SONO Water Filter: A Sustainable Solution for Arsenic Crisis and Clean Drinking Water

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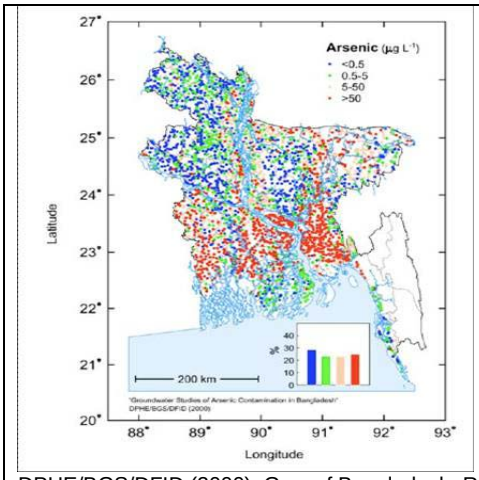


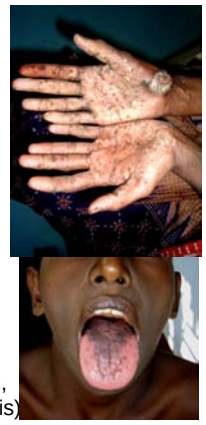
DPHE/BGS/DFID (2000): Gov. of Bangladesh. Recent maps show severe contamination throughout the Ganga-Meghna-Brahmbaputra basin.

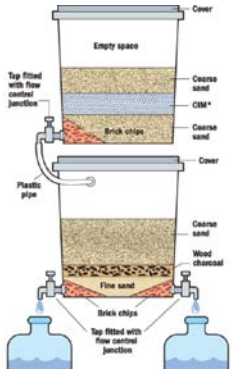
Bangladesh: Arsenic Scenario
Population: 150 million
Area: 46,560 sq. miles
Tube wells: 10 million (1940, UNICEF 1970)
Origin of arsenic: Groundwater (<200 m depth)
Cause: Bio-geochemical reduction process
Contaminated wells: 27-50%
People affected: 75-95 million
Arsenical skin lesions: 1.2 mil
Children at risk: 35 million
Cancer risk: 1-3 per 1000 people

The arsenic crisis in Bangladesh is one of the worst environmental disasters and a public health crisis of unprecedented dimension. A major portions of northern India (map on left), where about 500 million people lives, may be affected by arsenic and other groundwater contaminants.

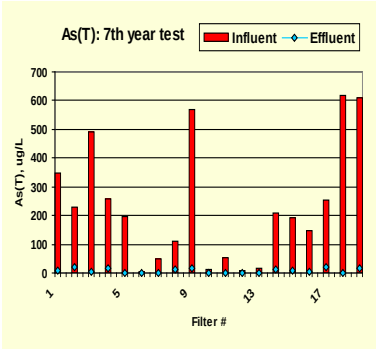
Toxic Levels of Arsenic in Water
WHO Guideline: 10 µg/L (ppb)
Bangladesh Limit: 50 µg/L
USEPA : 10 µg/L

Dermatological Symptoms
Diffuse melanosis
Spotted melanosis
Leucomelanosis
Mucus membrane melanosis
Spotted keratosis
Cancer
Human liver degenerates at 800 ppb
(Top: Keratosis and cancer on hand, Bottom: Mucus membrane melanosis)





To solve the arsenic crisis we have developed a composite iron matrix (CIM) adsorbent to remove arsenic and other toxic metals from groundwater. The CIM in combination with sand, gravel, and charcoal produced the SONO filter. The filter has been tested by three environmental technology verification projects for arsenic mitigation (ETVAM) and won the 2007 Grainger Challenge Gold Prize for Sustainability from the US National Academy of Engineering.



Test results compiled over seven years show SONO can remove arsenic (to < 10 ppb), manganese (a neurotoxin to < 400 ppb)), iron, and all transition metal ions to a safe potable water.

About 225,000 SONO filters are now producing clean drinking water in Bangladesh, India and Nepal. The filters are distributed by all means including boat to remote places in Bangladesh.

SONO filter capacity and cost ($ 35)
100 L / day
40,000 L/ year
200,000 L / 5 years (= 200,000 Taka or $ 2800 saved)

SONO spent material is non-toxic (TCLP test)
200 ug/L As removed / day
USEPA limit 2 kg arsenic /hectare per year = spent media from 10 million liter water at 1000% safety margin

SONO/MSUK buy back spent CIM and recycle

Within localities inside Bangladesh, a flat-bed rickshaw-van is a very efficient means of transport for small number of filters.

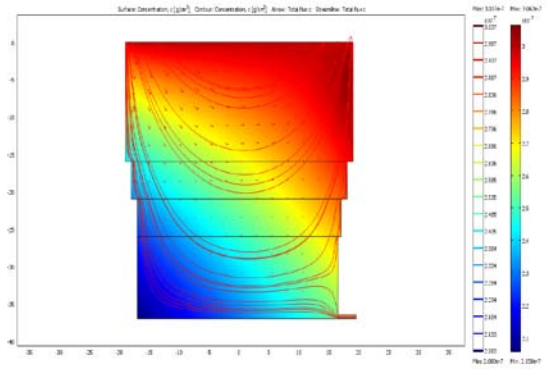


Figure shows arsenic (in red) percolating through the SONO top bucket. The active media in the middle is barely affected even at 30,000 ppb As input!

The very high arsenic breakthrough capacity of SONO filter was studied using the COMSOL Multiphysics finite element solute mass transport model. It predicts that these filters could last at least 14 years without breakthrough at the present usage rate of 100 L per day. This amount of water is sufficient for a family of five for drinking and cooking. SONO has developed larger filters to produce 100 L/hour for community and semi-commercial use. Much smaller table-top units are also under development. We also have developed a process to embed active CIM in fabrics for much lighter and efficient water filtration platform. Research on small inline filter is in progress at CCWST. Reactive transport model using COMSOL Multiphysics is now used for all filter development work.

SONO Filters: 2001- April 2010

- **225,000 SONO^{tm} filters installed in Bangladesh, Nepal (1000), India (100)**
- **60-180 liters per day consumed for 2- 8 years**
- **>750,000 direct beneficiaries (1.6% of the needy)**
- **>1 Billion liter of clean water consumed and continues**
- **Cost: <0.0013 Taka / Liter**
- **Further technology developments are in progress at CCWST-MSUK and SONO Tech Research Inc., Kushtia.**

This work is possible through the tireless efforts of Dr. Abul K. M. Munir, Professors Amir H Khan, and Abul Barkat, the workers of MSUK, and SONO Technology and Research Inc. (STRI), Kushtia (picture above) and my students at CCWST, George Mason University.