Chemical quality of household water in Bangladesh

Experiences from a national survey

Richard Johnston, *Mi Hua, Syed Adnan Ibna Hakim, Moshiur Rahman, and Yan Zheng*

UNC Water and Health Conference

October 6, 2011

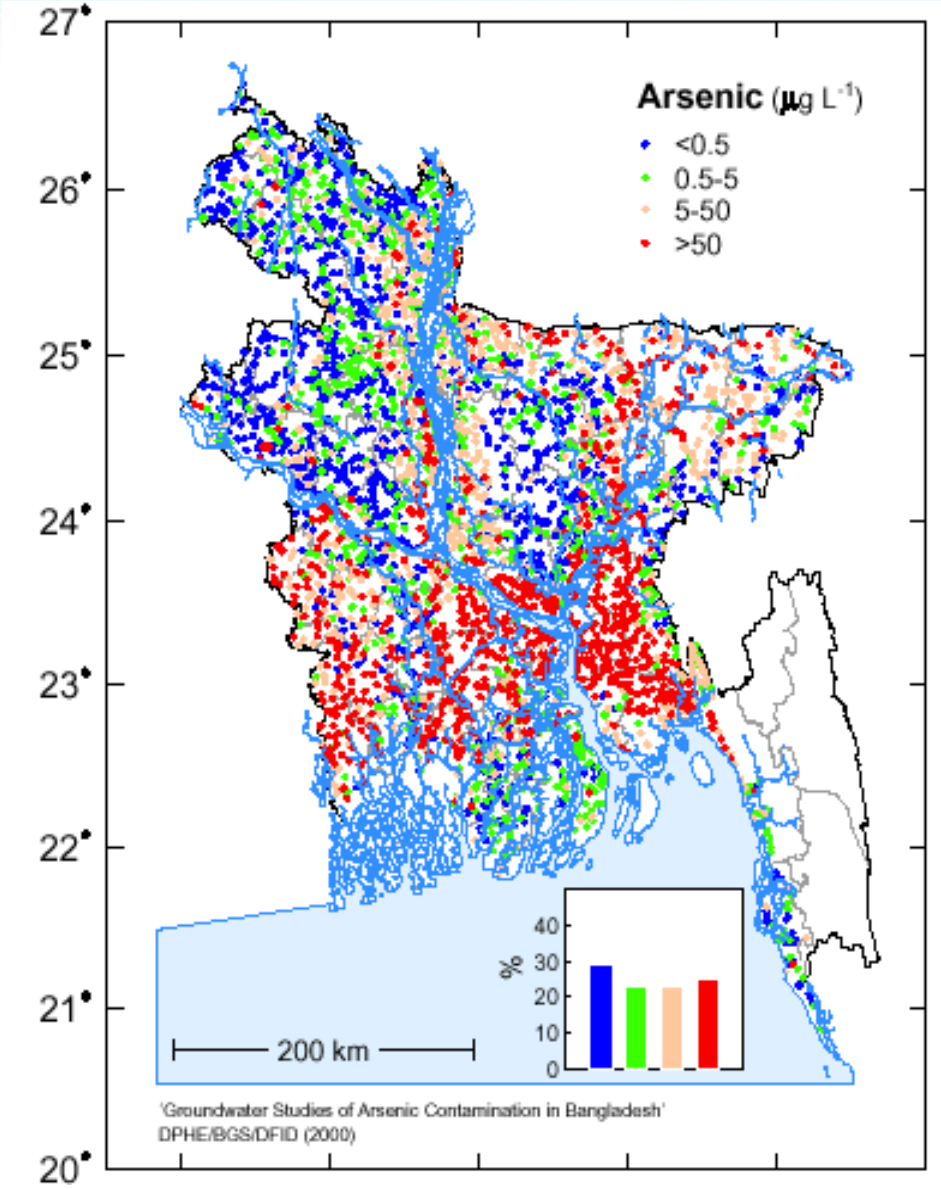
Background

Arsenic widespread

- 2000 BGS/DPHE survey
- 25% wells > 50 ppb
- 42% wells > 10 ppb

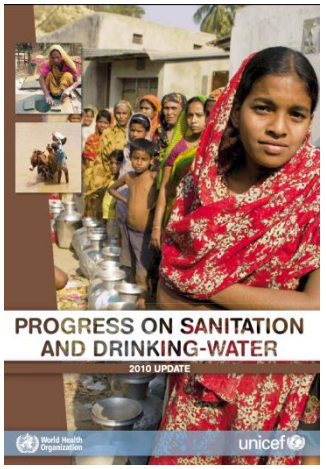
Mitigation approaches:

- Testing
- Awareness raising
- Arsenic-free sources
- Arsenic removal filters
  - BETV-SAM verification-unit.org



Joint Monitoring Programme

MDG Target 7C: To halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation (from baseline at 1990)



