Nepal Project

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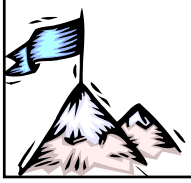
The Nepal Water Crisis

Project Motivation

- 70% do not have access to clean water
- 1 in 10 children die before age 5
  - 33% of waterborne diseases
- 54% of children are stunted
  - due to waterborne diseases
- Proximity to Bangladesh
  - Arsenic

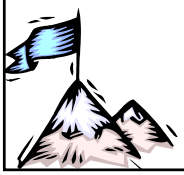
Project History

- Continuation of work from last year's project
- Many issues unresolved
  - Filter flow rate
  - Disinfection
  - Social considerations
  - Arsenic contamination



Mission Statement

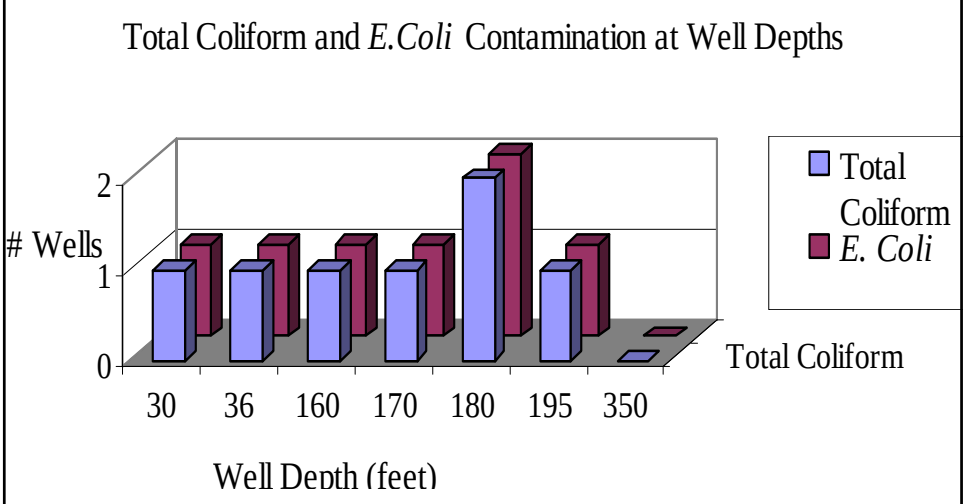
- Remove contamination
- Appropriate technology
  - Local availability
  - Rural focus
  - Simple design
  - Low Cost
- Social considerations



Microbial Contamination

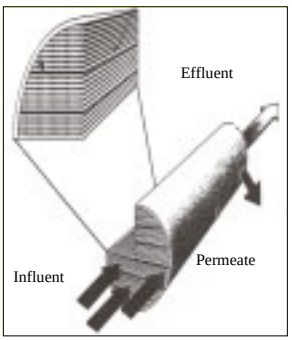
- High incidence of waterborne disease due to microbial contamination
- Water Sources
  - Piped Water
  - Tubewells
  - Hand-dug wells
  - Surface waters
  - Springs

Well Survey



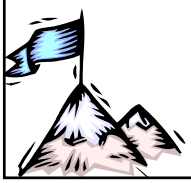
CerCor Filter

- 0.2µm filter (bacteria size range 0.15 - 35µm)
- 28 Microbial Trials
  100 % Microbial Removal Efficiency
- 1 Kaolin Run at 40 NTU
  - Over 14 hours w/o flow reduction,
  - Flow = 18 L/hr
- Backflushing Alone
  - Restores flow to 195 ml/hr after reduction to 40ml per hour
- EXPENSIVE $$



Solar Disinfection of Water

- Use of solar radiation to disinfect (no chemicals)
- Two disinfection methods
  - Light and Heat
- SIMPLE
- ACCEPTABLE
- INEXPENSIVE $$$$



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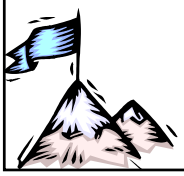
SODIS

- Lumbini January 2001 Data
  - 1 day tests 92% effective
  - 2 day tests 100% effective
- Kathmandu, Data June/July 2000 Monsoon Season
  - 1 day tests 54% effective
  - 2 day tests 100 % effective
  - Bagmati River water SODIS 25% effective in 3 days



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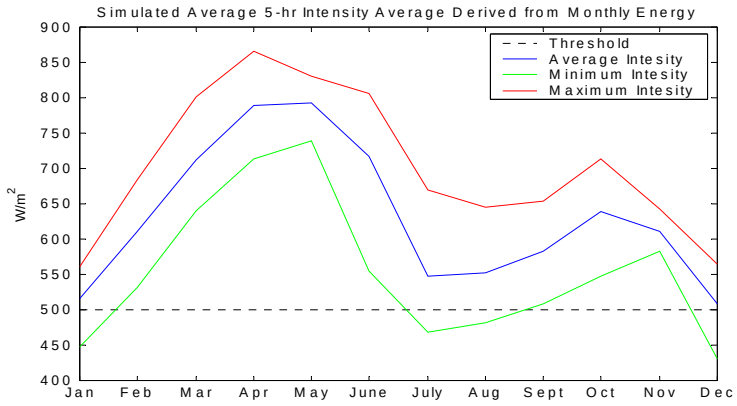
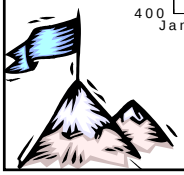
Available Solar Energy





SODIS LOOKS GOOD !!!

