the Canadian Center for International Studies and Cooperation (CECI) has been researching and developing practical fog water collection for rural water supply in Nepal since the spring of 1997. In December 1998 Nepal Water for Health (NEWAH) with the support of a CECI volunteer, took over the management of the Nepal Water from Fog Project (NWFP). This paper presents the results of this research. There is currently a database of nine research sites.

1.1 Justification for Fogwater collection in Nepal

Any project undertaken without the full support of the intended end users is almost sure to be a failure. Therefore for fogwater projects implementation in Nepal an emphasis is placed on a social demand for water. In Nepal a social demand for water arises in communities that have settled on ridge tops for reasons other than the availability of water. Often these settlements are at a higher elevation than all nearby water sources. This is a problem because usually the only technology available to people in rural Nepal is gravity flow water systems. As a result women in these communities can spend 6-8 hours per day only carrying water up from sources lower down the ridges.

1.2 Methodology

Information on Potential fog collection sites is gathered in Nepal through a network of Non-Governmental Developmental Organizations (NGDOs) working in partnership with NEWAH. The sites under consideration are evaluated by field study and information gathering from local residents. Prime considerations are potential quantity of fog water for collection a *social* demand for water. In Nepal these conditions occur in communities settled on top or near ridge tops from approximately 2000 – 3500 m MSL. Below 2000m altitude there is little advective or orographic fog and above 3500m temperatures drop below freezing in the winter months making fog collection impossible

When a site is initially selected 2-4 Standard Fog Collectors (SFCs) Schemenauer et al (1993) are placed strategically in the area. A local data collector is trained to measure volume of water collected from at the SFC and a simple rain gauge, temperature, wind speed and direction and sky conditions. Observations are made at the SFCs each morning and evening. Based on six to twelve months of data a decision is made to proceed with building Large Fog Collectors (LFCs) and full-scale fogwater collection project or not.

1.3 Site Locations

SFCs have been erected at Nine sites in Nepal:

- Gothbhanjyang, Lalitpur (N 27° 37' W 83° 25') May 8, 1997 to Sept 12, 1998
- Namche Bazar (N 27° 47' W 86° 42') February 7, 1999 to May 9, 2000
- Ranimatta, Surkhet (N 28° 41' W 81° 38') February 7, 1999 to May 9, 2000
- Naya Bazar, Ilam (N 26° 58-59' W 88° 1-2') February 17, 1999 to April 17 2000
- Kalpokhari, Ilam (N 28° 5' W 88° 1') February 20 1999 to June 17 2000
- Danda Bazar, Dhankuta (N 26° 42' W 87° 24') January 27 1999 to January 31 2001
- Bhadure, Ilam (N 27° 1' W 87° 51') May 5 2000 to present
- Megma, Ilam (N 27° 2' W 88° 5') May 13 1999, to present
- Pathivara, Taplejung (N 27° 28' W 87° 49') November 16, 2000 to present

2. RESULTS

2.1 SFC data

Table 1. shows monthly averages of fogwater collection obtained at six sites in Nepal. The other sites have unreliable or insufficient data. For each SFC the first column shows fogwater in $l/m^2/d$, the second column shows the number of days of data for that month and the third column shows the frequency of minimal fogwater collection. All calculations are obtained directly from the 12 hr data.

Fog water collection in Nepal is highly seasonal. The highest rates of collection are during the monsoon (mid May to mid September). Dry season rates are much lower. At Kalpokhari there was some collection of fog water even when the rainfall rate is minimal. This is a significant source of water for the few dry months of the year when no other source of water is available.

The other application of fogwater collection in Nepal is as a source of clean water on ridgetop settlements like Danda Bazar where at present water is manually carried from springs 100 – 200 m downhill. In these remote areas where there is often no electricity and pumping is prohibitively expensive an alternative source of water is a welcome option. These water supply systems also provide a good entry point for the further economic and social development of these remote communities.