- Improved vs unimproved sources
- Doesn't take into account water quality

- Bangladesh: 97% improved sources

MICS Survey 2009

- Multiple Indicator Cluster Survey
- 300,000 households in 15,000 clusters
- Sub-district disaggregation
- Fielded by Bangladesh Bureau of Statistics
  - Temporarily employed thousands of enumerators

National Drinking Water Quality Survey 2009

15,000 clusters

- Enumerators given plastic bottles prefilled with nitric acid
- Always collect sample from first household in cluster
- Training of Trainers

ID numbers: District, Sample, Cluster, Household

01-001	Bagerhat	01-001 Cluster ID __ __ __ __ __ Household ID: __ __ Date: _____	*NITRIC ACID Preservative*
01-002	Bagerhat	01-002 Cluster ID __ __ __ __ __ Household ID: __ __ Date: _____	*NITRIC ACID Preservative*
01-003	Bagerhat	01-003 Cluster ID __ __ __ __ __ Household ID: __ __ Date: _____	*NITRIC ACID Preservative*
01-004	Bagerhat	01-004 Cluster ID __ __ __ __ __ Household ID: __ __ Date: _____	*NITRIC ACID Preservative*
01-005	Bagerhat	01-005 Cluster ID __ __ __ __ __ Household ID: __ __ Date: _____	*NITRIC ACID Preservative*

Fluoride survey

- Separate collection by Public Health Engineering
- Different sample preservation requirement
- Same coding, QC system
- Same NGO partner and reference laboratory

Sample analysis

- Dhaka NGO laboratory (PMID)
  - 15,000 samples with Digital Arsenator
  - 3,000 samples with Hach fluoride kit

- Reference laboratory
  - 20% of samples in Canada by ICP-MS
  - Major elements: Ca, Cl, Mg, (Hardness), K, Si, Na
  - Minor elements: Al, Ba, B, F, Fe, Mn, P, Sr, Zn
  - Trace elements: As, Co, Cu, Li, Ni, Mo, Se, Ti, W, U, V

  - Really trace: Sb, Be, Bi, Cd, Cr, Pb, Ag, Te, Tl, Th, Sn, Zr

Quality Control

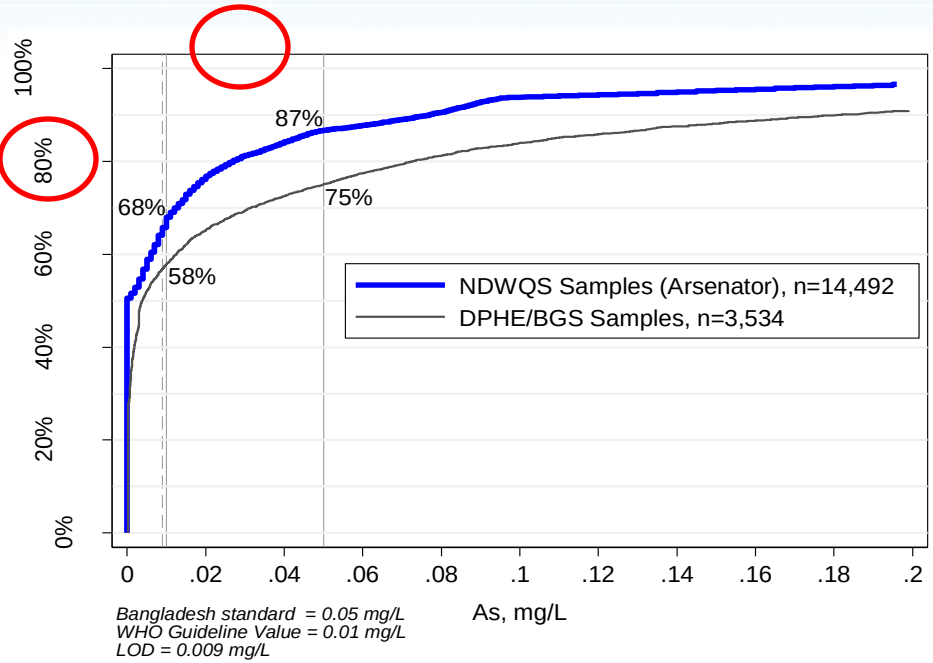
- Field blanks (5%)
  - Where Cluster ID ends in 00, 20, 40, 60, 80
- Field replicates (5%)
  - Where Cluster ID ends in 10, 30, 50, 70, 90