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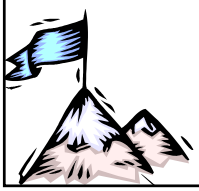
BioSand Water Filter

BioSand Technology

- Slow sand filter
  - Biological + Physical Removal Processes
- With some design modifications
  - Allows intermittent flows
- With slightly higher flow rate

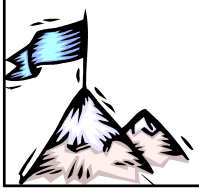


In Nepal

- Samaritan's Purse introduced BioSand
- Developed by a local NGO – Hope for the Nation
- More than 100 filters so far – still growing

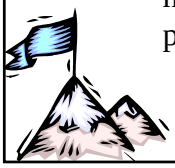
Nepal Trip – Jan 2001

- Went to 42 households
  - Tansen
  - Nawalparasi
- Analyzed Water Samples
  - Microbial Test
  - Turbidity Removal

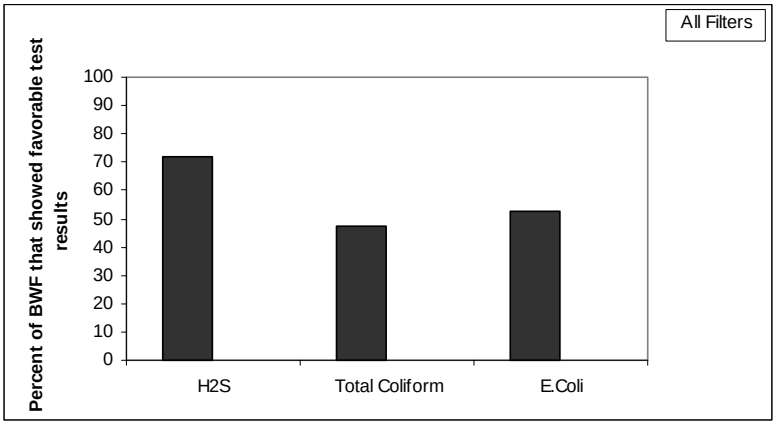


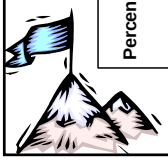
Results

- Better performance compared to previous filters
  - Faster flow rate
  - Does remove pathogens
- Problems at implementation stage
  - With sand level
  - With diffuser plate – a plate with holes that intercepts water that is poured in to reduce scouring action



Results





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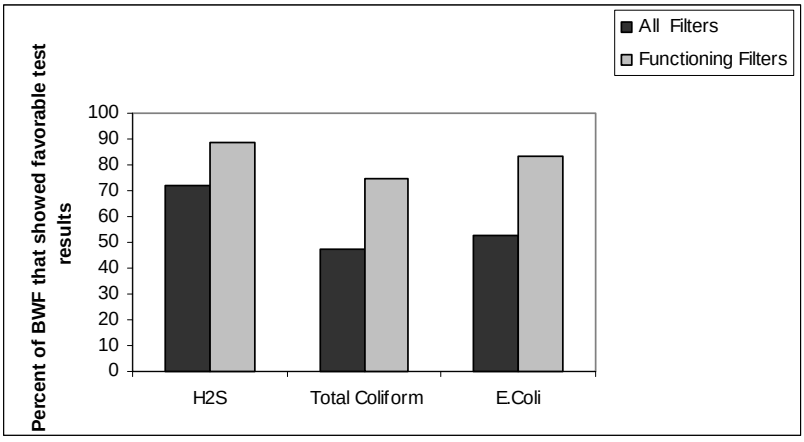
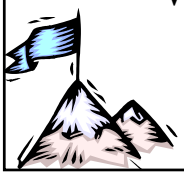


Follow-up Work

- More lab tests to verify that BioSand is effective technology
  - We have a unit of BioSand downstairs.
  - We want a better indication that it does remove bacteria.
  - Until then, we cannot fully recommend it and it remains a technology that is “promising”.