Table 1. Fogwater Collection rates and Rainfall rates

	Month	SFC #1			SFC #2			SFC #3			SFC #4			Rainfall		
		$l/m^2/d$	# of data	Fog freq.	$l/m^2/d$	# of data	Fog freq.	$l/m^2/d$	# of data	Fog freq.	$l/m^2/d$	# of data	Fog freq.	mm	# of data	Freq.
Ranimattar, Surkhet	Feb-99	0.0	22	0	0.0	22	0							0	22	0
	Mar-99	0.0	31	0	0.0	31	0							0	31	2
	Apr-99	0.0	30	2	0.0	30	2							3	30	2
	May-99	1.8	31	34	1.9	31	32							119	31	26
	Jun-99	4.3	30	60	3.9	30	60							277	30	42
	Jul-99	11.4	31	98	10.3	31	94							480	31	92
	Aug-99	12.7	31	92	12.6	31	97							427	31	65
	Sep-99	6.3	30	88	4.2	29	88							119	29	48
	Oct-99	4.7	31	53	4.3	31	53							68	26	15
	Nov-99	0.0	30	2	0.0	30	2							0	30	0
	Dec-99	0.7	31	29	0.9	31	27							12	31	3
	Jan-00	0.8	31	21	0.9	31	21							42	30	12
	Feb-00	1.5	29	45	1.5	29	48							51	29	17
	Mar-00	0.5	31	13	0.6	31	13							41	31	6
	Apr-00	1.0	29	29	1.0	29	28							133	29	23
	May-00	3.8	9	50	3.7	9	50							60	9	28
Naya Bazar, Ilam	Feb-99	0.1	12	39	0.4	12	52	1.9	12	70				0	12	0
	Mar-99	0.2	31	13	0.2	31	11	2.2	31	21				50	31	2
	Apr-99	1.4	29	40	1.4	29	40	10.3	29	63				0	29	0
	May-99	5.8	31	92	5.5	31	90	21.0	31	100				402	31	24
	Jun-99	5.9	30	80	6.5	30	83	15.9	30	85				254	30	18
	Jul-99	9.7	31	100	10.5	31	100	33.0	31	100				402	31	25
	Aug-99	6.3	31	100	7.9	30	100	30.8	31	100				304	29	22
	Sep-99	5.6	30	97	8.5	30	97	19.0	30	97				0	30	0
	Oct-99	3.1	31	71	3.8	31	73	10.5	31	79				5	31	3
	Nov-99	0.0	30	2	0.1	30	12	1.4	30	46				0	30	0
	Dec-99	0.2	30	7	0.5	30	13	1.5	30	40				3	30	2
	Jan-00	0.1	31	19	0.3	31	31	1.5	31	61				5	31	3
	Feb-00	0.4	29	12	0.7	29	36	1.9	29	47				0	29	0
	Mar-00	0.6	31	44	2.1	31	84	3.3	31	76				0	31	0
	Apr-00	2.7	21	71	5.0	21	80	6.7	21	85				0	21	0
Kalpokhari, Ilam	Feb-99	2.2	9	39	3.9	9	56	7.8	9	72	7.3	9	72	3	9	6
	Mar-99	2.0	31	27	1.4	31	23	3.1	31	21	2.5	31	21	0	31	0
	Apr-99	4.8	30	32	4.9	30	30	6.7	30	27	5.8	30	27	5	30	2
	May-99	16.0	31	62	15.9	31	62	22.7	30	72	18.2	31	62	357	31	44
	Jun-99	5.2	28	39	7.4	28	41	13.4	17	56	10.9	17	55	69	23	20
	Jul-99	12.6	30	73	13.2	30	75							470	16	84
	Aug-99	29.5	28	88	24.9	29	86							522	14	89
	Sep-99	12.5	29	93	14.9	29	93	22.5	29	93	22.7	29	93	586	29	84
	Oct-99	6.8	30	47	5.1	30	47	7.9	30	47	8.9	30	47	114	30	22
	Nov-99	0.2	30	18	0.4	30	18	0.5	30	18	0.9	30	18	0	30	3
	Dec-99	0.6	31	27	1.0	31	29	1.2	31	29	1.5	31	29	5	31	13
	Jan-00	0.5	31	15	0.6	31	16	1.0	31	16	1.3	31	16	4	31	2
	Feb-00	0.3	29	10	0.6	29	14	0.7	29	10	1.0	29	10	5	29	10
	Mar-00				5.4	31	50	6.7	31	52	8.4	31	53	35	31	24
	Apr-00				5.5	30	63	6.2	30	62	7.9	30	63	123	30	38
	May-00				3.5	8	69	17.2	31	85	6.3	8	69	309	31	57
	Jun-00							19.1	30	88				337	30	78
	Jul-00							37.1	17	94				328	17	85
Danda Bazar, Dhankuta	Jan-00	0.7	4	13	0.6	5	30							0	5	20
	Feb-00	0.7	29	21	0.3	29	22							19	29	3
	Mar-00	0.2	31	10	0.3	31	11							1	31	3
	Apr-00	1.8	30	33	1.5	27	26							131	30	23
	May-00	8.7	31	76	8.3	31	76							209	31	31
	Jun-00	16.2	30	98	15.1	30	98							307	30	53
	Jul-00	16.4	31	100	17.6	31	100							375	31	61
	Aug-00	21.4	31	97	22.0	31	98							372	31	45
	Sep-00	11.6	30	100	11.7	30	100							68	30	45
	Oct-00	2.7	31	73	2.6	31	73							6	31	13
	Nov-00	0.2	30	33	0.4	30	42							0	30	2
Bhadure, Ilam	May-00	3.8	28	78	4.9	27	85							134	28	42
	Jun-00	8.0	30	93	5.3	30	95							448	30	67
	Jul-00	16.8	31	100	7.5	31	100							430	31	79
	Aug-00	10.7	31	98	8.6	31	98							400	31	77
	Sep-00	12.3	30	88	5.0	30	83							329	30	65
	Oct-00	0.6	31	18	0.4	31	18							94	31	15
	Nov-00	0.2	30	5	0.2	30	7							5	30	2
Megma, Ilam	May-00	36.4	19	97	21.1	19	97	31.1	19	100				96	19	30
	Jun-00	23.5	30	93	17.4	30	92	24.8	30	97				643	30	77
	Jul-00	39.7	31	100	25.8	31	100	39.4	31	100				707	31	87
	Aug-00	41.8	31	100	30.6	17	100	31.9	31	100				812	31	95
	Sep-00	23.4	30	98				26.4	30	98				445	30	72
	Oct-00	3.6	31	77				4.1	31	79				34	31	21

