BANGLADESH
2009

BANGLADESH NATIONAL DRINKING WATER QUALITY SURVEY OF 2009

Bangladesh Bureau of Statistics
Planning Division, Ministry of Planning
Government of the People's Republic of Bangladesh

unicef

ACKNOWLEDGMENTS

UNICEF would like to thank the principal author of this publication, Rick Johnston of Eawag, the Swiss Federal Institute for Aquatic Science and Technology. During his previous position in UNICEF Bangladesh's Water and Environmental Sanitation (WES) Section he designed and managed the implementation of the survey. He was guided in preparing this detailed analysis of the survey by Yan Zheng from UNICEF Bangladesh WES Section, who saw the completion of the MICS data collection, wrote sections of the report, supervised the mapping effort and did the final eding.

Thanks are also due to several UNICEF Bangladesh staff members who contributed time and effort throughout the survey and subsequent reporting, especially Mi Hua and Syed Adnan Ibna Hakim of WES Section, and Siping Wang and Deqa Musa of Planning, Monitoring and Evaluation Section. Mohammad Moshiur Rahman of the North-South University of Bangladesh kindly provided assistance in producing maps for the report.

The National Drinking Water Quality Survey would not have been possible without the support and hard work of field workers from the Bangladesh Bureau of Statistics and the Bangladesh Department of Public Health Engineering, who attended training sessions and collected water samples. UNICEF would also like to thank the senior governmental staff who supported trainings and data collection: Mr. Md. Shamsul Alam of BBS; Mr. Alamgir Hossain, of BBS; Mr. S.M. Ihtishamul Huq of DPHE; and Mr. Sudhir Kumar Ghosh of DPHE.

The hard work of the private consulting firm, Participatory Management Initiative for Development (PMID) is gratefully acknowledged. Rafiqul Islam Khan and Mujibur Rahman worked long hours to meet ght deadlines both in Dhaka and in delivering and collecting samples from field sites.

The report and the data set are available at the websites of BBS, UNICEF and EAWAG.

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March 22, 2011

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FOREWORD

The Bangladesh Bureau of Statistics has been conducting the Multiple Indicator Cluster Survey (MICS) since 1993 with the technical support of UNICEF. In 2009, a household drinking water quality survey was included as part of the MICS for the first time. When the MICS 2009 final report went to print in 2010, the arsenic results available from 13,432 Ditigal Arsenator analyses were included in the report. Since then, more results for dozens of chemical parameters for a sub set of samples measured in a laboratory in Canada became available, including 2,896 arsenic data points obtained by inductively coupled plasmas mass spectrometry (ICP-MS). Comparison of the 1,925 samples for which both Digital Arsenator and ICP-MS arsenic data can be unquestionably matched, the correlation is excellent with a slope near unity, suggesting no significant analytical bias of the Digital Arsenator data set. A careful examination of the Digital Arsenator data set has identified that a total of 14,442 arsenic data points can be matched to their origin and are now included. This does not change the percentage of samples exceeding the Bangladesh drinking water standard of 50 micrograms per litre significantly: it is now 13.4%. These results delineate the status of chemical quality of household drinking water in 2009. Thus, it is deemed necessary to report the findings in this report entitled "Bangladesh National Drinking Water Quality Survey of 2009" to complement the MICS 2009 final report.

Over the years, BBS has worked on improving our methologies to measure the indicators in the MICS. Inclusion of the water quality parameters is one such attempt. I am very pleased that this important step has been taken. The results from "Bangladesh National Drinking Water Quality Survey of 2009", shared with the sector stakeholders on the World Water Day, March 22 of 2011, can further assist the planning and utilization of resources in the water sector. This critical step taken has demonstrated that water quality survey can be done in developing countries as part of MICS. This is an important lesson that Bangladesh can share with the world. We will continue to refine our water quality survey module such that the progress of access to safe drinking water will be monitored in future MICS.

I hope that the findings of the report will be used by the planners, researchers and policy makers to improve the lives of children and women in Bangladesh.

Md. Shahjahan Ali Mollah
Director General
(Additional Secretary)
Bangladesh Bureau of Statistics (BBS)

PREFACE

Bangladesh is unique in that rural water coverage is high, yet supply is almost entirely decentralized. The great majority of rural residents collect drinking water through handpumps, or tubewells. The Multiple Indicator Cluster Survey (MICS) of 2009, conducted jointly by the Bangladesh Bureau of Statistics and UNICEF, reports that individual tubewells, screened in either shallow (<150 m) or deep (> 150 m) layers, and fitted with various types of pumps, provide drinking water to 94.3% of rural households. In addition to roughly 1 million community tubewells installed by the Department of Public Health Engineering (DPHE), it is estimated that about 10 million private tubewells are in use. For more than a decade, it has been recognized that arsenic contamination is wide spread in tubewells, especially those installed to the shallow depth. This contamination affects the health of tens of millions of people, and reducing exposure remains a key public health need.

The aim of the Bangladesh National Drinking Water Quality Survey (NDWQS) of 2009, as part of the 2009 MICS, was to provide disaggregated data at district level on access to arsenic safe water. All previous surveys have sampled or tested water at the source, with the exception of the 2004 Bangladesh Demographic and Health Survey (BDHS) which used field testing kits to measure arsenic levels in 10,465 respondent households. The current survey represents the first attempt in Bangladesh to collect drinking water samples from 15,000 households, and to analyze the samples using more reliable analytical methods for arsenic as well as dozens more parameters.

I hope the findings that as of 2009, 22 million people in Bangladesh are still drinking water that does not meet the Bangladesh drinking water standard for arsenic of 0.05 milligrams per litre, and that 5.6 million of them are at particularly high risk because they are exposed to water with more than 0.2 milligrams per litre arsenic, will re-energize mitigation efforts. The even more ubiquitous presence of iron which primarly affects the taste of the water implies that finding alternative arsenic safe source water suitable for consumption from safety and user acceptance point of views continues be challenging. Although 93% of deep tube wells meet the Bangladesh standard for arsenic, only 60% of deep tube wells meet the Bangladesh standards for arsenic, manganese and iron. The tasks of arsenic mitigation require collaboration of health, agriculture, water supply and water resource sectors for sustainable solutions. Strengthening local testing capacity is crucial, although urgent attention to provide safe water to villages where more than 80% of wells are contaminated with arsenic is still needed. The geographic pattern of arsenic is well defined at village level by the 2000-2003 blanket screening. This survey conducted in 2009 finds progress but also implies there is a long way to go to declare an arsenic safe environment in Bangladesh.

UNICEF is committed to continue supporting the Government of Bangladesh in its challenging social development endeavours.

Carel de Rooy
Representative
UNICEF Bangladesh

EXECUTIVE SUMMARY

The National Drinking Water Quality Survey (NDWQS) of 2009 was conducted as part of the Multiple Indicator Cluster Survey (MICS 2009) by the Bangladesh Bureau of Statistics (BBS), with participation from the Department of Public Health and Engineering. Compared to previous surveys, MICS 2009 increased the sample size to 300,000 households in 15,000 randomly selected clusters around the country to allow disaggregated data analysis for 23 indicators at sub-district level. In addition to monitoring the achievement of the Millennium Development Goals (MDG), MICS 2009 is enhanced by data with sufficient geographic resolution that can be useful to guide planning by the Government of Bangladesh and its development partners. The drinking water quality survey is more modest, targeting only 15,000 households, or the first household that the MICS survey worker enumerated in each cluster. Thus, disaggregated analysis for safe water access can only be done reliably at district level. The upazila level analysis is included for reference use in the Appendix. MICS 2009 shows that similar to MICS 2006, 97.8 per cent of the population used an improved drinking water source as defined by the WHO/UNICEF Joint Monitoring Programme (JMP). Of the 14,442 samples analyzed using Digital Arsenator instruments in Bangladesh, 1,935 (13.4%) were found to contain more than 0.05 milligrams per litre of arsenic, the Bangladesh drinking water standard. Taking arsenic contamination into consideration, the proportion of the population using an improved drinking water source is 85.5 per cent (93.3 per cent in urban and 83.8 per cent in rural areas) following the Bangladesh national standard. There are an estimated 22 million people in 2009 consuming drinking water which does not meet the Bangladesh national standard for arsenic. Of those, 5.6 million are exposed to > 0.2 milligrams per litre and are in extreme health danger. Provision of arsenic safe water to this high risk population must be an urgent priority.

The spatial distribution of arsenic agrees with that found in previous surveys, namely, the National Hydrochemical Survey by the Department of Public Health and Engineering (DPHE) and the British Geological Survey (BGS) in 1999, and the blanket screening of nearly 5 million wells between 2000 and 2003, with data maintained by the National Arsenic Mitigation Information Centre (NAMIC). Eighteen of the 64 districts are found to have more than 20% of the drinking water samples tested to contain more than 0.05 milligrams per litre of arsenic. Nine of them, Comilla (49%), Gopalganj (48%), Sunamganj (48%), Chandpur (44%), Noakhali (40%), Faridpur (36%), Madaripur (32%), Netrakona (32%) and Brahmanbaria (30%), are especially high in arsenic occurrence. Furthermore, in seven of these districts more than 10% of drinking water samples contained very high levels of arsenic (more than 0.2 milligrams per litre). They are Chandpur (27%), Comilla (25%), Brahmanbaria (17%), Gopalganj (15%), Noakhali (13%), Madaripur (13%), and Faridpur (11%). Targeting villages identified by NAMIC as arsenic emergency villages should remain a priority because progress made has been insufficient.

The proportion of samples exceeding permissible limits for arsenic is lower in the current survey than in previous national surveys. The DPHE/BGS survey found 25% of samples to exceed 0.05 mg/L, while the NAMIC database shows an overall contamination rate of approximately 20%. The current finding of about 13% contamination may represent important progress in reducing arsenic exposure. However, it is important to note that both the DPHE/BGS and NAMIC surveys measured water quality at the source, while the NDWQS collected a sample of household drinking water. Water quality could be significantly different between tubewells and households. People may have preferentially selected drinking water sources with better quality water – either intentionally avoiding arsenic, or by simply avoiding water with high levels of dissolved iron, which correlates with arsenic. It is also possible that arsenic levels are reduced somewhat during household storage, due to settling of iron precipitates.

When arsenic levels are disaggregated by water source, the survey found that 14.4% of shallow tube wells (n=10,066) do not meet the Bangladesh standard, with an average concentration of 0.032 milligrams per litre, the highest occurrence and concentration compared to other water sources. However, arsenic was also detected in water from all self-reported sources, including dug wells, surface water, piped supplies, public taps/standpipes, and springs (n=116), although only at low levels. Deep tube wells (n=2,636), showed an occurrence of 7.5% with an average concentration of 0.015 milligram per litre. Assuming that the self reported source is correct, this high occurrence of arsenic in deep groundwater in part reflects wide spread presence of arsenic in deep groundwater of Sylhet division, but especially in areas within and around Sunamganj district. Although the first step is to confirm the depth of the self reported deep tube well, more sporadic occurrence of high arsenic in deep groundwater underlying shallow groundwater with high arsenic, especially in southeastern Bangladesh, is worrisome. With deep tube wells being increasingly used for arsenic mitigation, the quality of construction to prevent arsenic infiltration from shallow depth is an item worthy of attention.

Furthermore, a monitoring network for deep groundwater needs to be established for sustainable development and management of this precious resource for drinking water supply, including putting a limit on the pumping rate of a single deep tube well to avoid draw down and pollution of the deep groundwater.

Respondents (n=14,442) were asked if the source of their drinking water had been tested for arsenic, and whether or not they know the results. Of the 4,802 who responded that their wells were 'green', 92% of these wells were found to meet the Bangladesh standard. Of the 679 who responded that their wells were 'red', 80% were found to exceed the Bangladesh standard. Thus, the majority of people understood correctly the test results. However, 1,072 (7%) out of 14,442 respondents reported their wells were tested but they didn't know the results. Moreover, 6,529 (45%) responded that their wells were not tested; and 1,359 (9%) responded that they simply didn't know. In 2006, the proportion of household reporting that their wells were not tested was 37.5%. Because new private wells are being installed without regulation or any requirement of testing, it is not surprising that a significant and increasing proportion (now almost half), of the country's water sources have not been tested. Testing is crucial for people to be able to choose safer sources, especially in villages where safe and unsafe wells are located near each other. Local testing capacity using field testing kits should urgently be strengthened, with users being charged a small fee to cover the testing cost that is now below 50 taka per test even with imported field testing kits.

The focus on arsenic in this report is justified given the severe health impacts it has. This, however, does not imply other water quality parameters are not important. A sub set of samples was also measured for a range of metals and metalloids by Inductively Coupled Plasma Mass Spectrometry and several anions following standard laboratory methods as detailed in the Appendix. Of the parameters measured in this survey, ten (arsenic, barium, boron, copper, fluoride, manganese, molybdenum, nickel, selenium and uranium) have health-based WHO guideline values. The WHO guideline value most frequently exceeded is manganese, with 65% of the samples meeting the WHO guideline value of 0.4 milligrams per litre (the Bangladesh standard for manganese is stricter at 0.1 milligrams per litre – only 39% of samples met this target). Another element, iron, is found to exceed the Bangladesh standard of 1.0 milligrams per litre in 40% of samples. Although 93% of deep tube wells meet the Bangladesh standard for arsenic, only 60% of deep tube wells meet the Bangladesh standards for arsenic, manganese and iron. The same holds for other usually arsenic safe water sources: on average 62% of these meet the Bangladesh standards for arsenic, manganese and iron. The acceptance of arsenic safe water is affected by the taste of the water, and water containing iron or manganese or both, does not taste good. Whereas treatment of iron and manganese is simpler than treatment of arsenic, this adds an additional barrier for arsenic mitigation and the implication of wide spread iron and manganese in groundwater on arsenic mitigation has not been thoroughly examined.

A limitation of this survey is that it did not include any measure of microbial water quality. It is likely that microbiological contamination of household water is much more widespread than chemical contamination. Household water surveys conducted in the DPHE/UNICEF Sanitation Hygiene Education and Water Supply project area encompassing 19 of the 64 districts of Bangladesh show that more than half of samples contain *E. coli*, an indicator of faecal contamination, and 10% of samples contain very high levels (> 100 cfu/100 mL). These surveys are not nationally representative, but cover large portions of rural Bangladesh and give some idea of the microbial quality of household drinking water. If cost is not a limiting factor, microbiological water quality such as *E. Coli* is recommended to be included in future nationally representative surveys, such as the next MICS, planned for 2012. Advances are being made in development of simple robust methods for field use in rugged settings which could render this task less challenging.

The survey has provided for the first time a much improved baseline data to assess the progress that Bangladesh will make towards MDG Target 7c, 'to reduce, by 2015, the proportion of people without sustainable access to safe water.' The Joint Monitoring Programme of the WHO and UNICEF, which measures progress towards this target, estimates that in 1990 78% of the population in Bangladesh had access to arsenic safe water, which would imply a target of 89% safe coverage by 2015. This report suggests that with an arsenic-adjusted coverage of 86%, Bangladesh should be on track to achieve the MDG target for water. However, it should not be taken for granted that this will happen without substantial additional financial investment. The recent recognition that arsenic mitigation is multi-sectoral involving health, water supply, agriculture and water resources should inject renewed focus on solving this environmental problem facing Bangladesh.

INTRODUCTION

BACKGROUND

Bangladesh has achieved a very high level of drinking water coverage, largely because highly productive sand and gravel aquifers underlying most of the flood plain allow for the easy installation of inexpensive shallow tubewells. It is estimated that there are 10 million such wells in the country, 90% of which are privately installed, which implies that a tubewell serves only about fifteen people on average.

The discovery of widespread arsenic contamination in Bangladesh in the 1990s has led to a reassessment of the level of safe drinking water coverage in Bangladesh, and to a greater consideration of water quality in general. The Millennium Development Goals (MDGs) include Target 7c, 'to reduce, by 2015, the proportion of people without sustainable access to safe water.' However, nationally representative measures of drinking water quality have rarely been made in developing countries due to gaps in water quality testing capacity. The WHO/UNICEF Joint Monitoring Programme (JMP), which tracks progress towards the MDGs, uses a proxy indicator, 'water from an improved source' to measure progress towards the target. This assumes that water from an improved or protected source (e.g. piped water, tubewell, protected spring) is more likely to be safe than that from an unprotected source (e.g. open well, lake water). This may be a reasonable assumption when considering microbiological contamination. Even then, it is recognized that water from certain types of improved sources may be microbiologically contaminated, and that water collected from a pristine source may become contaminated before consumption due to poor hygiene. This assumption, unfortunately, holds even less truth for chemical contamination, either naturally occurring compounds in source water or those from industrial or agricultural pollution.

Arsenic in Bangladesh is a case in point: more than 98% of people in Bangladesh use groundwater, generally considered an improved source of water, for drinking. In rural areas, individual water point, most often a tube well with a hand pump, provides the access. In urban areas, groundwater can be delivered via piped water systems. Both tube wells and piped water systems are classified as 'improved sources' by JMP definitions. However, tubewell surveys indicate that 20% of shallow tubewells exceed the government drinking water limit of 0.050 milligrams per litre(mg/L) for arsenic[1]. In recognition of this widespread hazard in Bangladesh, the JMP reports the drinking water coverage in Bangladesh to be 80% in 2008, adjusting the 'improved source' statistically downward to account for the arsenic. This adjustment, while better than the simple 'improved source' indicator, suffers from a significant weakness. Massive public awareness and tubewell testing campaigns have encouraged people to identify and share water from safe tubewells (defined here as meeting the Bangladesh government standard of 50 µg/L arsenic , noting that the WHO guideline value is 10 µg/L). Following widespread testing of tube wells, many people have also reportedly identified relatively safe strata within shallow depths (e.g. < 100 m) and targeted these zones for new shallow tube wells. At the same time, deep tube wells (> 150 m) which are largely arsenic free have been installed in many affected areas. It is estimated that nearly 30% of the population originally at risk of arsenic exposure has gained access to safer sources[2]. By applying a blanket correction of 20% to shallow tube well users, the JMP estimate misses this important improvement.