- Different Sample ID range: 800-999

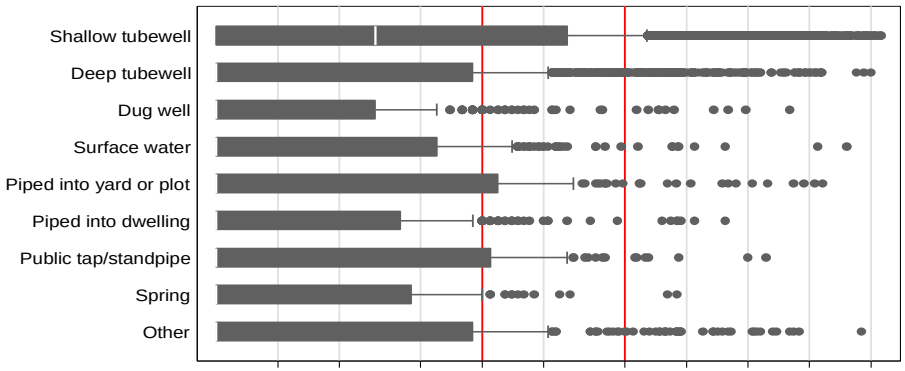
- Laboratory blanks and replicates

Results

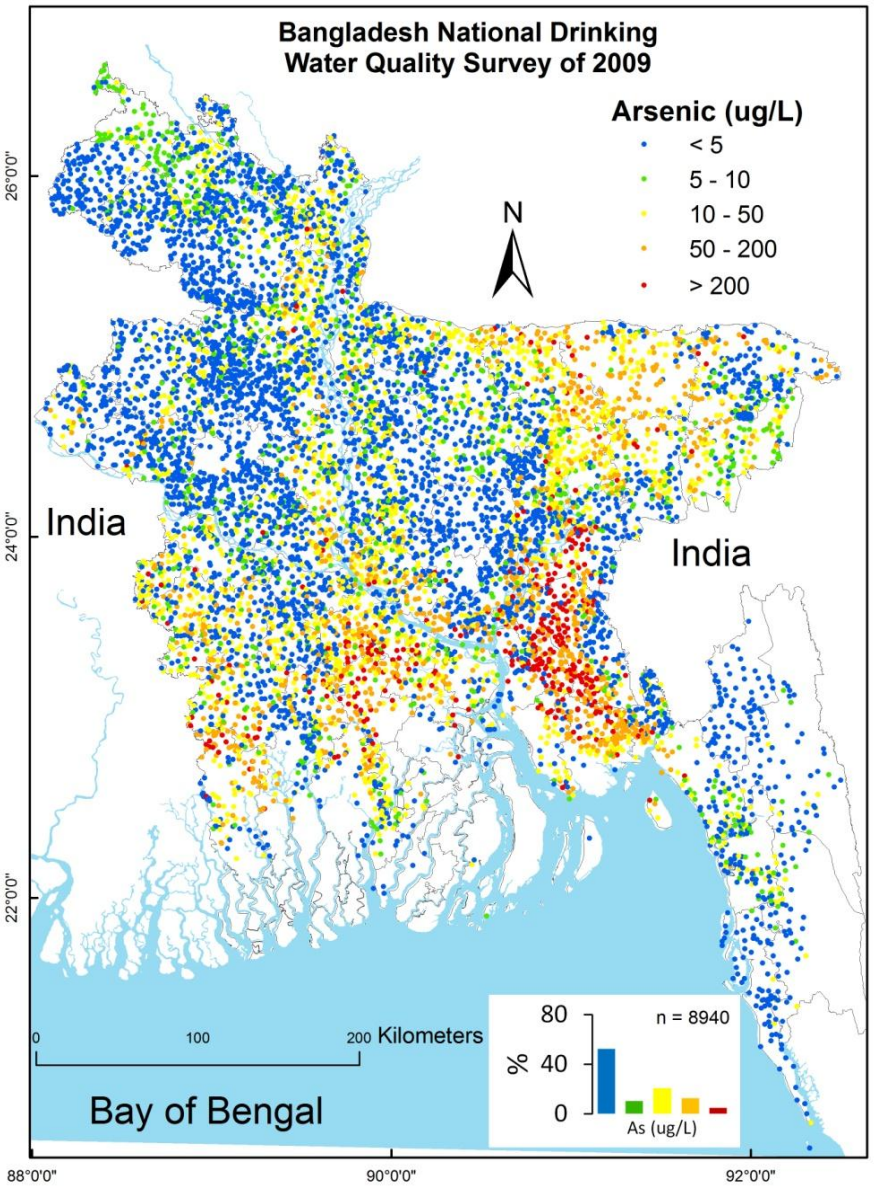
Arsenic



Bangladesh standard = 0.05 mg/L
WHO Guideline Value = 0.01 mg/L
LOD = 0.009 mg/L



WHO provisional guideline value 0.01 mg/L; Bangladesh standard 0.05 mg/L



Arsenic exposure

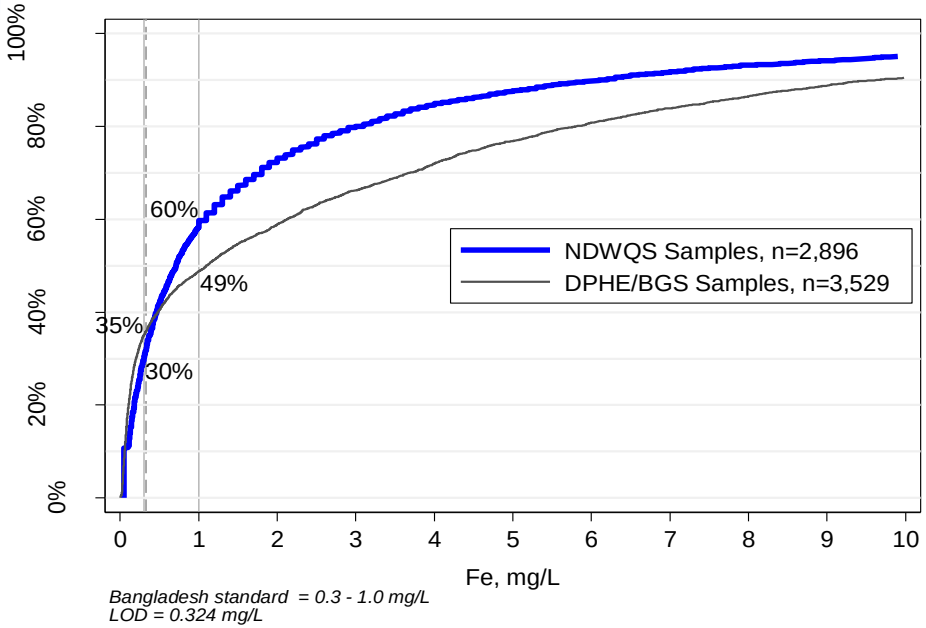