2.2 Mesh Comparison

A side by side comparison of a double layer of standard Rachel type mesh and a single layer of nominal 50 % shade mesh available from India was conducted at Kalpokhari, Ilam from March 14 to July 17. Overall during the four month period the Indian mesh collected 12% less water than the Rachel mesh. During times of high collection The Indian mesh collected more efficiently, occasionally exceeding the collection of the Rachel mesh however during times of low water collection the Indian mesh was much less efficient.

Table 2. Comparison of Available Mesh

Second quartile average * (l/m^2/12hr)		
Mesh type	Night	Day
double 35% Rachel	2.1	1.7
single 50% Indian	1.9	1.3
% difference	9	22

Forth quartile average (l/m^2/12hr)		
Mesh type	Night	Day
double 35% Rachel	15.1	1.7
single 50% Indian	14.0	1.6
% difference	7	8

* Note: first quartile data all zero

Considering that the greatest cost to build LFCs in Nepal is the structure components the decision has been made to continue using the best available mesh to obtain the most efficient collection of water.

2.3 LFC results

One LFC (12m x 4m) was erected at Kalpokhari, Ilam. This LFC was only operating for 6 months due to conflict within the community. However during the six months of operation this new source of water was well received by the community.

At present an array of 7 LFCs (10m x 4m) is under construction at Danda Bazar, Dhankuta. Construction is scheduled to be completed in May 2001. This system will provide a community of 75 people with 20 liters per person per day year round. Significant fog water is only collected at Danda bazar for five months of the year so a large reservoir is being built to store excess fog water collected for the dry season.

As part of the project implementation two tapstands will be built to service the community and subsidized toilets are being constructed. Also detailed training to the community of heath sanitation and maintenance aspects of the project is being provided.

3. CONCLUSIONS

Fog collection in Nepal is a feasible source of water for villages in Nepal in the range of 2000m – 3500 m. Sites in Nepal are dominated by microclimatic conditions so extensive research has to be done at each site to determine project feasibility.

The conditions for fogwater collection exist in Nepal and there is a demand for alternative sources of water. When both the necessary conditions and demand are present at the same place there is an opportunity for rewarding work. There are many such sites but the information gathering is a intrinsically slow process. With the present demonstrated success local people are more willing to try using fog collection, consequently NEWAH will be continuing and expanding its program of fogwater collection in Nepal.

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5. REFERENCES

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