The report describes chemical compositions of household drinking water samples from a National Drinking Water Quality Survey (NDWQS) conducted as part of the Multiple Indicator Cluster Surveys (MICS) in 2009, designed to provide a more accurate assessment on the progress of Bangladesh towards MDG Target 7c. For the first time, access to an improved water source can be adjusted for arsenic contamination reliably for each district. Other chemicals of health concerns are also noted. The survey is also motivated because since the completion of the blanket arsenic field testing campaign around 2003, there has been no routine testing of newly installed wells, possibly numbered in millions.

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[1] Johnston, R. B., and Sarker, M. H. (2007). "Arsenic mitigation in Bangladesh: national screening data and case studies in three upazilas." Journal of Environmental Science and Health, Part A: Environmental Science and Engineering, 42(12), 1889-1896; National Arsenic Mitigation Information Center (NAMIC)

[2] Ahmed et al. (2006). "Ensuring safe drinking water in Bangladesh." Science 314:1687.

MULTIPLE INDICATOR CLUSTER SURVEYS

Since the mid 1990s, UNICEF has supported governments around the world in collecting and analyzing data in order to fill gaps for monitoring the situation of children and women, through Multiple Indicator Cluster Surveys (MICS). MICS findings are used in monitoring progress towards Millennium Development Goals, and have been used extensively as a basis for policy decisions and programme interventions. In Bangladesh, MICS is implemented by the Bangladesh Bureau of Statistics (BBS) every year between 1995 and 2000, and since 2000 every three years. Field work of the MICS was completed by the BBS by the middle of 2009 and the final report[3] was published in June 2010.

OTHER WATER QUALITY SURVEYS

An overview of previous water quality surveys at national scale is provided below. Results of the NDWQS, when applicable, are compared with data from earlier surveys in this report.

DPHE/BGS data

The most comprehensive water quality dataset for Bangladesh groundwater is the national survey conducted by the Bangladesh Department of Public Health and Engineering (DPHE) and the British Geological Survey (BGS) in 1999[4]. It surveyed 3,207shallow and 327 deep tubewells throughout the country (except for the Chittagong Hill Tracts, which are mostly free of arsenic), and tested groundwater samples in a British laboratory for 20 inorganic parameters. The BGS also surveyed 115 irrigation wells monitored by the Bangladesh Water Development Board (BWDB), testing samples for 53 parameters. Fluoride levels were tested in only three special study areas.

The DPHE/BGS report found that 25% of all wells tested, and 27% of shallow wells, exceeded the 50 µg/L standard for arsenic; 42% of all wells tested, and 46% of shallow wells exceeded the WHO provisional guideline value of 10 µg/L. Where possible, data from the 2009 National Drinking Water Quality Survey are compared to the DPHE/BGS data; for chemicals which were not tested in the larger DPHE/BGS survey the smaller BWDB data set is used. It is important to note that the DPHE/BGS and BWDB surveys collected samples directly from tube wells, while the NDWQS collected samples of household drinking water. This results in differences in several water quality parameters.

NAMIC data

After the DPHE/BGS survey, it was clear that arsenic posed a national problem. It was also evident that arsenic levels were highly variable at the local level: a highly contaminated well might be located just meters away from a safe well. For this reason, it was decided to launch a massive blanket screening campaign, to test and mark every tube well in arsenic-prone areas. This screening was largely conducted from 2000 through 2003, though some testing continued until 2006. The resulting dataset consists of nearly 5 million field test kit results, and was maintained by the National Arsenic Mitigation Information Centre (NAMIC). The NAMIC dataset indicates that only about 20% of shallow tube wells exceed the 50 µg/L standard. The accuracy of this estimate is limited due to the lack of quality assurance measures (e.g. cross-checking subsets of results in laboratories) in the screening. The field kits used at the time could not reliably detect arsenic to 10 µg/L so no information can be gained regarding the number of wells exceeding the WHO guideline value. The NAMIC dataset serves as the basis for the correction factor currently applied by the JMP.

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[3] BBS/UNICEF. (2010). "Multiple Indicator Cluster Survey 2009: Volume 1, Technical Report." Bangladesh Bureau of Statistics/UNICEF, Dhaka. http://www.unicef.org/bangladesh/knowledgecentre_6292.htm

[4] DPHE/BGS/MML. (2001). "Groundwater Studies for Arsenic Contamination in Bangladesh. Phase 2: National Hydrochemical Survey." Department of Public Health Engineering, Government of Bangladesh, British Geological Survey and Mott MacDonald Ltd (UK), Dhaka, Bangladesh.http://www.bgs.ac.uk/arsenic/

BDHS 2004

The 2004 Bangladesh Demographic and Health Survey (BDHS) used field testing kits to measure arsenic levels in 10,465 respondent households. Unlike the DPHE/BGS and NAMIC surveys, BDHS measured water quality in the household, not at the tube well. The survey showed that 7.9% of household water samples exceeded the 50 μg/L limit, while 2.7% and 1.1% exceeded 100 and 250 μg/L, respectively[5]. These data may be subject to negative bias, since the Hach kit used is known to underestimate arsenic in the 10-100 μg/L range[6], and no results were cross-checked in laboratories. Unfortunately the arsenic testing module was not retained in the 2007 BDHS.

[5] Khan, M. M. H., Aklimunnessa, K., Kabir, M., and Mori, M. (2007). "Determinants of drinking arsenic-contaminated tubewell water in Bangladesh." Health Policy and Planning, 22(5), 335-343.

[6] van Geen, A., Cheng, Z., Seddique, A. A., Hoque, M. A., Gelman, A., Graziano, J., Ahsan, H., Parvez, F., and Ahmed, K. M. (2005). "Reliability of a commercial kit to test groundwater for arsenic in Bangladesh." Environmental Science & Technology, 39(1), 299-303.

METHODS

SAMPLING FOR METALS AND METALLOIDS ANALYSES

A household water quality testing component was included in the 2009 Bangladesh MICS for the first time. The sampling plan called for collection of one household drinking water sample from 15,000 clusters randomly selected from all geographic areas of Bangladesh. MICS field workers visited 15,000 clusters and conducted interviews in 20 households per cluster, for a total sample size of 300,000. The respondents answered questionnaires on the source of their drinking water. Tubewells reportedly deeper than 150 m were classified as 'deep tubewells', though no verification of the depth was made. Sample bottles, pre-acidified (To a 125-ml sample bottle, 1.5 millilitre of 1:1 diluted concentrated nitric acid of analytical grade, Merck, was added), were provided to field workers to collect a sample from the first household visited in each cluster. Survey respondents were asked to provide 'a glass of drinking water which you would give your child to drink', which was then poured into the bottle. A total of 17,205 sample bottles were filled, labeled and transported to Dhaka for analysis; 15,950 of these (93%), including 1,508 quality control samples, were adequately labeled and coded to be useful for geographical analysis. A total of 14,442 distinct household samples were analyzed for arsenic using Digital Arsenators (Wagtech, model WE-10500) in Dhaka. Approximately 20% of samples from each district were sent to a reference laboratory (Maxxam Analytics, Canada) for analysis of arsenic and a suite of metals and metalloids by inductively coupled plasma-mass spectrometry. The laboratory reported results from 2,896 distinct households. In addition, 375 quality control samples were analyzed, including 34 field replicates and 182 field blanks. Agreement was reasonable between field replicates (r^2 = 0.74). For 1,925 samples, arsenic measurements from both laboratory and Arsenator data were available; agreement between these two independent datasets was good (r^2 = 0.91). Details of the data collection, management and quality control are available in the Appendix.

SAMPLING FOR FLUORIDE AND ANION ANALYSES

Fluoride occurring naturally in groundwater of many countries can have severe health impacts, but only very limited data of fluoride in groundwater of Bangladesh are available. To measure anions such as fluoride, unacidified samples should be collected. This was considered to be too complicated to do by MICS field workers because there is a risk of mis-labelling and mixing up of the pre-acidified and unacidified sample bottles. DPHE arranged for a separate sample collection campaign also in 2009. DPHE field workers collected one unacidified sample but not necessarily from the same household where MICS field workers collected their acidified samples because household-specific location details of MICS respondents could not be accessed for privacy concerns. Only the mouza (the lowest level administrative unit that is consisted of multiple clusters) location information from where the MICS sampling took place were made available. Therefore, DPHE field workers collected one sample from a random household within the target mouza. After samples were delivered to DPHE in Dhaka, 3,079 samples were analyzed for fluoride using field test kits (Wagtech Photometer 5100). Approximately 20% of samples from each district were sent to a reference laboratory for analysis of chloride and fluoride. The laboratory reported results from 543 distinct households. In addition, 89 quality control samples were also analyzed, including 12 field replicates and 15 field blanks.

Quality control analysis from the field dataset showed poor agreement between 46 matched field replicates (r^2 = 0.20) and significant error in the blanks (fluoride levels up to 1.6 mg/L). Agreement was also poor between field test and laboratory data (r^2 = 0.31), so the field dataset are considered unreliable and are not analyzed further. However, laboratory reproducibility was excellent for fluoride. Details of the data collection, management and quality control are available in the Appendix.

Together, these two datasets constitute the National Drinking Water Quality Survey (NDWQS) of 2009.

DATA ANALYSIS

Stata SE version 11.0 (College Station, TX) was used for all statistical analysis, including calculations of the range, median, mean, and cumulative distribution. To compare NDWQS 2009 data with previous water quality survey data, the Wilcoxon rank-sum test, also known as the Mann-Whitney two-sample statistic, is performed. This non-parametric test computes the likelihood that probability of a random draw from the first population is larger than that of a random draw from the second population, but does not provide quantitative information about the magnitude of the difference.

Arc Info 9 (ESRI, USA) was used to generate maps to illustrate spatial patterns. Since precise locations of individual households were not available, latitudes and longitudes of 12,119 mouzas were collected and are used for the arsenic data analyzed using the Digital Arsenator in Bangladesh. The latitudes and longitudes of 2,795 mouzas are available and are used for the subset of data analyzed by the reference laboratory in Canada. Concentrations are averaged and mapped should more than one drinking water sample data is available for each mouza.

RESULTS

A summary of household water quality is presented in Table 1, followed by detailed results for each chemical as described below. Where possible, data are disaggregated by water source, and by geographical area.

Chemicals are grouped into three classes:

1) Major elements, with median concentrations > 1 mg/L

2) Minor elements, with median concentrations from 0.01 – 1.0 mg/L

3) Trace elements, with median concentrations < 0.01 mg/L

For each chemical analyzed, a brief introduction is given for the Bangladesh drinking water standard and the WHO guideline value, if these have been established. Health impacts on humans and relevant geochemical behavior of the analyte in natural water are briefly reviewed when appropriate. Results are shown graphically using a cumulative distribution function. This graph plots the proportion of samples which are equal to or less than a given concentration. The curve rises from 0% at zero concentration to 100% at the maximum value measured in the sample set. The cumulative frequency graphs indicate the WHO guideline value and the Bangladesh drinking water limit, if any, with solid vertical lines. The Limit of Detection (LOD), which represents the value below which the presence of the analyte cannot be stated with confidence, is indicated with a dashed line. The calculation of the LOD is presented in the Appendix. Comparable data from other surveys (i.e. the DPHE/BGS dataset) are also plotted in the same way, when available. If one of these curves is to the right of (below) the other, this means that that survey found higher levels of the chemical.

Results are also tabulated by district and division, and in some cases by drinking water source. Tables indicate the proportion of samples which exceed Bangladesh or WHO limits, where these exist. Yellow shading in the table indicates that the value is below the Limit of Detection (LOD). Blue shading indicates that either a Bangladesh standard or a WHO guideline value is exceeded. Darker blue shading indicates both are exceeded, or that one is exceeded by a factor of ten.

Maps for metals and metalloids are also presented to display the spatial pattern of concentration in samples with sources from shallow groundwater (< 150 m) and deep groundwater (> 150 m). Note that the depth is self reported and has not been verified and may contain errors. Maps for anions are not separated for depth because such information is not available. A histogram is included as an inset in each map. Whenever possible, the WHO guideline value and the Bangladesh drinking water limit are used to group the data in the histogram.

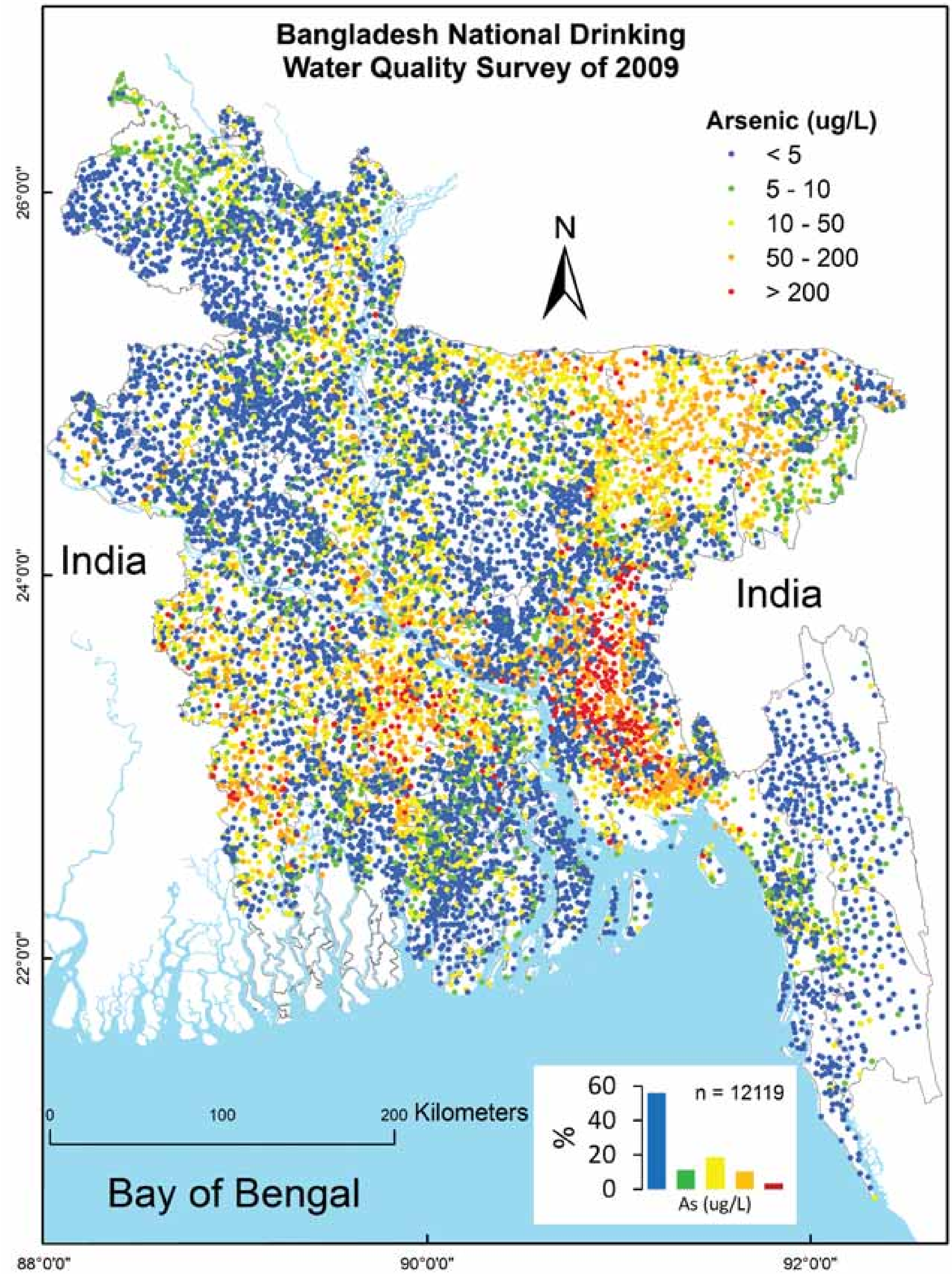
Table 1: **Summary of household drinking water quality in Bangladesh, 2009**

Analyte	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Major elements (median > 1 mg/L)										
Calcium (Ca)	14	30	70	110	520	47	0.000	0.174	n.a.	0.773
Chloride (Cl)	4	12	42	180	1900	74	0.013	0.165	n.a.	0.877
Magnesium (Mg)	6	13	24	36	210	18	0.000	0.040	n.a.	0.894
Hardness (as CaCO3)	65	138	289	434	1409	196	0.000	0.088	n.a.	0.936
Potassium (K)	2	3	5	9	520	5	0.001	0.029	n.a.	0.927
Silicon (Si)	13	17	22	27	40	18	0.000	0.740	n.a.	n.a.
Sodium (Na)	14	27	77	250	1700	87	0.000	0.036	n.a.	0.867
Minor elements (median 0.01 - 1.0 mg/L)										
Aluminium (Al)	0.035	0.051	0.087	0.160	16.0	0.098	0.021	0.875	n.a.	0.938
Barium (Ba)	0.05	0.09	0.15	0.26	1.50	0.13	0.001	0.731	0.992	n.a.
Boron (B)	0.012	0.027	0.094	0.330	3.0	0.110	0.217	0.737	0.939	0.993
Fluoride (F)	0.05	0.15	0.20	0.40	1.5	0.20	0.328	0.869	1.000	0.989
Iron (Fe)	0.24	0.71	2.30	6.10	43.0	2.22	0.109	0.324	n.a.	0.598
Manganese (Mn)	0.04	0.20	0.63	1.30	9.2	0.49	0.022	0.243	0.647	0.389
Phosphorus (P)	0.15	0.24	0.44	1.40	13.0	0.54	0.134	0.621	n.a.	0.935
Strontium (Sr)	0.09	0.16	0.31	0.47	2.50	0.23	0.000	0.033	n.a.	n.a.
Zinc (Zn)	0.009	0.015	0.034	0.077	5.5	0.046	0.078	0.825	n.a.	1.000
Trace elements (median < 0.01 mg/L)										
Arsenic (As)	0.001	0.001	0.004	0.041	0.910	0.018	0.559	0.605	0.821	0.915
Arsenic (As, Arsenator)	0.001	0.001	0.018	0.077	0.900	0.027	0.590	0.658	0.680	0.866
Cobalt (Co)	0.0003	0.0003	0.0005	0.0010	0.130	0.0006	0.741	0.740	n.a.	n.a.
Copper (Cu)	0.0003	0.0003	0.0005	0.0010	0.130	0.0006	0.741	0.740	1.000	1.000
Lithium (Li)	0.003	0.003	0.006	0.010	0.088	0.005	0.708	0.707	n.a.	n.a.
Nickel (Ni)	0.001	0.001	0.002	0.003	0.190	0.002	0.520	0.959	0.997	0.999
Molybdenum (Mo)	0.001	0.001	0.001	0.002	0.023	0.001	0.814	0.813	1.000	n.a.
Selenium (Se)	0.001	0.001	0.001	0.001	0.015	0.001	0.978	0.974	0.999	0.999
Titanium (Ti)	0.003	0.003	0.003	0.003	0.096	0.003	0.910	0.925	n.a.	n.a.
Tungsten (W)	0.001	0.001	0.001	0.001	0.022	0.001	0.917	0.946	n.a.	n.a.
Uranium (U)	0.0001	0.0001	0.0006	0.0041	0.063	0.0013	0.582	0.630	0.989	n.a.
Vanadium (V)	0.001	0.001	0.002	0.003	0.019	0.001	0.660	0.730	n.a.	n.a.