Arsenic level	% of samples	# districts with 10% of samples above value	# districts with 20% of samples above value	Population exposed, M
> 10 ppb	32%	54	43	53
> 50 ppb	13%	30	16	22
> 200 ppb	2.6%	7	2	5.6

Arsenic exposure trends

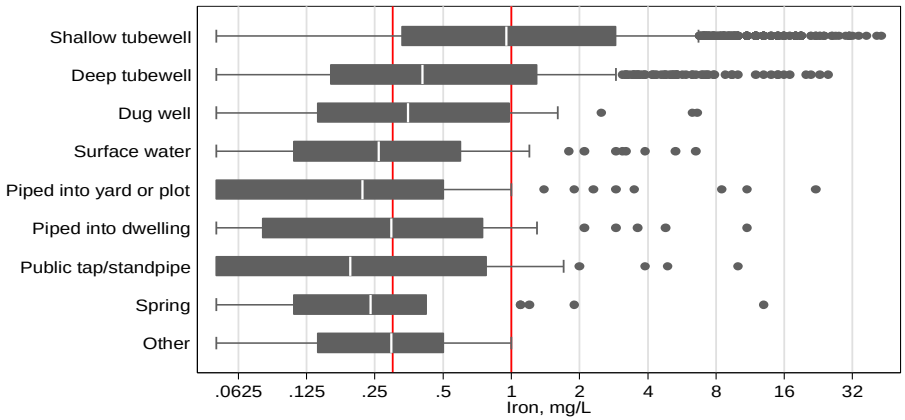
Year	Survey	Sampling	> 10 ppb	> 50 ppb
2000	BGS	Wells 3,534 lab tests	42%	25%
2005	NAMIC	Wells 5 M field kit tests	--	20%
2009	MICS	Households 14,492 field kit tests 2,896 lab tests	32%	13%

Real reduction or methodological differences?