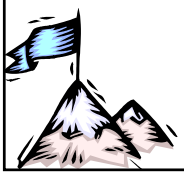
Background

- Filter pilot project among rural Nepalese
  - Had never been evaluated
- Need for more data on social considerations
  - What are water needs?
  - How is water used?
  - Water/pathogen understanding



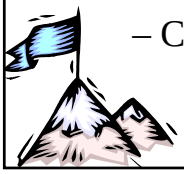
Survey Data

- 38 interviews, 12 villages, 2 regions
- Respondents
  - 51% female, 49% male
  - 94% Hindu, 6% Christian
  - Caste/Ethnicity
    - 6 represented, majority Brahmin



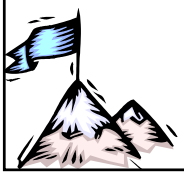
BioSand Evaluation

- Widespread acceptance of filter
  - 89% report that they “like” the filter
  - Like taste, high flow, removes cloudiness, Cold water temperature
  - Critical of constant flow, weight, maintenance
- 56% reported drop in incidence of diarrhea
  - Conflicted understanding of water contamination

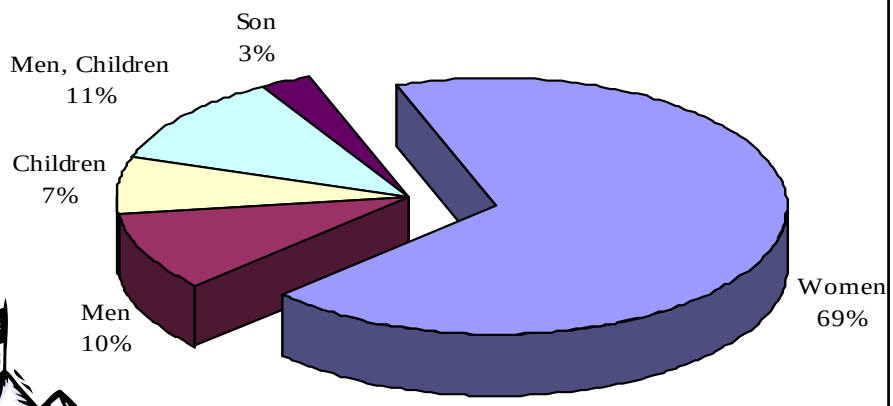


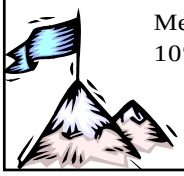
Water Collection

- Women predominantly collect water
  - 10m to water
  - 15-16 gagris/day, 14-17L/gagri
  - 210-272L/day
- 75% of water to livestock



Water Collection





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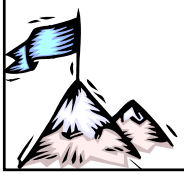
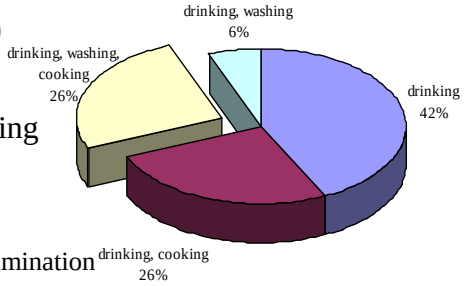


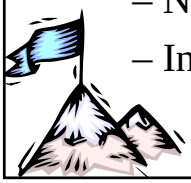
Filtered Water Use

- 25% of water collected
  - ~60L/family (6L/person)
- Three uses
  - Drinking, washing, cooking
  - Predominantly drinking
  - Cooking – mostly boiled
    - Not necessary for decontamination
  - Rarely washing – dishes, hands
    - More work



Acceptability

- No cultural/religious conflicts
  - Biased data
- Not universally appropriate
  - Expensive (~15% of annual income)
  - Limitations on turbidity capacity
  - No information on Buddhist, Muslims
  - Ineffective for chlorinated water supply



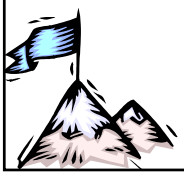
Evaluation of Arsenic Removal Technologies

•Why is this project important?

•Which technologies were evaluated?

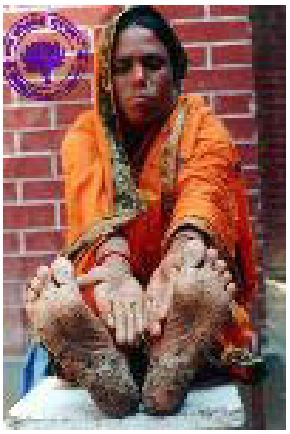
•How were they evaluated?

•Results



Why is this project important?

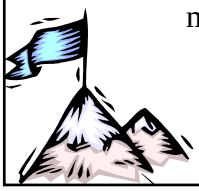
- Arsenic is a toxic metal causing chronic effects with ingestion
  - –Adversely effects the skin
  - –Cancer causing
- WHO set MCL at 10 ppb
- Tubewell water is contaminated



3 Remediation Technologies

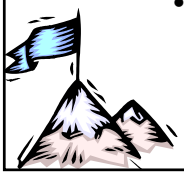
- Theory = Adsorption
  - –Iron
  - –Activated alumina metal oxide
- Three-Gagri System
- Jerry Can
- Arsenic Treatment Unit (ATU)

  made by Apyron Technologies Inc.