Yellow shading in the above table indicates that the value is below the Limit of Detection (LOD). Blue shading indicates that either a Bangladesh standard or a WHO guideline value is exceeded. Darker blue shading indicates both are exceeded, or that one is exceeded by a factor of ten. Several trace elements[7] were measured, but are not included in Table 1 because most or all results were below the Limit of Detection.

[7] Antimony, beryllium, bismuth, cadmium, chromium, lead, silver, tellurium, thallium, thorium, tin, and zirconium

Map1: **Spatial distribution of arsenic in drinking water of Bangladesh, 2009, with 13.4% of samples exceeding the Bangladesh drinking water limit of 50 µg per litre and 32.0% of samples exceeding the WHO guideline value of 10 µg per litre.**

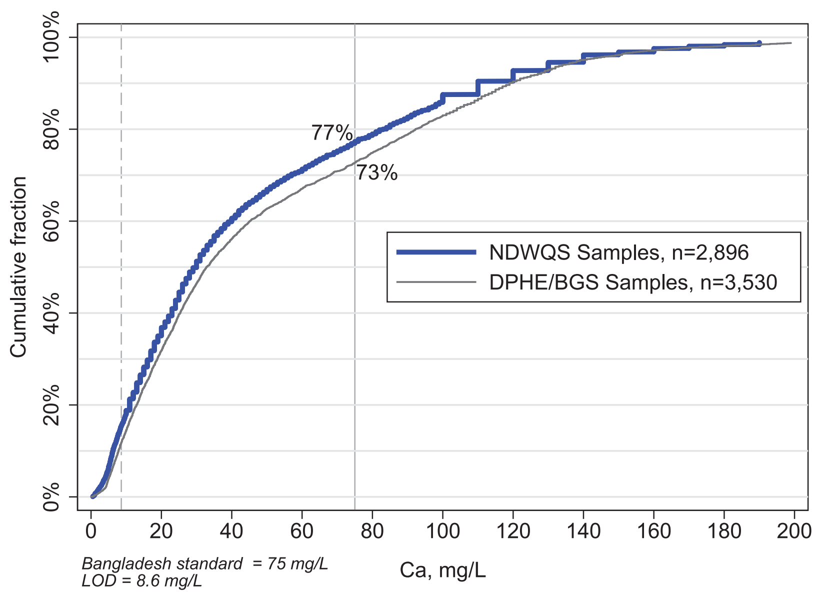


MAJOR ELEMENTS

CALCIUM (CA)

The Bangladesh standard for calcium in drinking water is 75 mg/L. There is no WHO guideline value, and calcium does not have any particular health impacts at levels typically found in natural waters. Calcium is a major contributor to hardness.

Figure 2: **Calcium distribution, 77% of samples met the Bangladesh standard.**

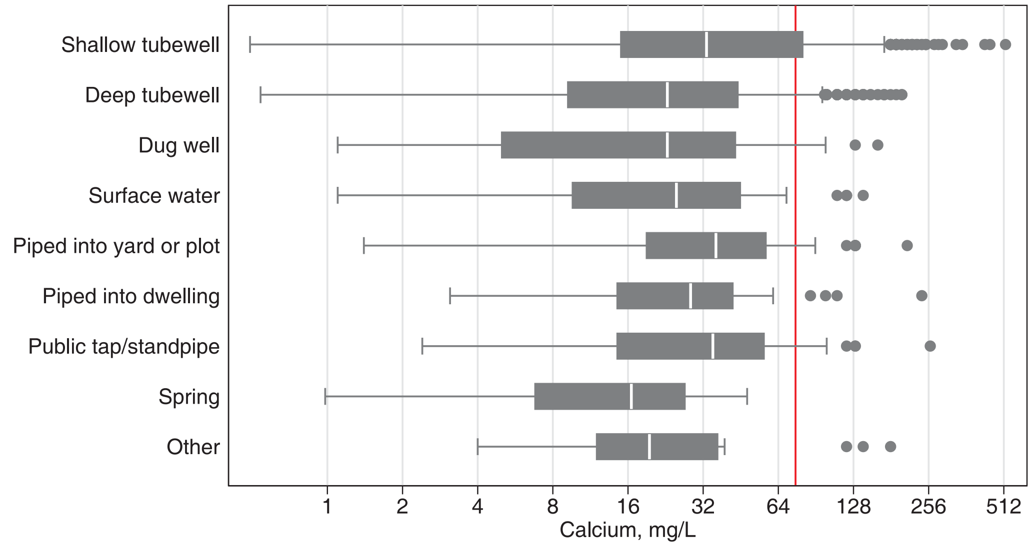


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 53.2% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 2a: Calcium levels by water source

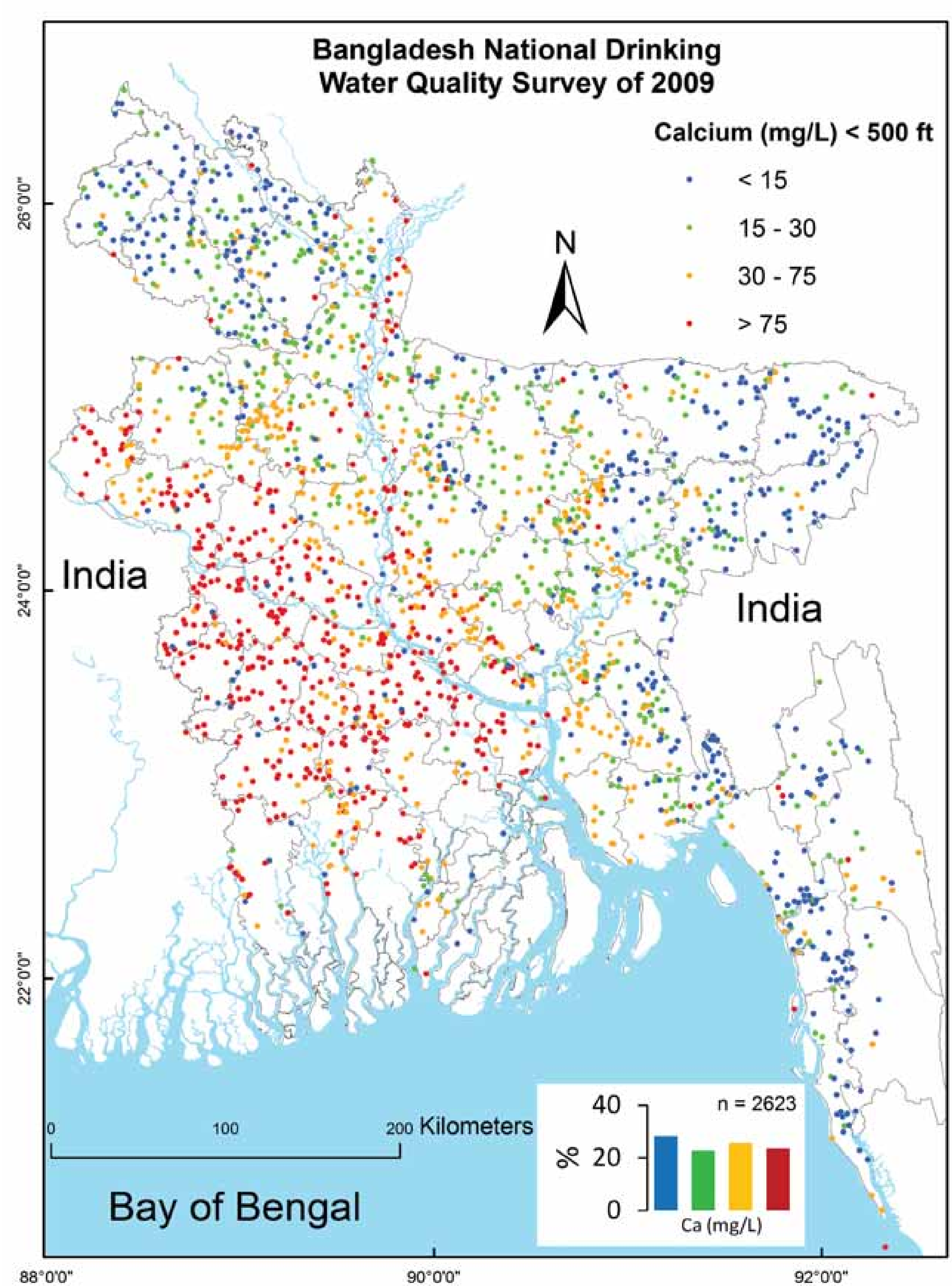
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	15	33	80	120	520	52	0.000	0.126	n.a.	0.733
Deep tubewell	526	9	23	44	89	200	35	0.000	0.234	n.a.	0.863
Dug well	59	5	23	43	81	160	31	0.000	0.339	n.a.	0.898
Surface water	67	10	25	45	65	140	32	0.000	0.224	n.a.	0.940
Piped into yard/plot	54	19	36	57	120	210	47	0.000	0.074	n.a.	0.833
Piped into dwelling	48	15	29	42	61	240	35	0.000	0.125	n.a.	0.917
Public tap/standpipe	44	15	35	56	100	260	46	0.000	0.091	n.a.	0.818
Spring	22	7	17	27	41	48	19	0.000	0.318	n.a.	1.000
Other	16	12	20	37	140	180	42	0.000	0.188	n.a.	0.813

Figure 2b: Calcium levels by water source



Bangladesh standard = 75 mg/L

Map 2a: Calcium levels in shallow tubewells (<150 m)



Map 2b: **Calcium levels in deep tubewells (> 150 m)**

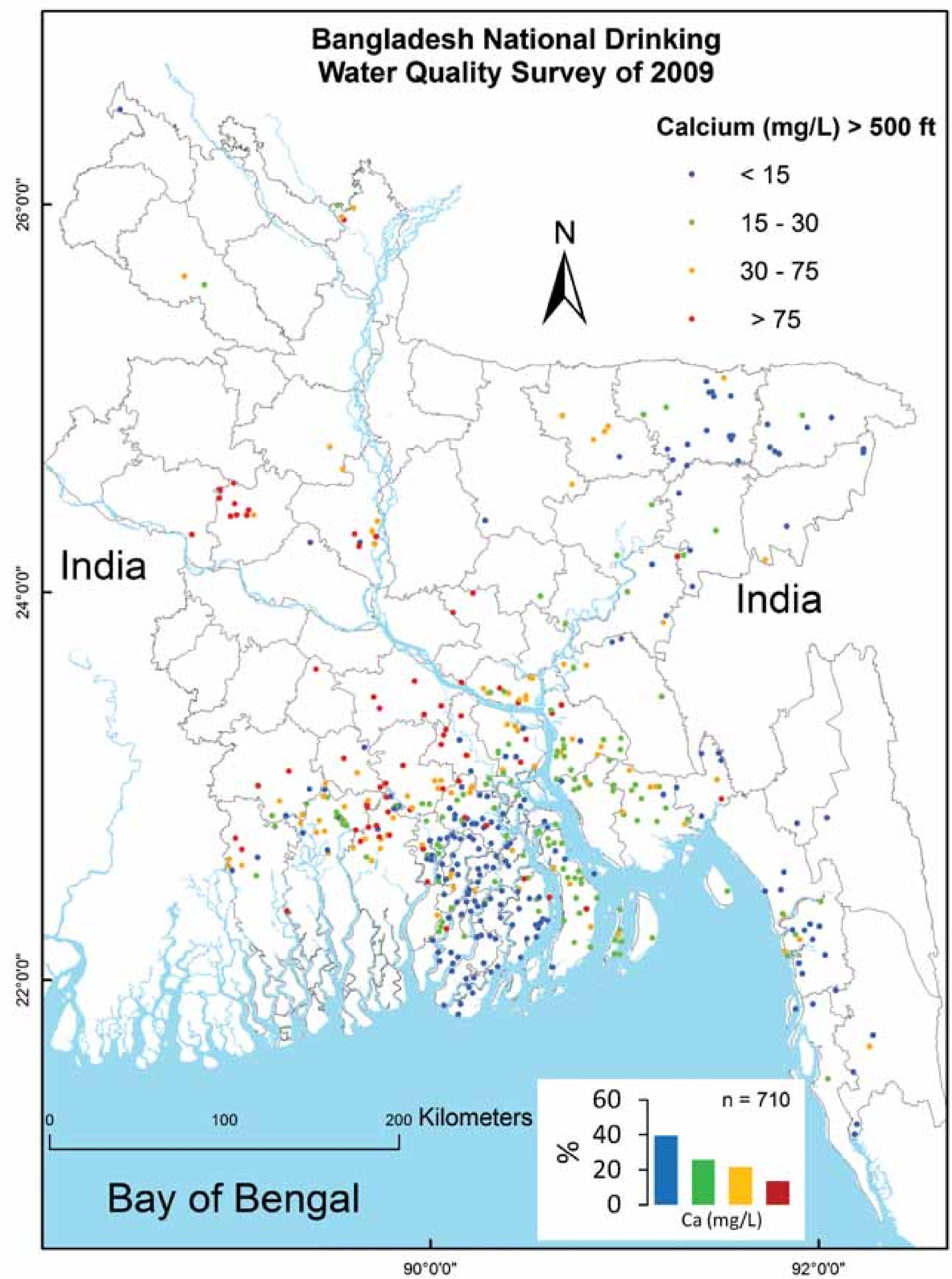


Table 2b: Geographic distribution of calcium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	4	5	17	23	180	16	0.000	0.657	n.a.	0.943
Barisal	65	6	12	24	72	290	29	0.000	0.446	n.a.	0.908
Bhola	36	21	25	30	38	200	29	0.000	0.056	n.a.	0.972
Jhalokati	26	5	9	29	56	110	22	0.000	0.423	n.a.	0.923
Patuakhali	46	6	7	13	24	120	14	0.000	0.674	n.a.	0.957
Pirojpur	40	13	35	53	73	120	37	0.000	0.175	n.a.	0.925
Barisal Division	*248*	*6*	*13*	*28*	*55*	*290*	*25*	*0.000*	*0.460*	*n.a.*	*0.935*
Bandarban	44	5	14	27	35	40	16	0.000	0.409	n.a.	1.000
Brahamanbaria	52	15	20	34	51	100	27	0.000	0.077	n.a.	0.981
Chandpur	47	26	35	50	92	120	44	0.000	0.021	n.a.	0.851
Chittagong	92	6	12	22	41	73	17	0.000	0.348	n.a.	1.000
Comilla	86	12	23	43	61	190	30	0.000	0.140	n.a.	0.953
Cox's Bazar	38	6	13	48	89	180	32	0.000	0.316	n.a.	0.842
Feni	38	8	11	15	31	57	14	0.000	0.316	n.a.	1.000
Khagrachhari	47	4	14	19	44	100	18	0.000	0.447	n.a.	0.957
Lakshmipur	32	25	31	41	93	250	48	0.000	0.000	n.a.	0.875
Noakhali	51	20	26	38	64	85	33	0.000	0.000	n.a.	0.961
Rangamati	56	7	16	36	48	98	23	0.000	0.268	n.a.	0.964
Chittagong Division	*583*	*10*	*19*	*34*	*56*	*250*	*26*	*0.000*	*0.249*	*n.a.*	*0.952*
Dhaka	74	28	46	69	110	450	64	0.000	0.000	n.a.	0.797
Faridpur	48	91	110	135	180	430	119	0.000	0.000	n.a.	0.125
Gazipur	33	17	25	29	33	63	24	0.000	0.061	n.a.	1.000
Gopalganj	31	53	84	99	150	190	87	0.000	0.000	n.a.	0.419
Jamalpur	39	20	27	48	100	110	39	0.000	0.026	n.a.	0.846
Kishoreganj	75	20	31	48	69	180	38	0.000	0.067	n.a.	0.933
Madaripur	22	44	105	130	140	210	97	0.000	0.000	n.a.	0.318
Manikganj	40	62	76	100	135	160	82	0.000	0.000	n.a.	0.500
Munshiganj	36	34	59	92	130	220	70	0.000	0.000	n.a.	0.611
Mymensingh	71	17	25	32	38	67	25	0.000	0.099	n.a.	1.000
Narayanganj	31	25	42	76	110	200	54	0.000	0.032	n.a.	0.742
Narsingdi	33	15	23	35	46	80	27	0.000	0.030	n.a.	0.970
Netrakona	53	11	22	36	63	100	28	0.000	0.151	n.a.	0.981
Rajbari	27	74	94	110	160	170	96	0.000	0.000	n.a.	0.259
Shariatpur	36	47	63	130	170	220	90	0.000	0.000	n.a.	0.556
Sherpur	31	14	19	28	32	45	21	0.000	0.129	n.a.	1.000
Tangail	73	20	37	67	99	270	52	0.000	0.110	n.a.	0.795
Dhaka Division	*753*	*22*	*38*	*76*	*120*	*450*	*56*	*0.000*	*0.056*	*n.a.*	*0.740*