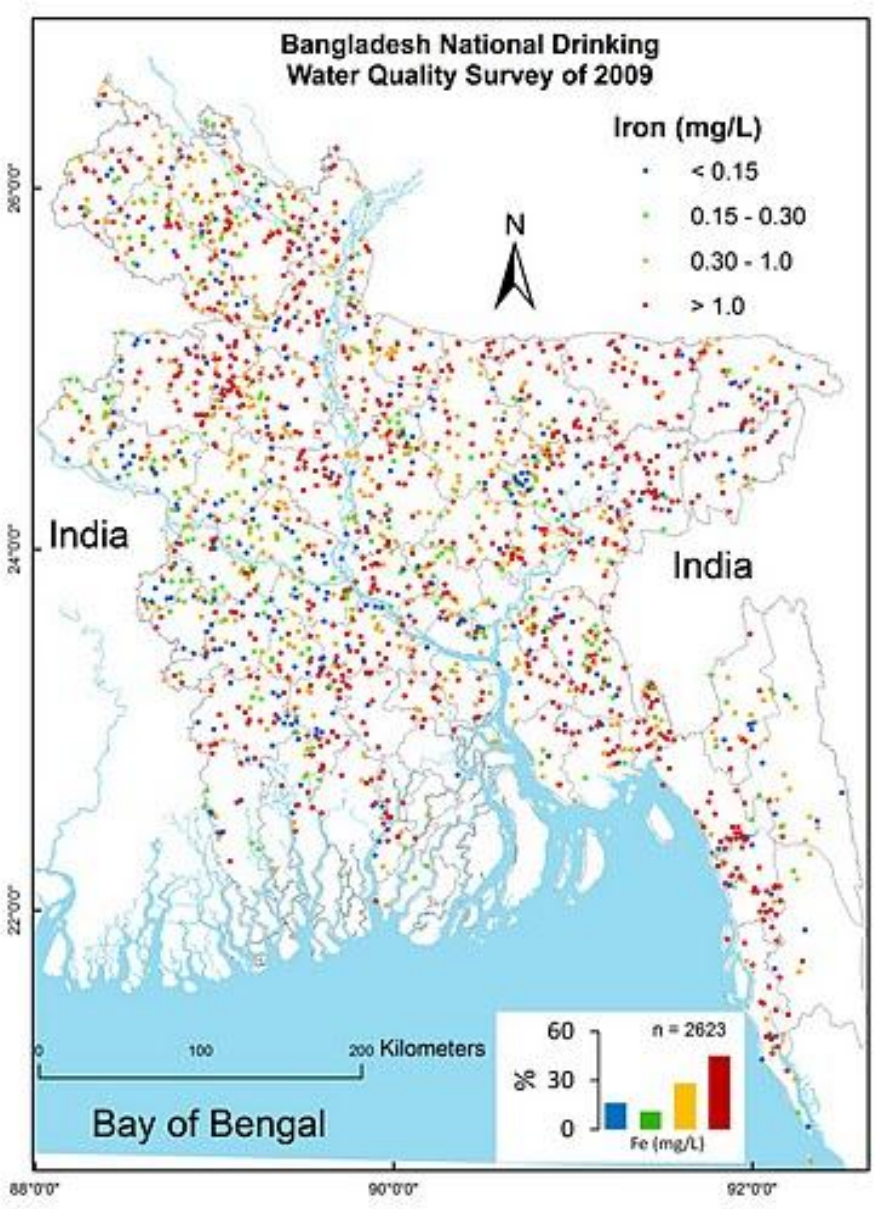
Iron



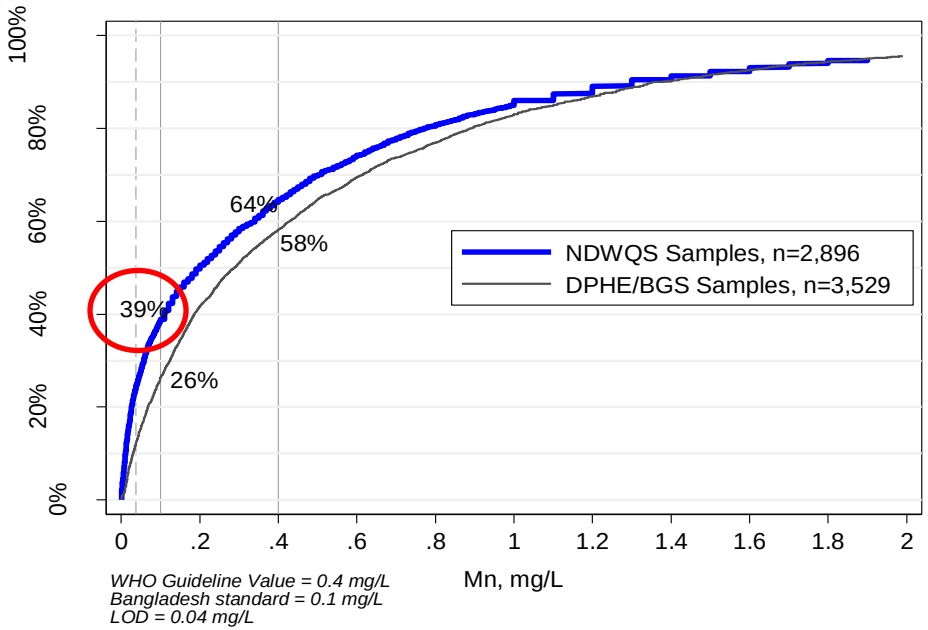
Bangladesh standard = 0.3 - 1.0 mg/L
LOD = 0.324 mg/L