Evaluation of Technologies

- Is effluent As concentration < 10 ppb?
- Is the system simple and reliable?
- Is it affordable?



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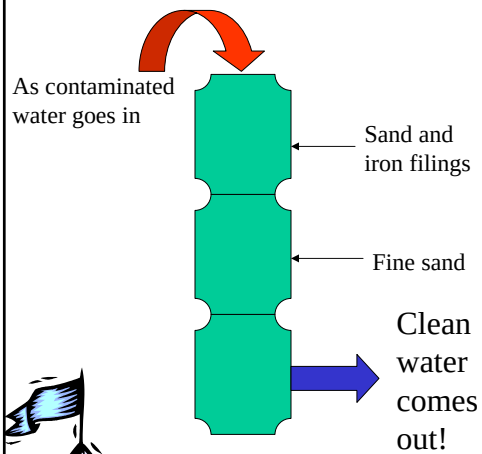
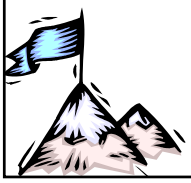
Three-Gagri System



The real thing!



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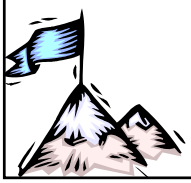
Three-Gagri System

- A Success! A 98.4% Reduction!!

Run #	Influent Conc (ppb)	Effluent Conc (ppb)
1	242*	11
2	242*	3
3	242	6
4	242*	3
5	263	3
6	212	0
7	244	0
8	242*	0
9	252	8
Average	242.6	3.8

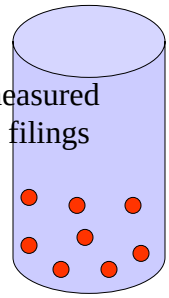
- System is simple to assemble and use
- Cost of gagris, availability of iron filings



Jerry Can

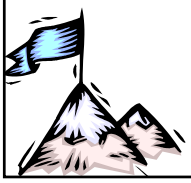
1. Fill 10 L plastic jug with As contaminated water.

2. Add pre-measured packet of iron filings



3. Allow 3 hours for As to sorb to iron.

4. Decant clean water?

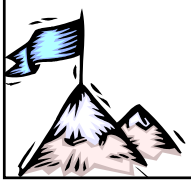


Jerry Can

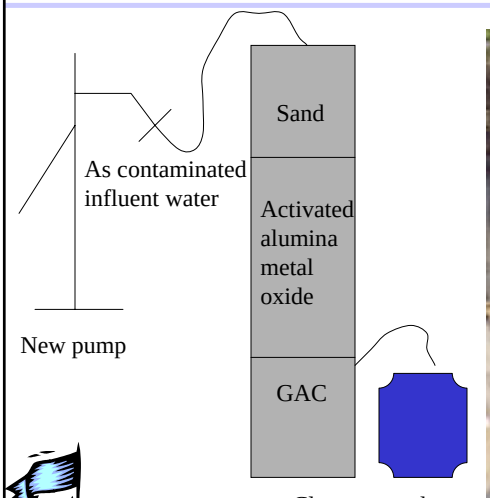
- A Failure. 0% Reduction.

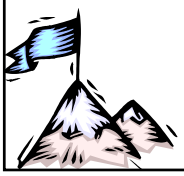
Run #	Time	Influent Conc (ppb)	Effluent Conc (ppb)
1	3 hours	186	186
2	3 hours	N/A	244
3	45 minutes	N/A	260

- Too bad, cause it is cheap!
- Need to add sulfate – chemical addition is problem



ATU

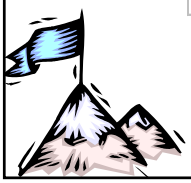




ATU

- A Success! A 99.9% Reduction!

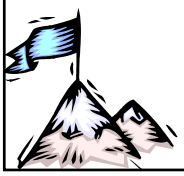
Run #	Influent Conc (ppb)	Effluent Conc (ppb)
1	141	4
2	314	0
3	369	0
4	315	0
5	349	0
6	245	0
7	232	0
8	251	0
9	250	0
10	375	0.0
Average	284.1	0.4



- Treats water for an entire community
- $2000 per unit

Conclusions

Technology	Effective	Appropriate
CerCor	Yes	No – too expensive
SODIS	Yes – climactically dependent	Yes
BioSand	Yes – turbidity, maintenance	Yes - expensive
3-Gagri	Yes	Yes
Jerry Can	No	Yes
ATU	Yes	No – too expensive




Namaste
Thanks for coming!