Table 2b: **Geographic distribution of calcium, continued**

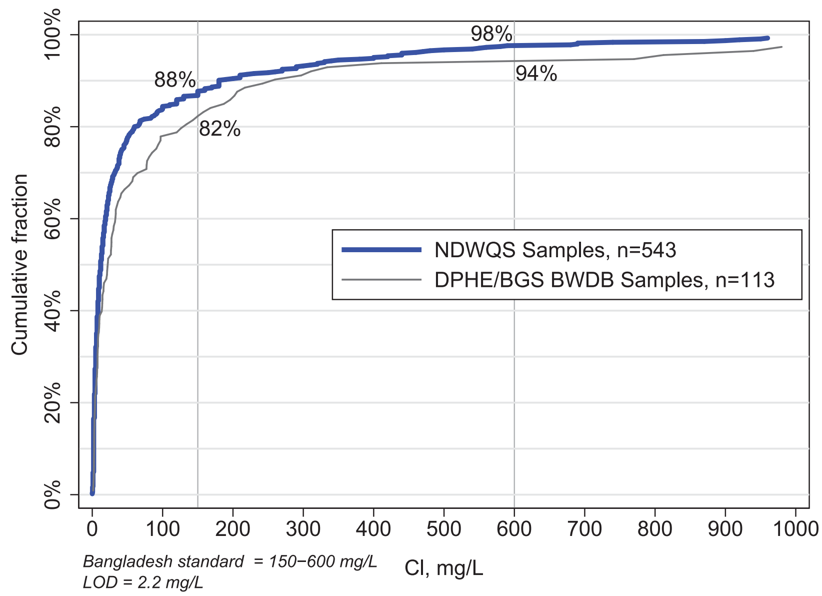
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	24	49	96	110	190	59	0.000	0.056	n.a.	0.648
Chuadanga	23	84	110	130	150	170	112	0.000	0.000	n.a.	0.087
Jessore	43	69	91	110	120	350	93	0.000	0.000	n.a.	0.302
Jhenaidah	36	89	100	110	140	190	105	0.000	0.000	n.a.	0.028
Khulna	64	30	48	100	150	230	66	0.000	0.000	n.a.	0.734
Kushtia	35	100	120	130	160	220	124	0.000	0.000	n.a.	0.029
Magura	27	76	90	110	120	240	95	0.000	0.000	n.a.	0.222
Meherpur	22	110	140	160	190	200	140	0.000	0.000	n.a.	0.045
Narail	21	75	120	140	250	330	129	0.000	0.000	n.a.	0.286
Satkhira	39	26	77	120	170	240	84	0.000	0.026	n.a.	0.487
Khulna Division	*364*	*53*	*93*	*120*	*150*	*350*	*93*	*0.000*	*0.019*	*n.a.*	*0.360*
Bogra	72	27	37	54	85	230	48	0.000	0.014	n.a.	0.875
Dinajpur	82	10	17	26	50	81	22	0.000	0.207	n.a.	0.988
Gaibandha	40	20	29	40	81	140	38	0.000	0.025	n.a.	0.900
Joypurhat	31	22	28	38	40	53	28	0.000	0.000	n.a.	1.000
Kurigram	45	24	37	78	110	210	54	0.000	0.000	n.a.	0.733
Lalmonirhat	33	8	11	16	29	180	21	0.000	0.333	n.a.	0.939
Naogaon	57	22	33	45	79	520	47	0.000	0.000	n.a.	0.895
Natore	37	83	96	120	130	140	101	0.000	0.000	n.a.	0.162
Nawabganj	32	71	87	120	160	190	97	0.000	0.000	n.a.	0.344
Nilphamari	34	11	15	26	49	92	23	0.000	0.118	n.a.	0.971
Pabna	46	75	94	110	140	160	92	0.000	0.000	n.a.	0.261
Panchagarh	32	6	9	11	17	24	9	0.000	0.500	n.a.	1.000
Rajshahi	66	73	92	120	140	160	95	0.000	0.000	n.a.	0.303
Rangpur	49	9	16	31	42	110	22	0.000	0.224	n.a.	0.980
Sirajganj	42	36	47	81	110	180	63	0.000	0.000	n.a.	0.714
Thakurgaon	33	10	13	22	42	57	18	0.000	0.242	n.a.	1.000
Rajshahi Division	*731*	*16*	*33*	*75*	*110*	*520*	*49*	*0.000*	*0.118*	*n.a.*	*0.754*
Habiganj	47	10	16	18	35	66	18	0.000	0.128	n.a.	1.000
Maulvi Bazar	41	5	8	11	21	40	10	0.000	0.610	n.a.	1.000
Sunamganj	65	6	10	19	31	110	15	0.000	0.477	n.a.	0.985
Sylhet	64	4	6	18	30	220	17	0.000	0.625	n.a.	0.953
Sylhet Division	217	6	10	18	31	220	15	0.000	0.507	n.a.	0.982
Grand Total	***2896***	***14***	***30***	***70***	***110***	***520***	***47***	***0.000***	***0.174***	***n.a.***	***0.773***

CHLORIDE (CL)

The Bangladesh standard is 150-600 mg/L. There is no WHO guideline value.

Elevated concentrations of chloride is related to sea water in Bangladesh groundwater, frequently caused by ancient sea water trapped in aquifers during the formation of the delta over the last ten thousand years.

Figure 3: **Chloride distribution, with 98% of samples meeting the Bangladesh standard of 600 mg per litre.**



The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 58.1% that the DPHE/BGS distribution is greater than the NDWQS distribution.

No disaggregation can be made by source, since the chloride sample was collected by DPHE field workers and not by MICS field workers.

Map 3: **Chloride levels in all samples**

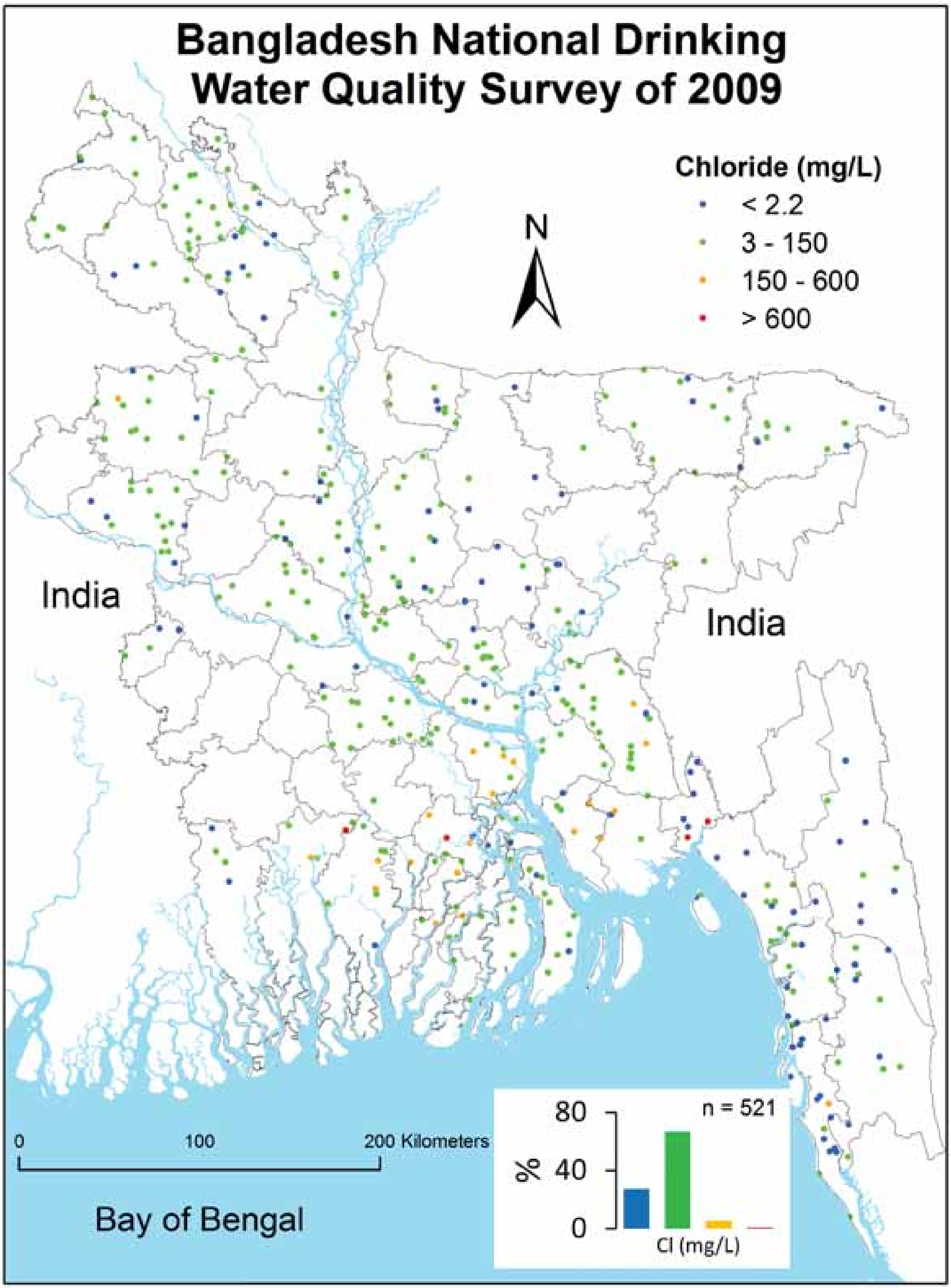


Table 3: Geographic distribution of chloride

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 600 mg/L	Below 150 mg/L
Barguna	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Barisal	11	120	160	320	900	1100	311	0.000	0.000	0.818	0.455
Bhola	7	5	67	99	110	110	57	0.000	0.000	1.000	1.000
Jhalokati	6	84	260	340	500	500	253	0.000	0.000	1.000	0.333
Patuakhali	7	7	22	52	93	93	35	0.000	0.000	1.000	1.000
Pirojpur	4	220	380	505	540	540	363	0.000	0.000	1.000	0.250
Barisal Division	*35*	*50*	*105*	*250*	*500*	*1100*	*195*	*0.000*	*0.028*	*0.944*	*0.639*
Bandarban	15	2	8	190	1600	1900	283	0.000	0.400	0.867	0.733
Brahamanbaria	8	2	14	102	690	690	116	0.125	0.250	0.875	0.750
Chandpur	9	4	35	45	230	230	52	0.000	0.222	1.000	0.889
Chittagong	16	2	4	10	20	33	8	0.000	0.375	1.000	1.000
Comilla	18	3	9	130	590	960	137	0.000	0.167	0.944	0.833
Cox's Bazar	8	2	14	115	440	440	88	0.125	0.375	1.000	0.750
Feni	9	1	2	2	1300	1300	221	0.000	0.778	0.778	0.778
Khagrachhari	0	0	0	0	0	0	0	0.000	1.000	1.000	1.000
Lakshmipur	5	32	67	150	160	160	83	0.000	0.000	1.000	0.800
Noakhali	10	21	150	290	515	550	196	0.000	0.000	1.000	0.500
Rangamati	10	2	2	2	14	23	4	0.000	0.800	1.000	1.000
Chittagong Division	*108*	*2*	*8*	*67*	*440*	*1900*	*122*	*0.019*	*0.349*	*0.945*	*0.817*
Dhaka	16	10	20	31	44	48	21	0.000	0.125	1.000	1.000
Faridpur	11	8	25	54	120	160	42	0.000	0.000	1.000	0.909
Gazipur	5	2	2	19	39	39	13	0.000	0.600	1.000	1.000
Gopalganj	7	7	45	330	330	330	129	0.000	0.000	1.000	0.571
Jamalpur	10	6	7	10	21	22	9	0.000	0.000	1.000	1.000
Kishoreganj	10	3	8	45	85	120	26	0.000	0.200	1.000	1.000
Madaripur	6	25	40	420	560	560	183	0.000	0.000	1.000	0.667
Manikganj	9	4	4	9	95	95	16	0.000	0.111	1.000	1.000
Munshiganj	6	36	92	180	210	210	105	0.000	0.000	1.000	0.667
Mymensingh	12	2	3	5	10	38	6	0.000	0.417	1.000	1.000
Narayanganj	6	13	19	210	270	270	89	0.000	0.000	1.000	0.667
Narsingdi	6	7	17	47	68	68	27	0.000	0.000	1.000	1.000
Netrakona	5	5	7	36	36	36	17	0.000	0.200	1.000	1.000
Rajbari	5	9	19	42	55	55	25	0.000	0.200	1.000	1.000
Shariatpur	8	125	220	375	400	400	236	0.000	0.000	1.000	0.375
Sherpur	6	4	9	23	32	32	13	0.000	0.167	1.000	1.000
Tangail	11	3	11	18	38	40	14	0.000	0.182	1.000	1.000
Dhaka Division	*139*	*4*	*12*	*40*	*180*	*560*	*51*	*0.000*	*0.129*	*1.000*	*0.892*

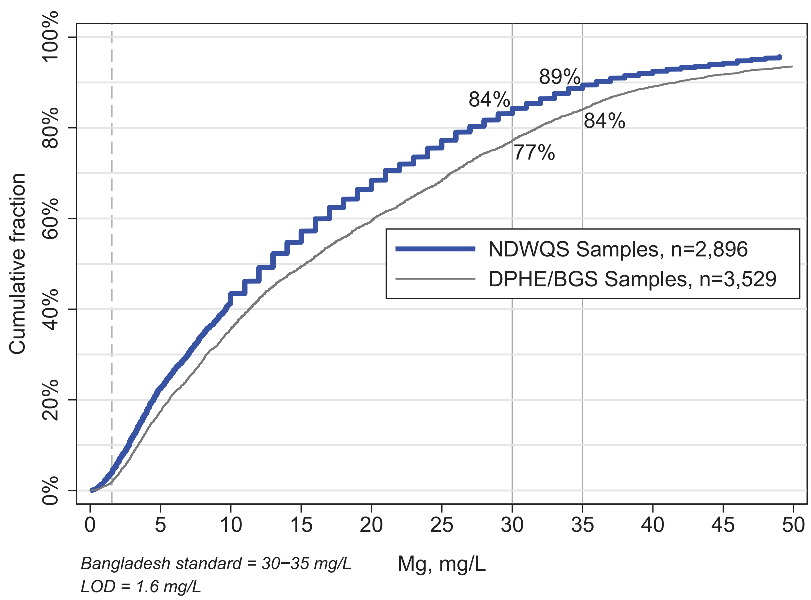
Table 3: Geographic distribution of chloride, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 600 mg/L	Below 150 mg/L
Bagerhat	9	5	24	180	920	920	169	0.000	0.111	0.889	0.667
Chuadanga	7	4	7	17	52	52	14	0.000	0.000	1.000	1.000
Jessore	9	15	15	41	690	690	104	0.000	0.000	0.889	0.889
Jhenaidah	6	4	17	20	42	42	17	0.000	0.167	1.000	1.000
Khulna	15	68	270	420	740	950	293	0.000	0.000	0.867	0.333
Kushtia	7	4	16	26	83	83	23	0.000	0.000	1.000	1.000
Magura	6	6	11	28	40	40	17	0.000	0.000	1.000	1.000
Meherpur	5	2	4	46	57	57	22	0.000	0.400	1.000	1.000
Narail	6	20	103	460	580	580	211	0.000	0.000	1.000	0.667
Satkhira	7	4	8	100	870	870	149	0.000	0.143	0.857	0.857
Khulna Division	*77*	*6*	*20*	*120*	*440*	*950*	*126*	*0.000*	*0.065*	*0.935*	*0.779*
Bogra	12	13	14	19	110	180	35	0.000	0.000	1.000	0.917
Dinajpur	12	5	7	16	20	45	12	0.000	0.167	1.000	1.000
Gaibandha	10	6	14	16	30	38	15	0.000	0.000	1.000	1.000
Joypurhat	5	10	12	25	38	38	19	0.000	0.000	1.000	1.000
Kurigram	9	10	17	39	71	71	27	0.000	0.111	1.000	1.000
Lalmonirhat	7	2	3	15	24	24	8	0.000	0.286	1.000	1.000
Naogaon	10	7	16	29	154	250	41	0.000	0.000	1.000	0.900
Natore	9	7	10	24	88	88	24	0.000	0.000	1.000	1.000
Nawabganj	7	5	12	21	38	38	15	0.000	0.000	1.000	1.000
Nilphamari	8	8	14	30	68	68	22	0.000	0.000	1.000	1.000
Pabna	12	7	10	24	28	35	14	0.000	0.000	1.000	1.000
Panchagarh	7	3	9	10	27	27	9	0.000	0.143	1.000	1.000
Rajshahi	10	4	11	29	49	60	18	0.000	0.100	1.000	1.000
Rangpur	11	1	3	15	23	59	11	0.091	0.455	1.000	1.000
Sirajganj	10	4	10	17	70	120	20	0.100	0.200	1.000	1.000
Thakurgaon	6	7	18	25	26	26	17	0.000	0.000	1.000	1.000
Rajshahi Division	*145*	*5*	*11*	*21*	*39*	*250*	*19*	*0.014*	*0.097*	*1.000*	*0.986*
Habiganj	9	2	3	5	31	31	6	0.000	0.444	1.000	1.000
Maulvi Bazar	2	5	7	9	9	9	7	0.000	0.000	1.000	1.000
Sunamganj	13	2	4	5	23	50	9	0.077	0.385	1.000	1.000
Sylhet	15	1	5	14	22	51	10	0.133	0.333	1.000	1.000
Sylhet Division	39	2	5	8	23	51	8	0.077	0.359	1.000	1.000
Grand Total	***543***	***4***	***12***	***42***	***180***	***1900***	***74***	***0.013***	***0.165***	***0.976***	***0.877***

MAGNESIUM (MG)

The Bangladesh standard for magnesium is 30-35 mg/L. There is no WHO guideline value for magnesium. Magnesium contributes to hardness.