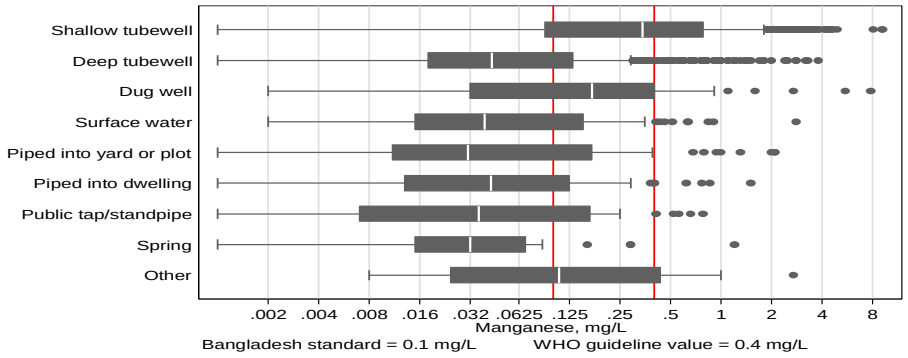
Bangladesh standard 0.3 - 1.0 mg/L

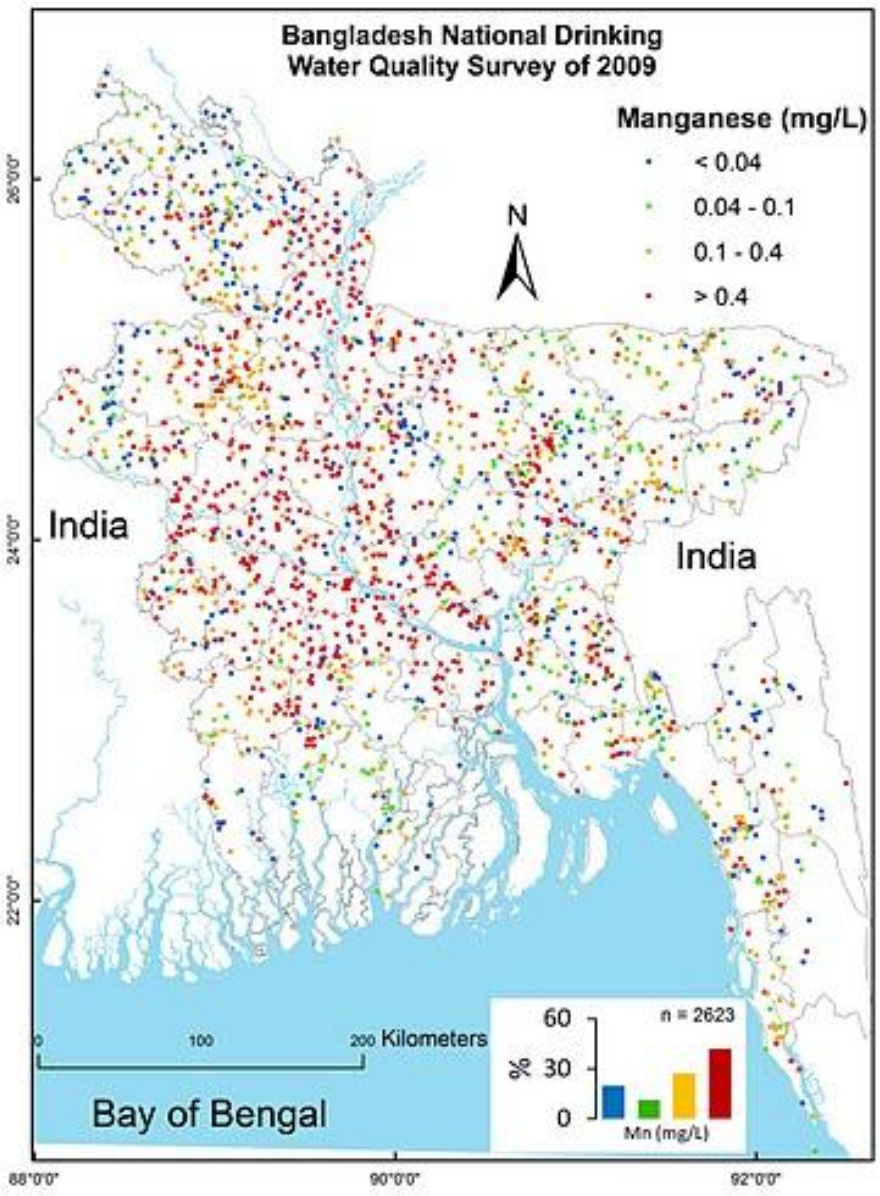


Manganese



WHO Guideline Value = 0.4 mg/L
Bangladesh standard = 0.1 mg/L
LOD = 0.04 mg/L





Overall compliance

- WHO Guideline Values

As (10 ppb)	68%
+ Mn (400 ppb)	54%
+ B	49%
+ Cu, Mn, Ni, Se, U	48%

- Bangladesh standards

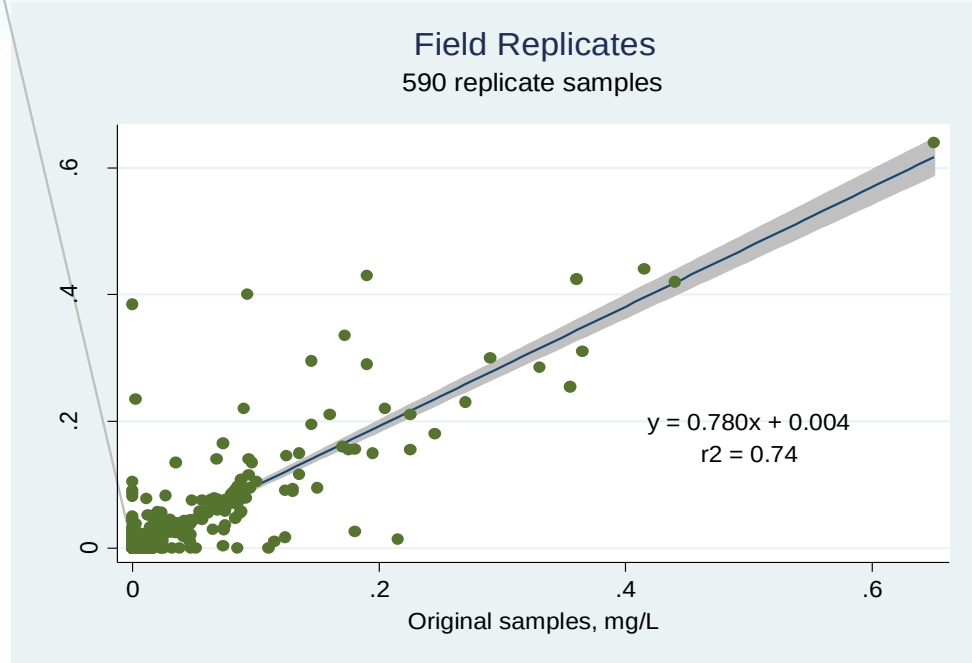
As (50 ppb)	87%
+ Mn (100 ppb)	36%
+ Fe	30%
+ Ca, Mg, hardness, Na	21%
+ Al, B, Cu, Mg, Ni, P, K, Se, Zn	19%

Quality control

- Confusion between Cluster and Sample ID, QC
- Miscoded 186/1508 for MICS survey
  - Miscoded 173/274 for DPHE fluoride survey
- Blanks (5%)
  - Had to discard 33/665 blanks based on major ions
- Trace metal contamination
  - Sn, Cd, Pb