Figure 4: **Magnesium distribution, with 89% of samples meeting the Bangladesh standard of 35 mg/L.**

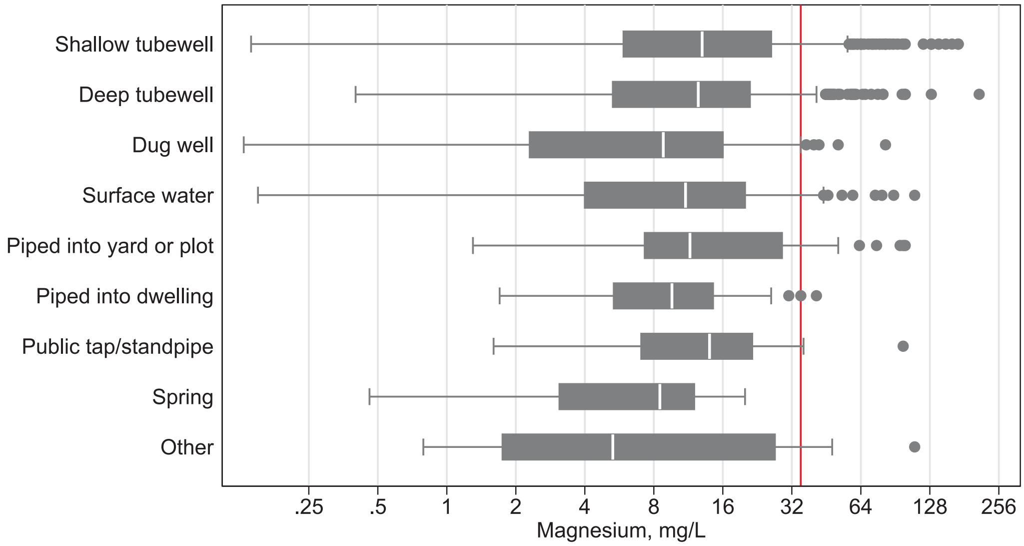


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 55.1% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 4a: Magnesium levels by water source

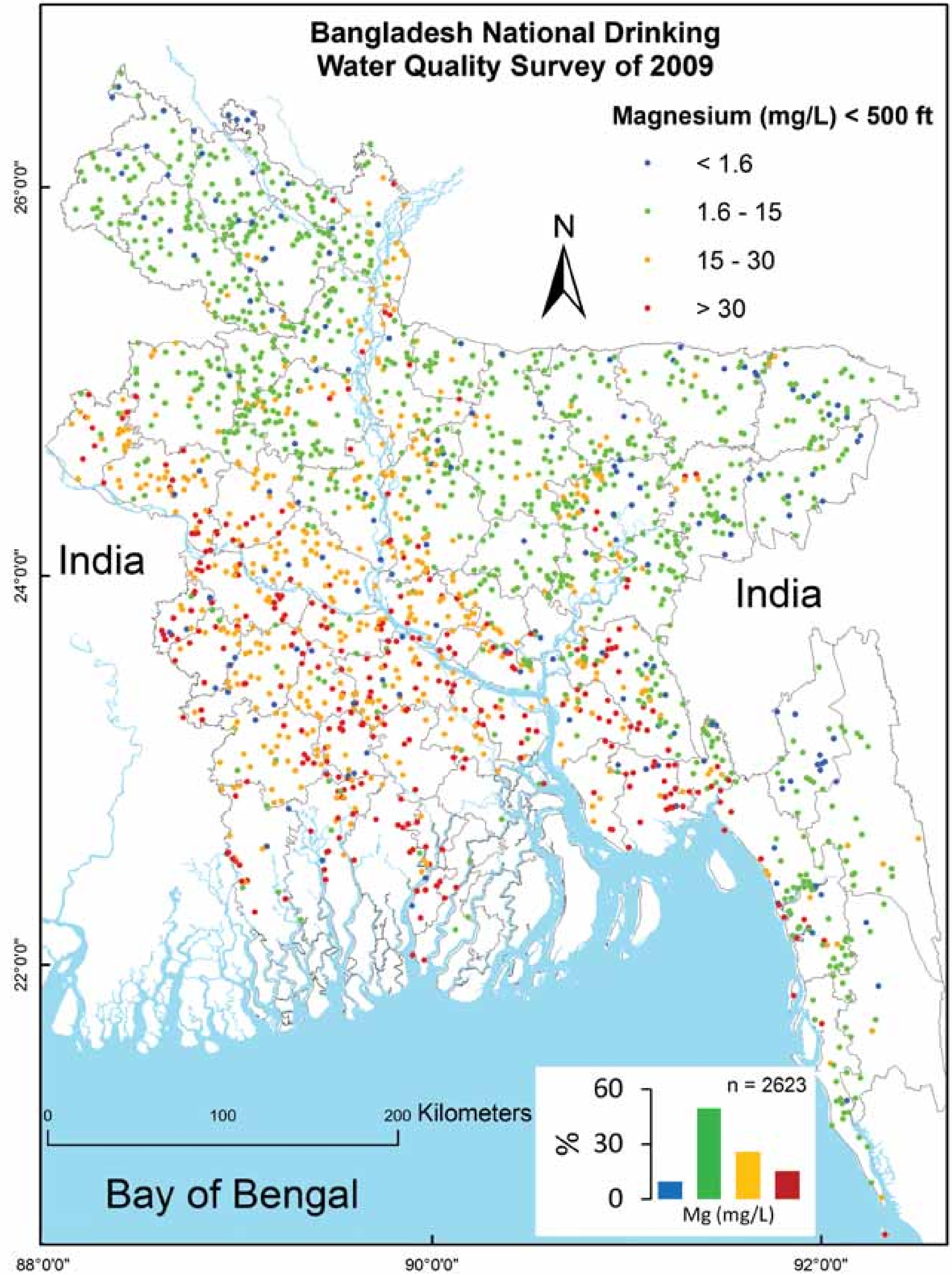
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 30 mg/L	Below 35 mg/L
Shallow tubewell	2060	6	13	26	37	170	18	0.000	0.040	0.829	0.891
Deep tubewell	526	5	13	21	36	210	17	0.000	0.017	0.878	0.899
Dug well	59	2	9	16	35	82	13	0.000	0.136	0.881	0.915
Surface water	67	4	11	20	46	110	18	0.000	0.119	0.851	0.881
Piped into yard or plot	54	7	12	29	51	100	22	0.000	0.037	0.796	0.870
Piped into dwelling	48	5	10	15	24	41	11	0.000	0.000	0.938	0.979
Public tap/standpipe	44	7	14	22	29	98	17	0.000	0.000	0.909	0.909
Spring	22	3	9	12	15	20	8	0.000	0.091	1.000	1.000
Other	16	2	5	27	48	110	19	0.000	0.250	0.813	0.813

Figure 4b: Magnesium levels by water source



Bangladesh standard = 30−35 mg/L

Map 4a: **Magnesium levels in shallow tubewells (< 150 m)**



Map 4b: **Magnesium levels in deep tubewells (> 150 m)**

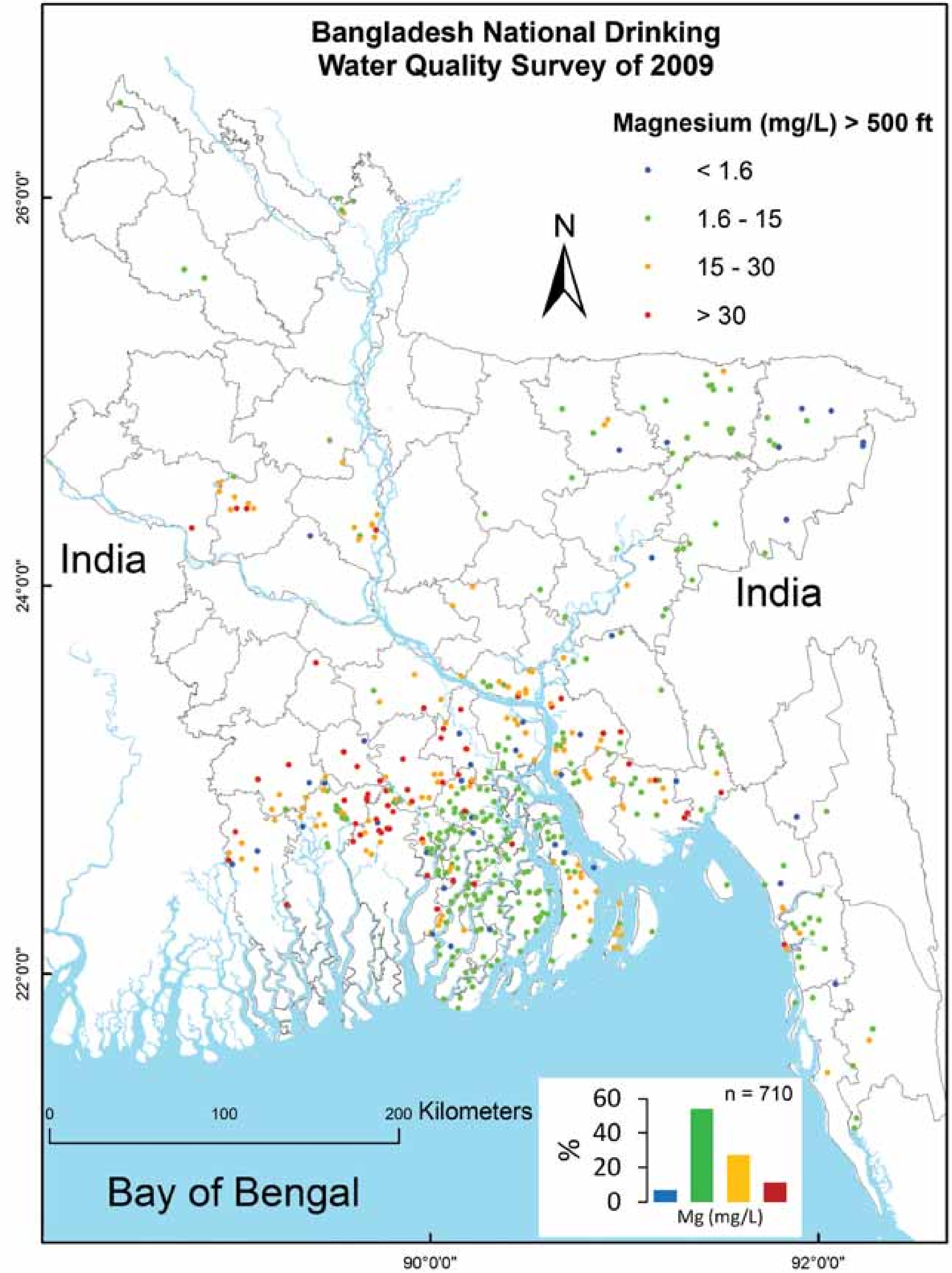


Table 4b: Geographic distribution of magnesium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 30 mg/L	Below 35 mg/L
Barguna	35	3	4	11	22	150	12	0.000	0.029	0.914	0.943
Barisal	65	3	5	10	34	130	12	0.000	0.015	0.892	0.923
Bhola	36	11	16	18	21	27	15	0.000	0.000	1.000	1.000
Jhalokati	26	3	5	17	39	210	22	0.000	0.000	0.808	0.846
Patuakhali	46	4	4	6	8	13	5	0.000	0.000	1.000	1.000
Pirojpur	40	7	14	34	48	100	22	0.000	0.025	0.725	0.800
Barisal Division	*248*	*4*	*6*	*16*	*34*	*210*	*14*	*0.000*	*0.012*	*0.895*	*0.923*
Bandarban	44	3	7	12	17	49	9	0.000	0.136	0.977	0.977
Brahamanbaria	52	5	8	14	27	38	11	0.000	0.019	0.904	0.942
Chandpur	47	15	19	39	53	82	27	0.000	0.000	0.702	0.723
Chittagong	92	5	9	18	52	160	20	0.000	0.043	0.837	0.870
Comilla	86	7	14	29	45	72	19	0.000	0.047	0.779	0.849
Cox's Bazar	38	6	11	25	55	140	20	0.000	0.053	0.842	0.868
Feni	38	4	7	13	36	51	11	0.000	0.079	0.895	0.895
Khagrachhari	47	1	3	7	11	24	4	0.000	0.298	1.000	1.000
Lakshmipur	32	16	23	38	72	170	40	0.000	0.000	0.656	0.719
Noakhali	51	21	35	48	74	140	40	0.000	0.000	0.431	0.510
Rangamati	56	2	7	12	18	40	9	0.000	0.107	0.982	0.982
Chittagong Division	*583*	*5*	*12*	*24*	*43*	*170*	*19*	*0.000*	*0.069*	*0.820*	*0.852*
Dhaka	74	10	14	20	25	49	15	0.000	0.000	0.932	0.959
Faridpur	48	22	30	38	46	52	30	0.000	0.000	0.521	0.708
Gazipur	33	6	8	10	12	26	8	0.000	0.061	1.000	1.000
Gopalganj	31	23	31	46	98	100	41	0.000	0.000	0.484	0.581
Jamalpur	39	9	13	19	29	55	15	0.000	0.000	0.923	0.974
Kishoreganj	75	6	12	20	25	51	13	0.000	0.040	0.973	0.973
Madaripur	22	19	26	35	38	61	27	0.000	0.000	0.682	0.773
Manikganj	40	19	26	31	37	51	26	0.000	0.000	0.750	0.875
Munshiganj	36	15	24	32	45	79	26	0.000	0.000	0.722	0.833
Mymensingh	71	7	10	12	15	22	10	0.000	0.014	1.000	1.000
Narayanganj	31	12	18	23	36	51	20	0.000	0.000	0.806	0.871
Narsingdi	33	7	11	16	27	32	13	0.000	0.000	0.970	1.000
Netrakona	53	5	7	12	21	26	9	0.000	0.019	1.000	1.000
Rajbari	27	16	26	33	39	55	27	0.000	0.000	0.630	0.815
Shariatpur	36	14	23	35	46	59	25	0.000	0.000	0.694	0.778
Sherpur	31	5	10	14	17	32	11	0.000	0.032	0.968	1.000
Tangail	73	7	15	21	28	47	16	0.000	0.055	0.959	0.959
Dhaka Division	*753*	*9*	*15*	*24*	*35*	*100*	*18*	*0.000*	*0.016*	*0.857*	*0.908*

Table 4b: Geographic distribution of magnesium, continued

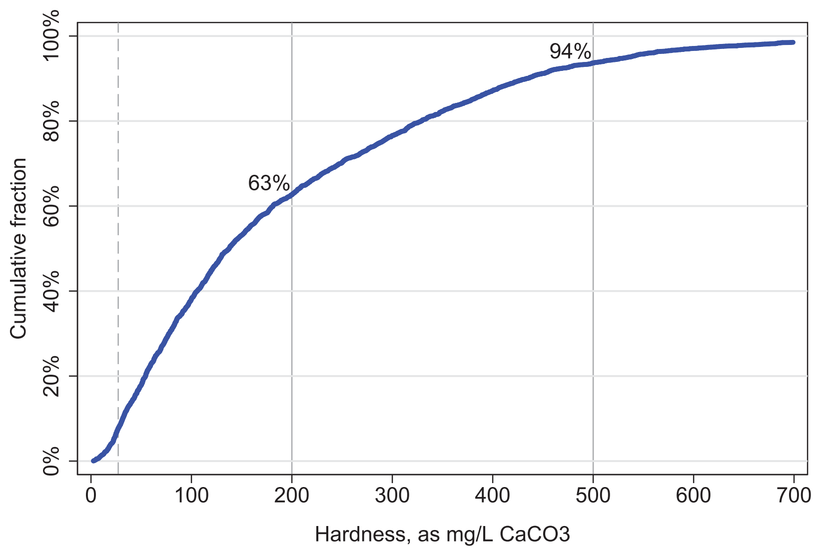
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 30 mg/L	Below 35 mg/L
Bagerhat	54	13	31	49	75	130	34	0.000	0.093	0.500	0.593
Chuadanga	23	23	29	35	39	44	29	0.000	0.000	0.522	0.783
Jessore	43	21	24	31	40	65	27	0.000	0.000	0.744	0.860
Jhenaidah	36	22	25	30	36	43	26	0.000	0.000	0.750	0.889
Khulna	64	15	24	56	89	130	39	0.000	0.000	0.578	0.625
Kushtia	35	24	29	33	37	69	30	0.000	0.000	0.543	0.800
Magura	27	19	25	31	33	48	25	0.000	0.000	0.741	0.926
Meherpur	22	28	43	51	58	93	42	0.000	0.000	0.273	0.409
Narail	21	26	46	60	76	86	46	0.000	0.000	0.333	0.333
Satkhira	39	20	29	44	66	130	35	0.000	0.026	0.538	0.692
Khulna Division	*364*	*20*	*28*	*39*	*60*	*130*	*33*	*0.000*	*0.016*	*0.571*	*0.701*
Bogra	72	9	11	15	18	40	12	0.000	0.000	0.972	0.972
Dinajpur	82	3	6	9	16	24	7	0.000	0.024	1.000	1.000
Gaibandha	40	7	10	17	26	40	13	0.000	0.000	0.925	0.950
Joypurhat	31	7	10	13	15	18	10	0.000	0.000	1.000	1.000
Kurigram	45	10	14	22	28	34	16	0.000	0.000	0.956	1.000
Lalmonirhat	33	2	3	6	9	43	5	0.000	0.152	0.970	0.970
Naogaon	57	8	11	15	21	30	12	0.000	0.000	1.000	1.000
Natore	37	19	26	31	36	38	25	0.000	0.000	0.703	0.892
Nawabganj	32	17	24	31	35	44	24	0.000	0.000	0.719	0.906
Nilphamari	34	2	4	6	12	28	5	0.000	0.059	1.000	1.000
Pabna	46	20	25	29	33	51	26	0.000	0.000	0.870	0.913
Panchagarh	32	1	3	3	5	7	3	0.000	0.313	1.000	1.000
Rajshahi	66	19	26	31	35	41	25	0.000	0.000	0.712	0.924
Rangpur	49	4	5	9	15	19	6	0.000	0.082	1.000	1.000
Sirajganj	42	13	19	24	32	37	19	0.000	0.000	0.881	0.952
Thakurgaon	33	3	4	7	10	11	5	0.000	0.091	1.000	1.000
Rajshahi Division	*731*	*5*	*11*	*21*	*29*	*51*	*14*	*0.000*	*0.036*	*0.921*	*0.969*
Habiganj	47	4	6	7	18	31	8	0.000	0.043	0.957	1.000
Maulvi Bazar	41	2	3	5	8	10	4	0.000	0.244	1.000	1.000
Sunamganj	65	3	5	8	15	30	7	0.000	0.077	1.000	1.000
Sylhet	64	2	3	5	10	25	5	0.000	0.172	1.000	1.000
Sylhet Division	*217*	*3*	*4*	*7*	*12*	*31*	*6*	*0.000*	*0.129*	*0.991*	*1.000*
Grand Total	***2896***	***6***	***13***	***24***	***36***	***210***	***18***	***0.000***	***0.040***	***0.843***	***0.894***

HARDNESS

The Bangladesh standard is 200-500 mg/L as $CaCO_3$. There is no WHO guideline value. Hardness was not measured directly, but was calculated by summing the molar equivalents of all divalent metals (Ca, Mg, Fe, Mn, and Sr), and converting to an equivalent amount of $CaCO_3$.

"In the first edition of the Guidelines for Drinking-water Quality, published in 1984, it was concluded that there was no firm evidence that drinking hard water causes any adverse effects on human health and that no recommendation on the restriction of municipal water softening or on the maintenance of a minimum residual calcium or magnesium level was warranted. A guideline value of 500 mg/litre (as calcium carbonate) was established for hardness, based on taste and household use considerations. No health-based guideline value for hardness was proposed in the 1993 Guidelines, although hardness above approximately 200 mg/litre may cause scale deposition in the distribution system. Public acceptability of the degree of hardness may vary considerably from one community to another, depending on local conditions, and the taste of water with hardness in excess of 500 mg/litre is tolerated by consumers in some instances."[8]

Figure 5: **Hardness distribution, with 94% of samples meeting the Bangladesh standard of 500 mg/L.**



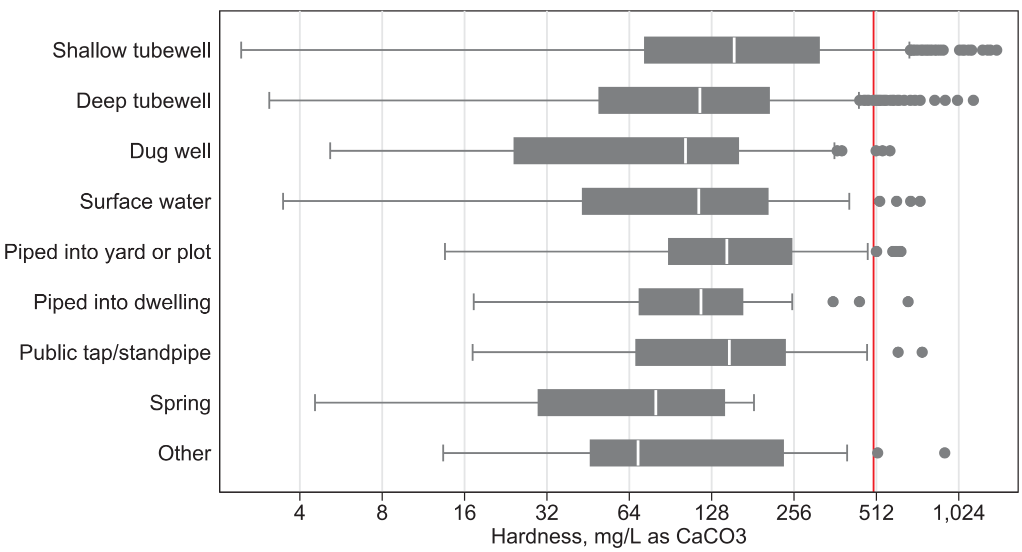
Bangladesh standard = 200–500 mg/L
LOD = 27.1 mg/L

[8] WHO. (2004). Guidelines for drinking-water quality, 3rd edition, World Health Organization, Geneva.

Table 5a: Hardness levels by water source

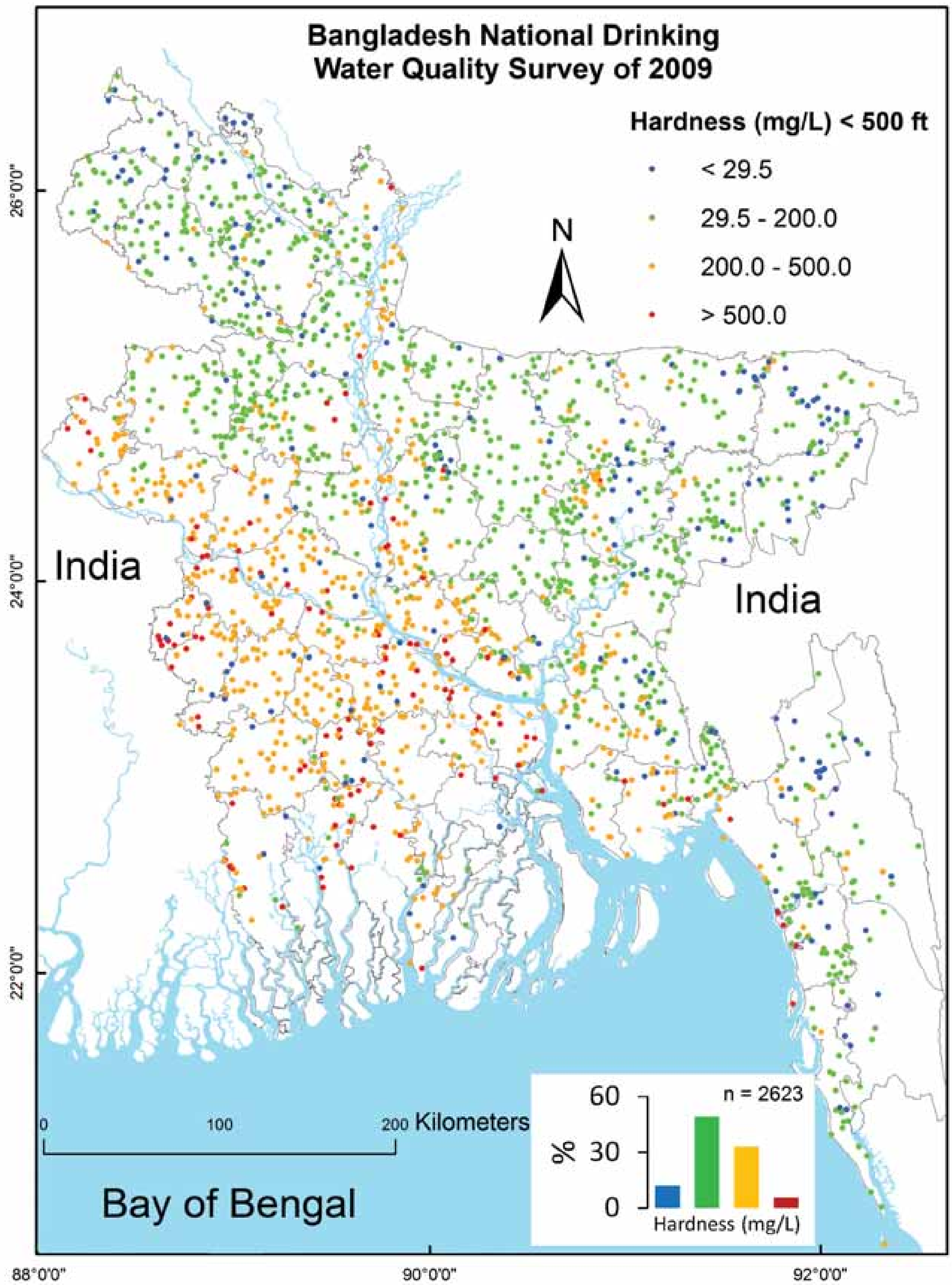
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 200 mg/L	Below 500 mg/L
Shallow tubewell	2060	73	155	316	448	1400	212	0.000	0.063	0.932	0.578
Deep tubewell	526	50	116	207	361	1200	159	0.000	0.095	0.954	0.740
Dug well	59	24	103	160	360	574	133	0.000	0.271	0.949	0.780
Surface water	67	43	115	205	393	740	155	0.000	0.179	0.940	0.746
Piped into yard or plot	54	89	145	251	513	630	210	0.000	0.056	0.870	0.667
Piped into dwelling	48	70	117	166	252	668	137	0.000	0.021	0.979	0.833
Public tap/standpipe	44	68	149	237	394	752	186	0.000	0.046	0.955	0.636
Spring	22	30	80	142	172	183	85	0.000	0.227	1.000	1.000
Other	16	46	69	233	518	909	183	0.000	0.125	0.875	0.750

Figure 5b: Hardness levels by water source



Bangladesh standard = 200−500 mg/L

Map 5a: **Hardness in shallow tubewells (< 150 m)**



Map 5b: **Hardness in deep tubewells (> 150 m)**

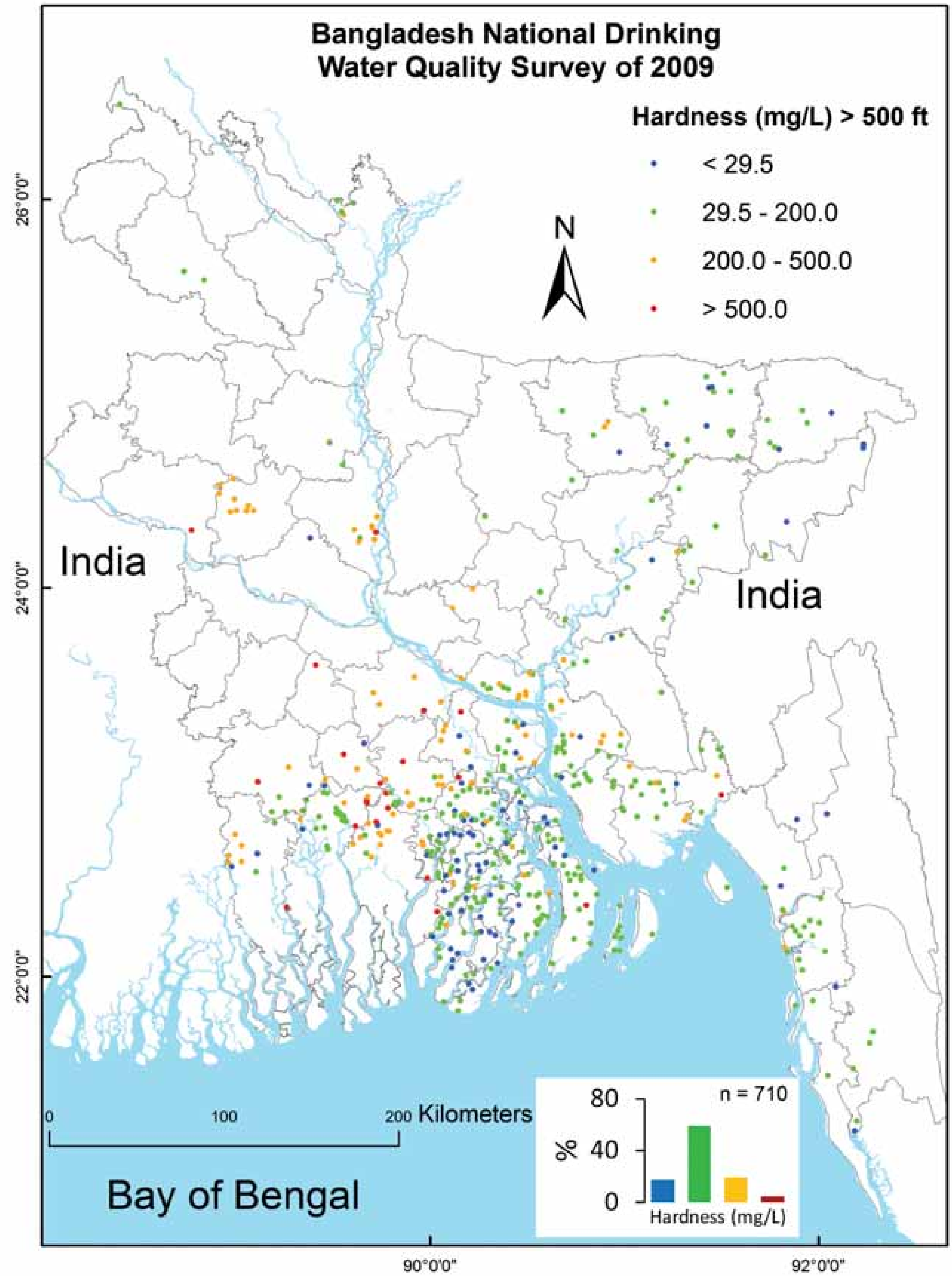


Table 5b: Geographic distribution of hardness

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 500 mg/L	Below 200 mg/L
Barguna	35	25	31	104	229	865	93	0.000	0.457	0.971	0.886
Barisal	65	28	51	100	303	881	123	0.000	0.277	0.923	0.815
Bhola	36	101	129	150	182	590	135	0.000	0.028	0.972	0.944
Jhalokati	26	24	45	159	265	1157	146	0.000	0.346	0.923	0.769
Patuakhali	46	31	38	54	94	331	57	0.000	0.196	1.000	0.957
Pirojpur	40	61	142	301	391	578	183	0.000	0.125	0.950	0.600
Barisal Division	*248*	*31*	*58*	*137*	*293*	*1157*	*120*	*0.000*	*0.234*	*0.956*	*0.831*
Bandarban	44	29	77	117	158	272	80	0.000	0.250	1.000	0.977
Brahamanbaria	52	63	91	154	250	334	119	0.000	0.038	1.000	0.808
Chandpur	47	138	166	321	433	499	226	0.000	0.000	1.000	0.596
Chittagong	92	48	72	133	327	816	135	0.000	0.087	0.935	0.826
Comilla	86	74	130	214	319	704	162	0.000	0.081	0.988	0.674
Cox's Bazar	38	50	86	188	382	1032	167	0.000	0.132	0.921	0.789
Feni	38	49	69	89	200	330	90	0.000	0.079	1.000	0.895
Khagrachhari	47	19	50	82	210	279	67	0.000	0.383	1.000	0.894
Lakshmipur	32	131	179	252	539	1335	287	0.000	0.000	0.875	0.594
Noakhali	51	153	217	292	424	777	252	0.000	0.000	0.922	0.451
Rangamati	56	31	71	145	205	368	94	0.000	0.250	1.000	0.893
Chittagong Division	*583*	*56*	*103*	*189*	*317*	*1335*	*149*	*0.000*	*0.117*	*0.969*	*0.763*
Dhaka	74	110	182	274	364	1306	227	0.000	0.000	0.919	0.581
Faridpur	48	337	408	496	643	1253	429	0.000	0.000	0.792	0.000
Gazipur	33	66	97	115	129	275	98	0.000	0.061	1.000	0.970
Gopalganj	31	276	384	501	623	837	393	0.000	0.000	0.742	0.129
Jamalpur	39	93	128	228	376	480	169	0.000	0.026	1.000	0.692
Kishoreganj	75	80	130	206	279	562	154	0.000	0.067	0.987	0.720
Madaripur	22	187	380	444	557	682	358	0.000	0.000	0.864	0.273
Manikganj	40	249	305	381	485	551	320	0.000	0.000	0.925	0.100
Munshiganj	36	147	250	382	511	684	285	0.000	0.000	0.889	0.361
Mymensingh	71	79	110	130	164	262	106	0.000	0.014	1.000	0.972
Narayanganj	31	122	180	321	417	595	221	0.000	0.032	0.903	0.581
Narsingdi	33	78	117	165	218	313	126	0.000	0.000	1.000	0.848
Netrakona	53	53	85	147	241	329	115	0.000	0.094	1.000	0.811
Rajbari	27	255	352	414	561	564	354	0.000	0.000	0.815	0.111
Shariatpur	36	190	270	475	575	753	329	0.000	0.000	0.778	0.333
Sherpur	31	64	100	129	142	251	101	0.000	0.065	1.000	0.968
Tangail	73	94	167	273	354	794	200	0.000	0.096	0.945	0.575
Dhaka Division	*753*	*99*	*165*	*308*	*444*	*1306*	*220*	*0.000*	*0.032*	*0.927*	*0.568*

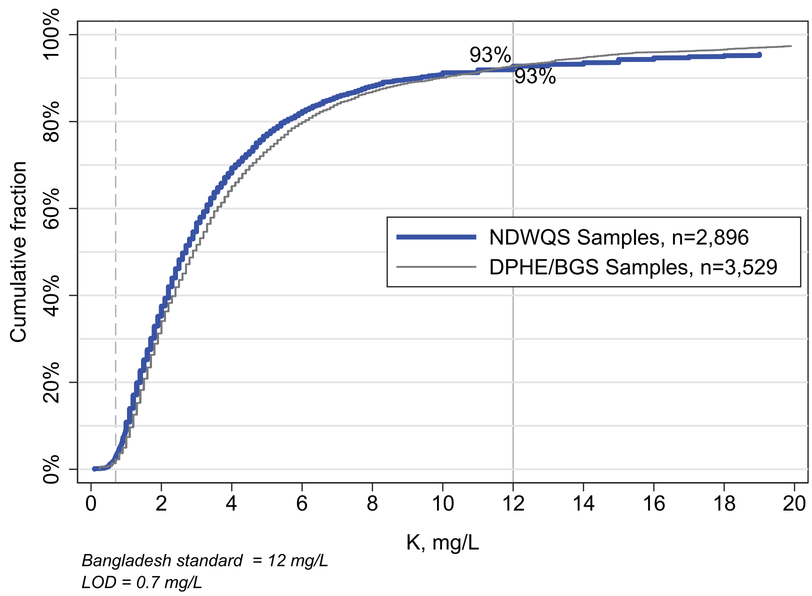
Table 5b: Geographic distribution of hardness, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 500 mg/L	Below 200 mg/L
Bagerhat	54	115	241	433	544	1013	290	0.000	0.056	0.870	0.370
Chuadanga	23	336	406	471	529	574	403	0.000	0.000	0.783	0.000
Jessore	43	275	342	401	477	1112	349	0.000	0.000	0.930	0.116
Jhenaidah	36	330	359	405	466	644	373	0.000	0.000	0.944	0.000
Khulna	64	134	225	458	747	1072	326	0.000	0.000	0.766	0.438
Kushtia	35	371	422	469	561	840	436	0.000	0.000	0.886	0.000
Magura	27	276	330	380	430	746	345	0.000	0.000	0.926	0.037
Meherpur	22	441	540	625	687	803	525	0.000	0.000	0.364	0.000
Narail	21	304	515	635	785	1069	515	0.000	0.000	0.476	0.095
Satkhira	39	173	316	474	666	1141	358	0.000	0.026	0.795	0.256
Khulna Division	*364*	*238*	*356*	*456*	*612*	*1141*	*371*	*0.000*	*0.011*	*0.805*	*0.181*
Bogra	72	113	143	193	296	644	176	0.000	0.000	0.958	0.764
Dinajpur	82	43	72	102	201	313	90	0.000	0.122	1.000	0.890
Gaibandha	40	104	129	177	328	514	161	0.000	0.025	0.975	0.775
Joypurhat	31	87	119	148	171	199	119	0.000	0.000	1.000	1.000
Kurigram	45	114	178	296	397	627	213	0.000	0.000	0.956	0.600
Lalmonirhat	33	30	39	57	140	490	80	0.000	0.242	1.000	0.939
Naogaon	57	97	127	177	286	1409	172	0.000	0.000	0.982	0.807
Natore	37	279	347	428	475	510	358	0.000	0.000	0.973	0.000
Nawabganj	32	266	295	434	546	621	345	0.000	0.000	0.844	0.125
Nilphamari	34	41	59	94	181	316	84	0.000	0.118	1.000	0.912
Pabna	46	284	342	386	503	617	339	0.000	0.000	0.891	0.109
Panchagarh	32	23	33	49	64	90	39	0.000	0.406	1.000	1.000
Rajshahi	66	273	332	421	496	551	344	0.000	0.000	0.909	0.076
Rangpur	49	41	74	117	188	385	89	0.000	0.163	1.000	0.918
Sirajganj	42	164	225	300	421	570	250	0.000	0.000	0.905	0.381
Thakurgaon	33	41	59	86	152	165	70	0.000	0.182	1.000	1.000
Rajshahi Division	*731*	*70*	*140*	*283*	*404*	*1409*	*186*	*0.000*	*0.068*	*0.962*	*0.636*
Habiganj	47	55	76	91	172	267	86	0.000	0.043	1.000	0.915
Maulvi Bazar	41	23	48	69	94	119	51	0.000	0.293	1.000	1.000
Sunamganj	65	33	52	88	156	412	74	0.000	0.185	1.000	0.938
Sylhet	64	24	35	73	157	578	68	0.000	0.375	0.984	0.906
Sylhet Division	*217*	*32*	*52*	*84*	*142*	*578*	*70*	*0.000*	*0.230*	*0.995*	*0.935*
Grand Total	***2896***	***65***	***138***	***289***	***434***	***1409***	***196***	***0.000***	***0.088***	***0.936***	***0.626***

POTASSIUM (K)

The Bangladesh standard for potassium is 12 mg/L. There is no WHO guideline value for potassium.