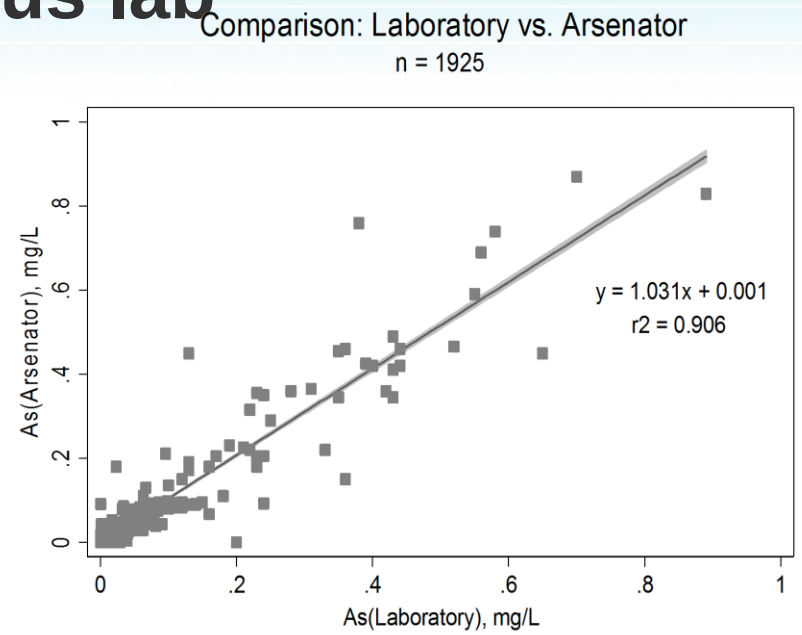
Quality control: field replicates

- Matched 590/657

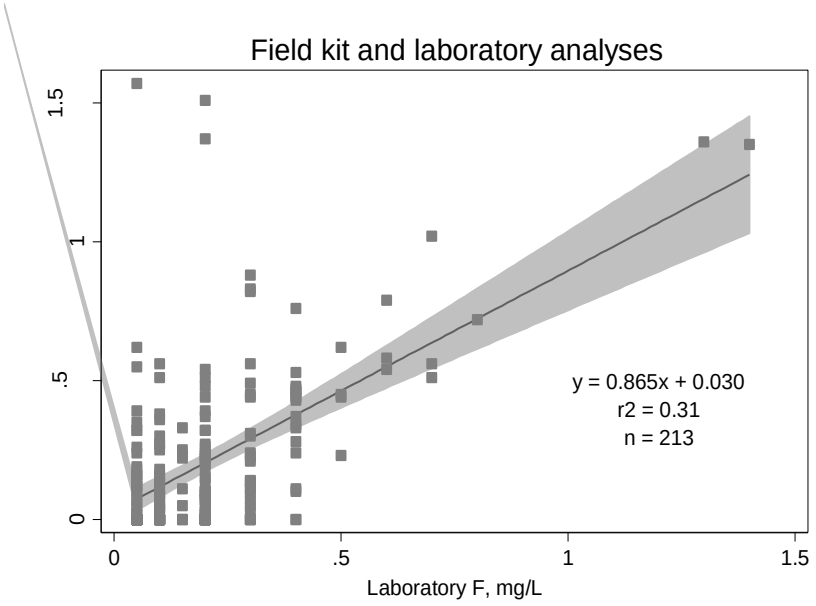


Quality control: field kit versus lab

- Good for arsenic



- Poor for fluoride



Survey costs

- Field kit testing: ~$5 per household
- Laboratory testing: ~$60 per household

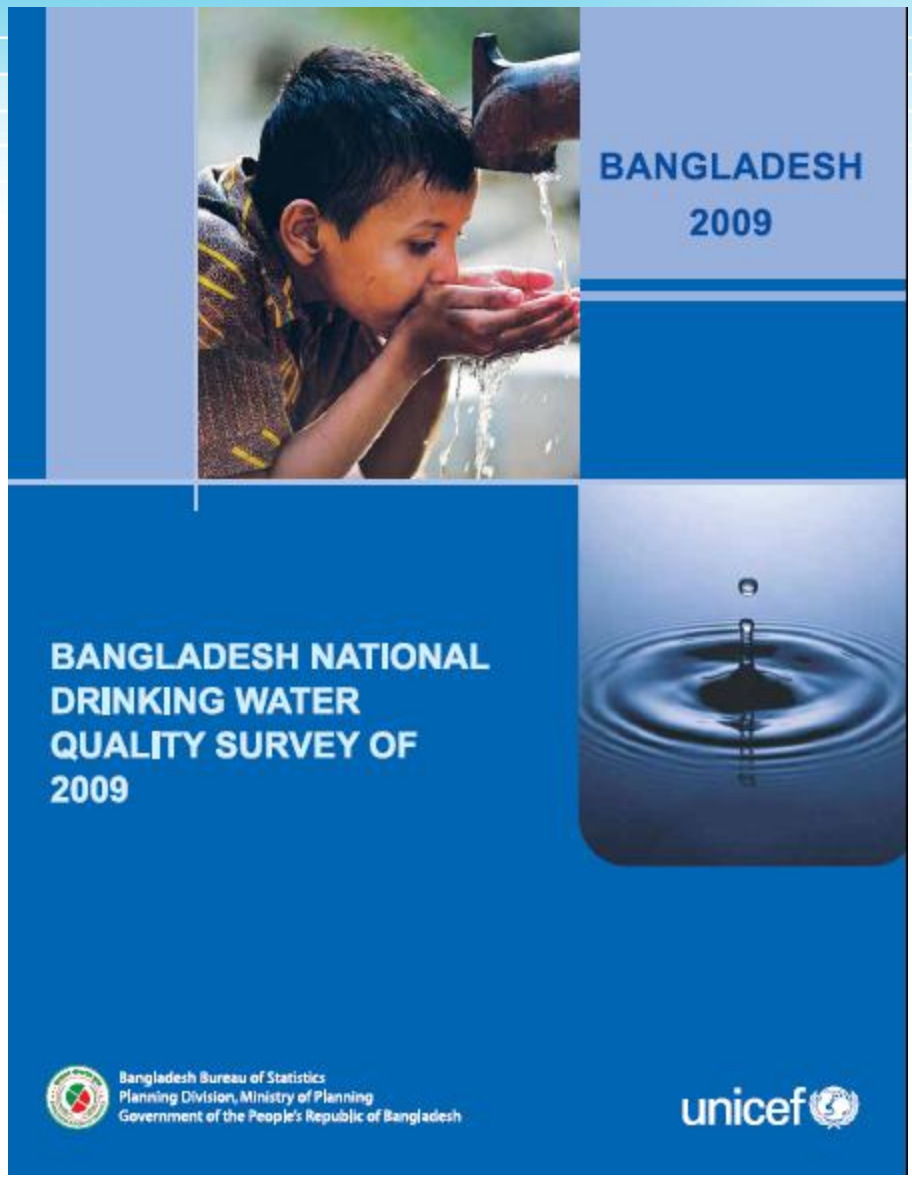
- Not including sample collection costs
- Including testing kit, quality control, NGO fees
  - NGO fees > field kit costs
  - Lab costs >> NGO fees

Conclusions

- Water quality testing is possible in national surveys
- Exposure, not just well survey
- Differences
  - Decreased exposure
  - Or result of different sampling
- Plan to continue in next MICS round

Recommendations

- Keep some geocode in sample code
- More training
- Strengthen quality control
  - Blanks more useful than replicates
  - Standards would add value
- Import bottles and acid
- Smaller sample size: 1500, not 15000
- Microbial testing



www.unicef.org/bangladesh/knowledgecentre_6868.htm
goo.gl/tCP53