Figure 6: **Potassium distribution, with 93% of samples meeting Bangladesh standard of 12 mg/L.**

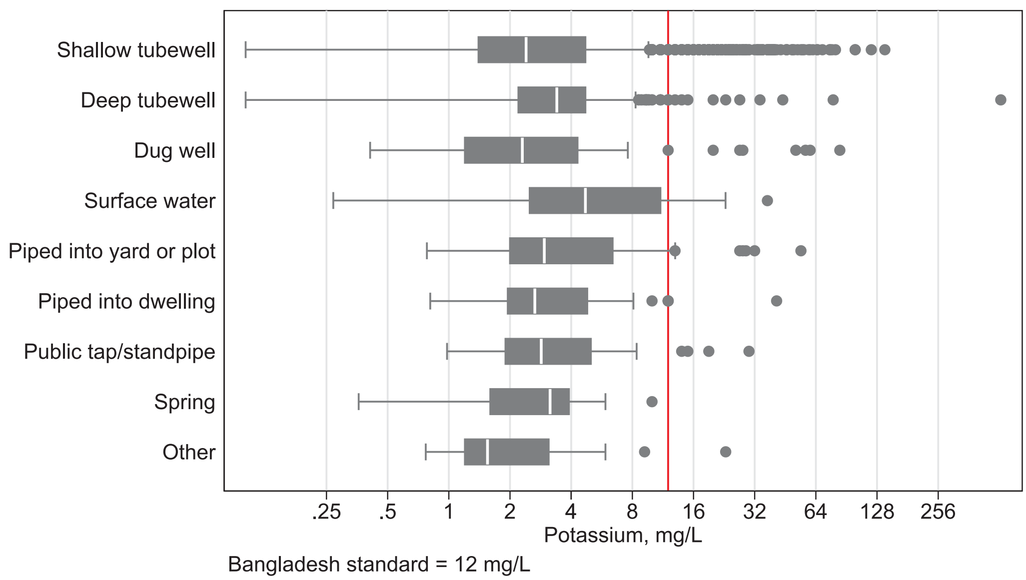


The NDWQS and DPHE/BGHE distributions are significantly different, with a probability of 53.2% that the DPHE/BGS distribution is greater than the NDWQS distribution. However, the magnitude of the difference is small.

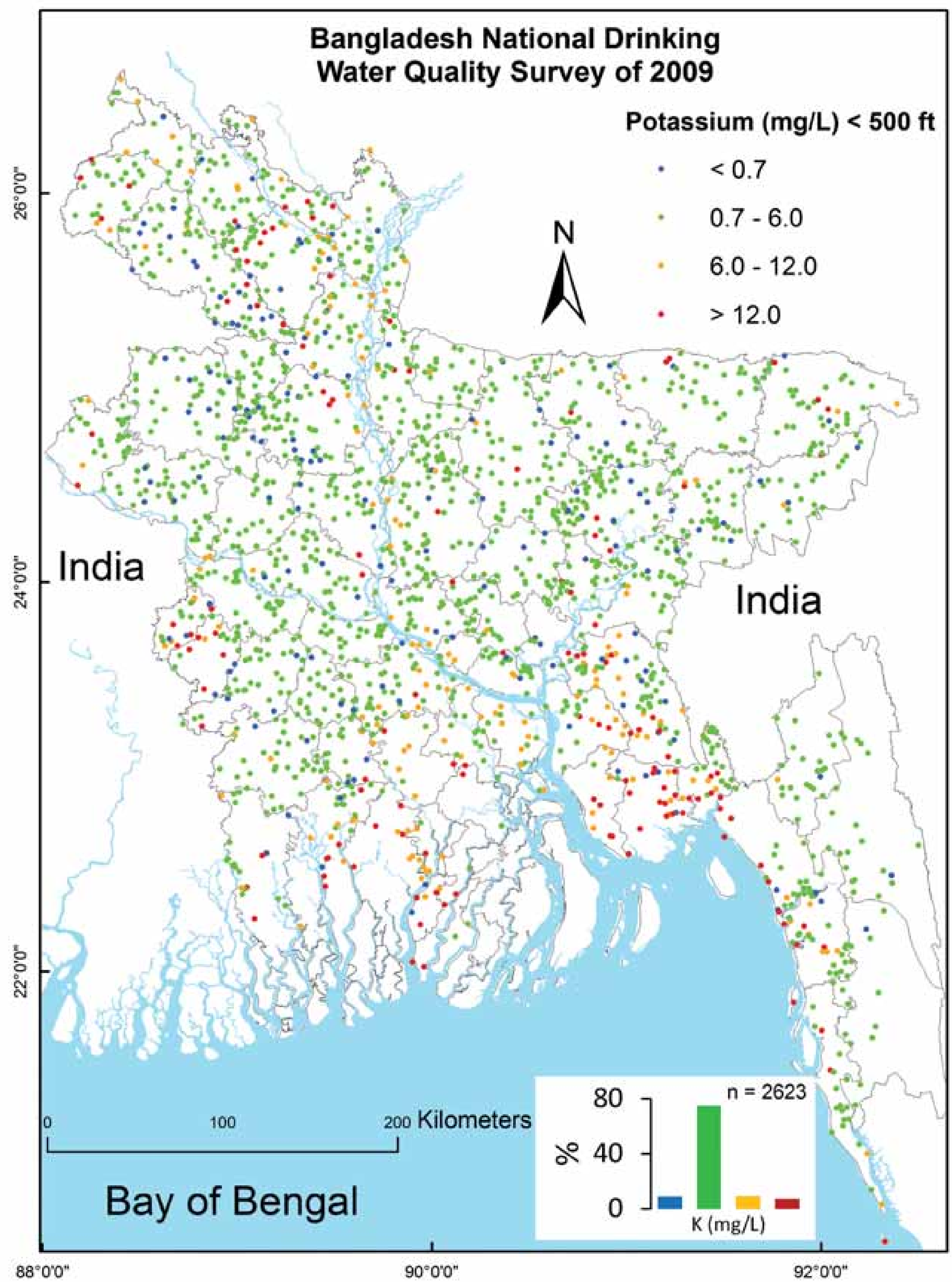
Table 6a: **Potassium levels by water source**

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	1	2	5	10	140	5	0.002	0.035	n.a.	0.919
Deep tubewell	526	2	3	5	7	520	5	0.002	0.008	n.a.	0.981
Dug well	59	1	2	4	27	84	8	0.000	0.051	n.a.	0.881
Surface water	67	3	5	11	18	37	7	0.000	0.045	n.a.	0.791
Piped into yard or plot	54	2	3	6	13	54	6	0.000	0.000	n.a.	0.889
Piped into dwelling	48	2	3	5	10	41	5	0.000	0.000	n.a.	0.979
Public tap/standpipe	44	2	3	5	8	30	5	0.000	0.000	n.a.	0.909
Spring	22	2	3	4	5	10	3	0.000	0.091	n.a.	1.000
Other	16	1	2	3	9	23	4	0.000	0.000	n.a.	0.938

Figure 6b: **Potassium levels by water source**



Map 6a; **Potassium in shallow tubewells (< 150 m)**



Map 6b: **Potassium in deep tubewells (> 150 m)**

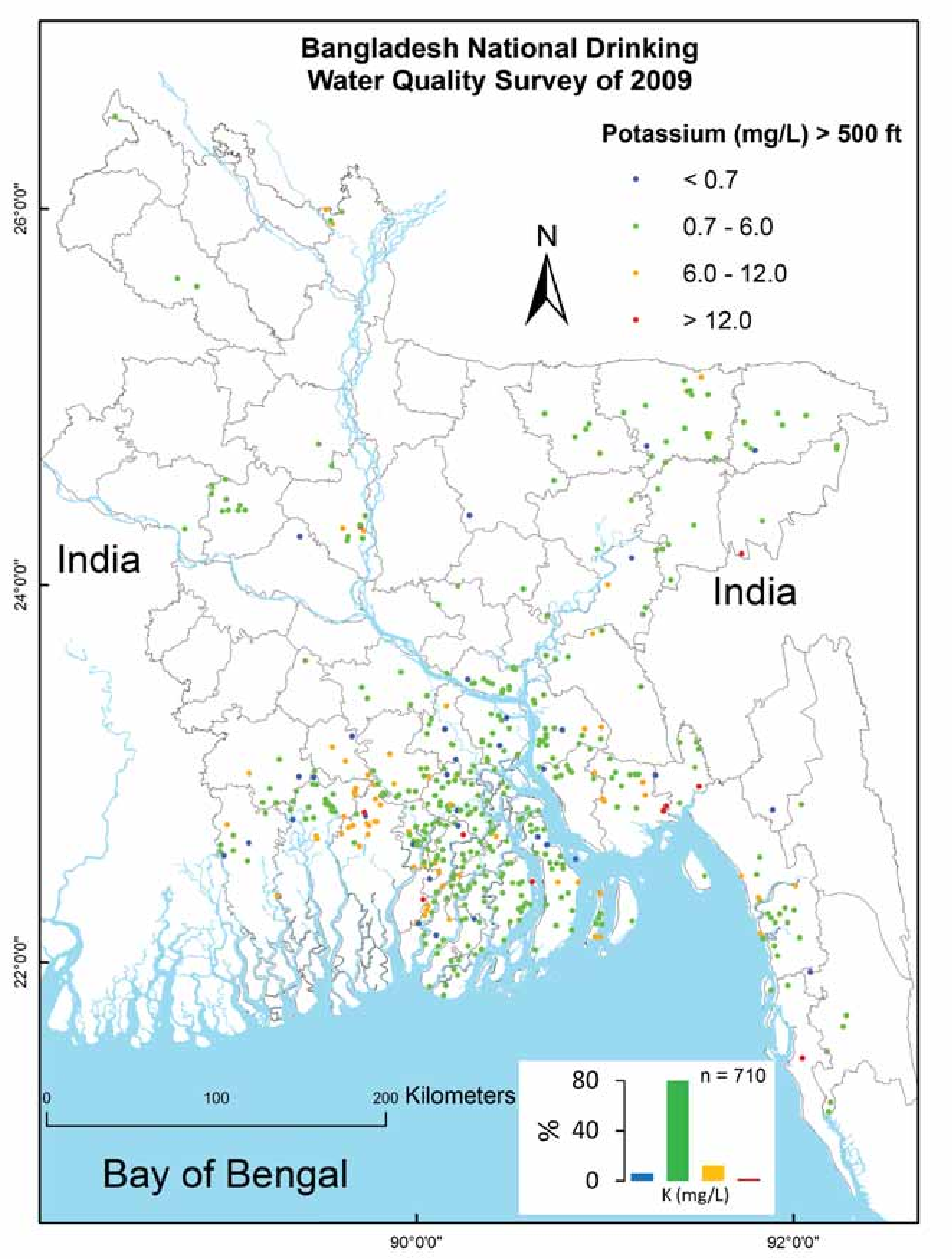


Table 6b: Geographic distribution of potassium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	3	3	7	8	43	6	0.029	0.029	n.a.	0.943
Barisal	65	2	2	4	6	38	4	0.000	0.015	n.a.	0.969
Bhola	36	4	4	5	6	10	5	0.000	0.000	n.a.	1.000
Jhalokati	26	2	3	7	23	520	27	0.000	0.000	n.a.	0.808
Patuakhali	46	3	3	4	5	15	3	0.000	0.000	n.a.	0.978
Pirojpur	40	4	5	8	16	34	7	0.000	0.000	n.a.	0.850
Barisal Division	*248*	*2*	*4*	*5*	*8*	*520*	*7*	*0.004*	*0.008*	*n.a.*	*0.935*
Bandarban	44	1	2	4	5	7	3	0.023	0.114	n.a.	1.000
Brahamanbaria	52	1	2	4	7	84	6	0.000	0.019	n.a.	0.942
Chandpur	47	3	4	8	11	25	6	0.000	0.000	n.a.	0.915
Chittagong	92	3	4	8	24	46	8	0.000	0.011	n.a.	0.848
Comilla	86	2	3	8	15	120	8	0.000	0.047	n.a.	0.872
Cox's Bazar	38	2	5	8	27	55	8	0.000	0.000	n.a.	0.816
Feni	38	2	3	4	13	24	5	0.000	0.000	n.a.	0.895
Khagrachhari	47	2	3	3	4	10	3	0.000	0.021	n.a.	1.000
Lakshmipur	32	4	7	12	22	38	10	0.000	0.000	n.a.	0.781
Noakhali	51	5	11	17	23	56	13	0.000	0.000	n.a.	0.588
Rangamati	56	2	3	3	4	10	3	0.000	0.036	n.a.	1.000
Chittagong Division	*583*	*2*	*3*	*7*	*15*	*120*	*7*	*0.002*	*0.024*	*n.a.*	*0.878*
Dhaka	74	2	2	4	6	100	4	0.000	0.041	n.a.	0.986
Faridpur	48	3	5	6	7	25	5	0.000	0.000	n.a.	0.979
Gazipur	33	1	1	2	2	3	1	0.000	0.091	n.a.	1.000
Gopalganj	31	4	7	9	28	32	10	0.000	0.000	n.a.	0.774
Jamalpur	39	2	3	3	7	24	4	0.000	0.000	n.a.	0.923
Kishoreganj	75	1	2	3	4	28	3	0.000	0.040	n.a.	0.960
Madaripur	22	4	5	6	6	10	5	0.000	0.000	n.a.	1.000
Manikganj	40	2	4	5	7	20	4	0.000	0.000	n.a.	0.975
Munshiganj	36	2	2	3	6	27	3	0.000	0.028	n.a.	0.972
Mymensingh	71	1	1	2	3	49	2	0.000	0.070	n.a.	0.986
Narayanganj	31	2	2	3	3	8	3	0.000	0.000	n.a.	1.000
Narsingdi	33	1	2	3	5	32	4	0.000	0.000	n.a.	0.909
Netrakona	53	1	2	2	4	19	2	0.000	0.057	n.a.	0.981
Rajbari	27	1	3	5	6	6	3	0.000	0.037	n.a.	1.000
Shariatpur	36	3	4	6	7	12	5	0.000	0.000	n.a.	1.000
Sherpur	31	2	2	3	4	62	4	0.000	0.000	n.a.	0.968
Tangail	73	1	2	4	6	26	3	0.014	0.014	n.a.	0.986
Dhaka Division	*753*	*1*	*2*	*4*	*6*	*100*	*4*	*0.001*	*0.027*	*n.a.*	*0.968*

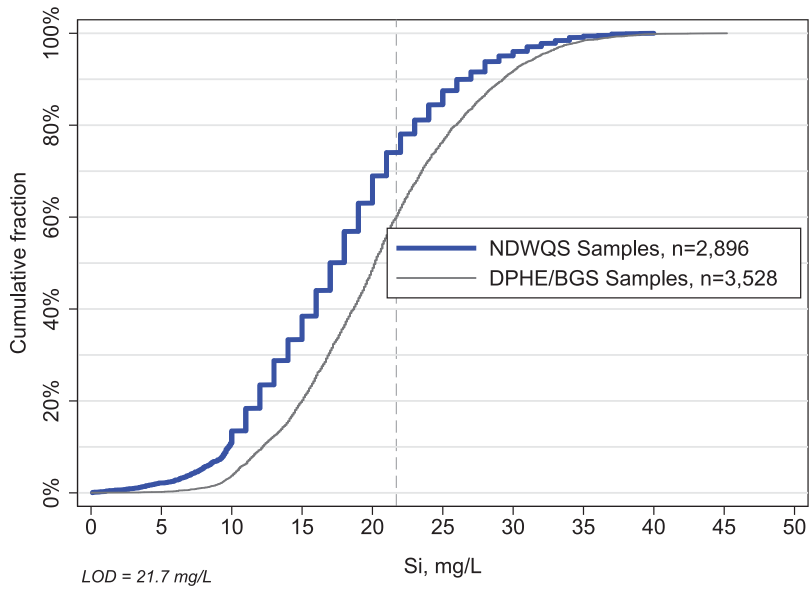
Table 6b: Geographic distribution of potassium, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	5	8	10	19	41	9	0.000	0.019	n.a.	0.796
Chuadanga	23	2	3	16	54	80	14	0.000	0.000	n.a.	0.739
Jessore	43	1	2	4	5	8	3	0.000	0.023	n.a.	1.000
Jhenaidah	36	2	2	3	4	15	3	0.000	0.000	n.a.	0.972
Khulna	64	3	5	12	22	37	8	0.000	0.016	n.a.	0.813
Kushtia	35	2	2	3	5	9	3	0.000	0.000	n.a.	1.000
Magura	27	1	2	3	4	4	2	0.000	0.037	n.a.	1.000
Meherpur	22	5	6	24	65	140	22	0.000	0.000	n.a.	0.636
Narail	21	2	2	5	7	21	4	0.000	0.000	n.a.	0.952
Satkhira	39	3	5	11	19	30	7	0.026	0.051	n.a.	0.821
Khulna Division	*364*	*2*	*4*	*7*	*15*	*140*	*7*	*0.003*	*0.016*	*n.a.*	*0.874*
Bogra	72	1	2	3	7	37	3	0.000	0.139	n.a.	0.931
Dinajpur	82	1	2	3	6	52	5	0.000	0.134	n.a.	0.927
Gaibandha	40	3	4	7	10	20	5	0.000	0.025	n.a.	0.950
Joypurhat	31	1	1	2	2	4	2	0.000	0.065	n.a.	1.000
Kurigram	45	3	4	6	7	30	5	0.000	0.000	n.a.	0.978
Lalmonirhat	33	2	4	7	16	37	7	0.000	0.000	n.a.	0.879
Naogaon	57	1	1	2	3	6	2	0.000	0.175	n.a.	1.000
Natore	37	1	2	2	4	4	2	0.000	0.000	n.a.	1.000
Nawabganj	32	1	2	2	7	25	3	0.000	0.063	n.a.	0.938
Nilphamari	34	2	4	6	29	49	8	0.000	0.000	n.a.	0.824
Pabna	46	1	1	3	6	15	2	0.000	0.000	n.a.	0.978
Panchagarh	32	1	3	6	9	13	4	0.000	0.031	n.a.	0.969
Rajshahi	66	1	1	2	3	8	2	0.000	0.030	n.a.	1.000
Rangpur	49	2	4	6	39	65	10	0.000	0.041	n.a.	0.837
Sirajganj	42	2	4	5	6	78	6	0.000	0.024	n.a.	0.952
Thakurgaon	33	2	3	9	21	51	8	0.000	0.000	n.a.	0.788
Rajshahi Division	*731*	*1*	*2*	*4*	*8*	*78*	*4*	*0.000*	*0.057*	*n.a.*	*0.938*
Habiganj	47	1	2	2	5	75	4	0.000	0.000	n.a.	0.979
Maulvi Bazar	41	2	3	4	4	27	3	0.000	0.000	n.a.	0.976
Sunamganj	65	1	1	2	4	13	2	0.000	0.000	n.a.	0.985
Sylhet	64	2	2	4	12	59	5	0.000	0.000	n.a.	0.922
Sylhet Division	217	1	2	3	6	75	4	0.000	0.000	n.a.	0.963
Grand Total	***2896***	***2***	***3***	***5***	***9***	***520***	***5***	***0.001***	***0.029***	***n.a.***	***0.927***

SILICON (SI)

There is no Bangladesh standard nor WHO guideline value for silicon. In natural water, silicon exists mostly as silicate.

Figure 7: **Silicon distribution.**

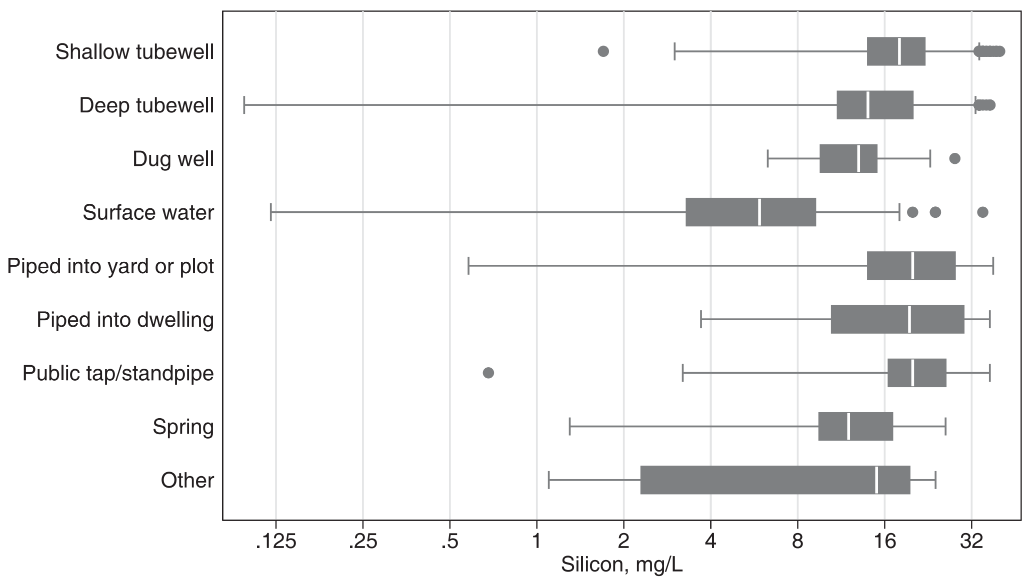


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 57.5% that the DPHE/BGS distribution is greater than the NDWQS distribution. The high limit of detection for silicon in the NDWQS probably reflects silicon contamination in sample bottles or preservatives. Thus, results should be interpreted with caution.

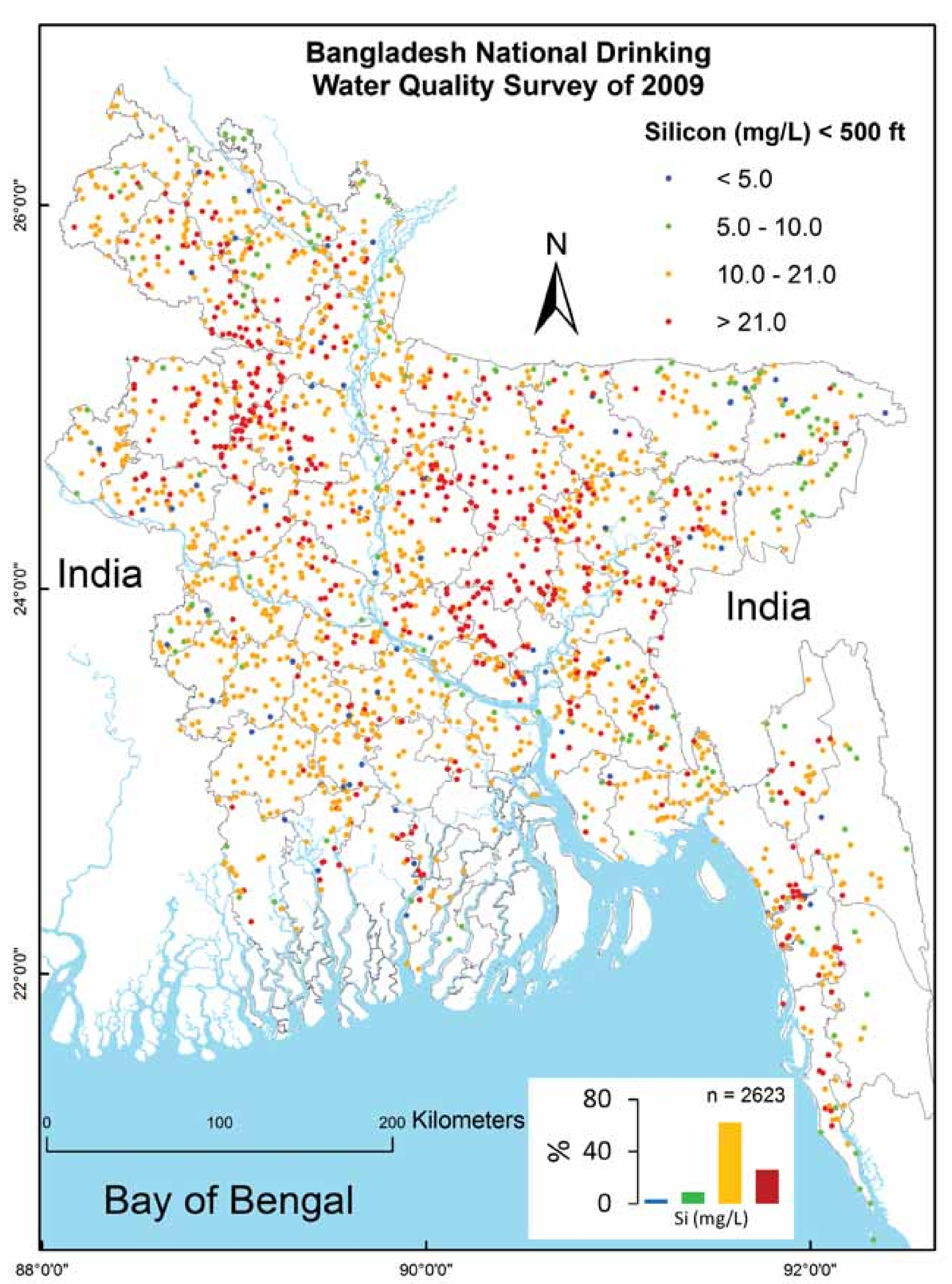
Table 7a: **Silicon levels by water source**

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	14	18	22	26	40	18	0.000	0.722	n.a.	n.a.
Deep tubewell	526	11	14	20	27	37	16	0.000	0.795	n.a.	n.a.
Dug well	59	10	13	15	20	28	13	0.000	0.949	n.a.	n.a.
Surface water	67	3	6	9	15	35	7	0.000	0.955	n.a.	n.a.
Piped into yard or plot	54	14	20	28	33	38	20	0.000	0.593	n.a.	n.a.
Piped into dwelling	48	11	20	30	34	37	20	0.000	0.542	n.a.	n.a.
Public tap/standpipe	44	17	20	26	32	37	20	0.000	0.591	n.a.	n.a.
Spring	22	10	12	17	20	26	13	0.000	0.955	n.a.	n.a.
Other	16	2	15	20	22	24	12	0.000	0.875	n.a.	n.a.

Figure 7b: **Silicon levels by water source**



Map 7a: **Silicon in shallow tubewells (< 150 m)**



Map 7b: Silicon in deep tubewells (>150 m)

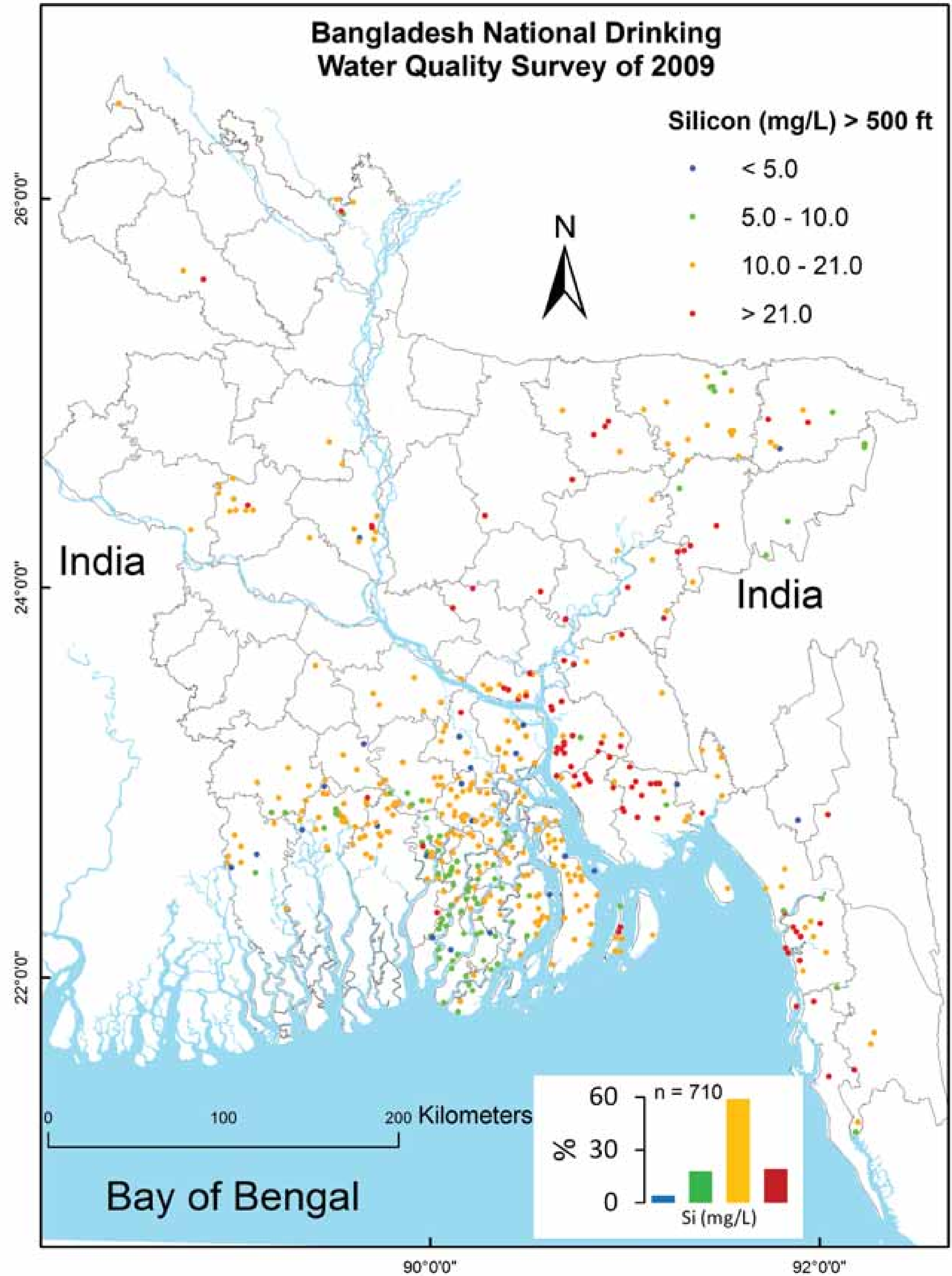


Table 7b: Geographic distribution of silicon

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	9	10	10	10	17	9	0.000	1.000	n.a.	n.a.
Barisal	65	11	12	14	15	34	13	0.000	0.969	n.a.	n.a.
Bhola	36	12	15	19	21	27	16	0.000	0.917	n.a.	n.a.
Jhalokati	26	10	11	16	21	32	14	0.000	0.923	n.a.	n.a.
Patuakhali	46	10	11	11	12	13	11	0.000	1.000	n.a.	n.a.
Pirojpur	40	10	11	17	27	29	13	0.000	0.850	n.a.	n.a.
Barisal Division	*248*	*10*	*11*	*13*	*19*	*34*	*12*	*0.000*	*0.948*	*n.a.*	*n.a.*
Bandarban	44	8	11	15	18	29	12	0.000	0.955	n.a.	n.a.
Brahamanbaria	52	19	24	29	34	40	25	0.000	0.385	n.a.	n.a.
Chandpur	47	17	23	29	32	36	23	0.000	0.426	n.a.	n.a.
Chittagong	92	14	19	23	28	34	19	0.000	0.663	n.a.	n.a.
Comilla	86	16	20	24	29	35	20	0.000	0.663	n.a.	n.a.
Cox's Bazar	38	9	17	24	28	36	17	0.000	0.684	n.a.	n.a.
Feni	38	13	16	20	27	34	18	0.000	0.816	n.a.	n.a.
Khagrachhari	47	13	16	20	30	39	17	0.000	0.809	n.a.	n.a.
Lakshmipur	32	13	19	28	32	34	21	0.000	0.563	n.a.	n.a.
Noakhali	51	13	16	25	33	35	20	0.000	0.667	n.a.	n.a.
Rangamati	56	8	13	17	20	28	13	0.000	0.911	n.a.	n.a.
Chittagong Division	*583*	*13*	*18*	*24*	*29*	*40*	*19*	*0.000*	*0.683*	*n.a.*	*n.a.*
Dhaka	74	22	29	32	34	38	27	0.000	0.216	n.a.	n.a.
Faridpur	48	15	17	19	21	24	17	0.000	0.958	n.a.	n.a.
Gazipur	33	24	27	29	31	33	26	0.000	0.091	n.a.	n.a.
Gopalganj	31	12	15	17	20	23	14	0.000	0.935	n.a.	n.a.
Jamalpur	39	15	18	21	27	33	19	0.000	0.769	n.a.	n.a.
Kishoreganj	75	15	19	22	25	29	19	0.000	0.707	n.a.	n.a.
Madaripur	22	15	16	20	21	22	17	0.000	0.955	n.a.	n.a.
Manikganj	40	16	20	23	26	30	19	0.000	0.675	n.a.	n.a.
Munshiganj	36	18	20	23	27	28	20	0.000	0.611	n.a.	n.a.
Mymensingh	71	18	23	27	30	39	22	0.000	0.408	n.a.	n.a.
Narayanganj	31	18	22	27	30	37	23	0.000	0.452	n.a.	n.a.
Narsingdi	33	17	20	25	27	31	21	0.000	0.576	n.a.	n.a.
Netrakona	53	13	17	20	25	27	17	0.000	0.774	n.a.	n.a.
Rajbari	27	15	18	21	22	25	18	0.000	0.778	n.a.	n.a.
Shariatpur	36	15	17	18	20	34	17	0.000	0.972	n.a.	n.a.
Sherpur	31	15	16	21	22	26	17	0.000	0.839	n.a.	n.a.
Tangail	73	16	20	24	30	35	20	0.000	0.616	n.a.	n.a.
Dhaka Division	*753*	*16*	*19*	*24*	*29*	*39*	*20*	*0.000*	*0.633*	*n.a.*	*n.a.*

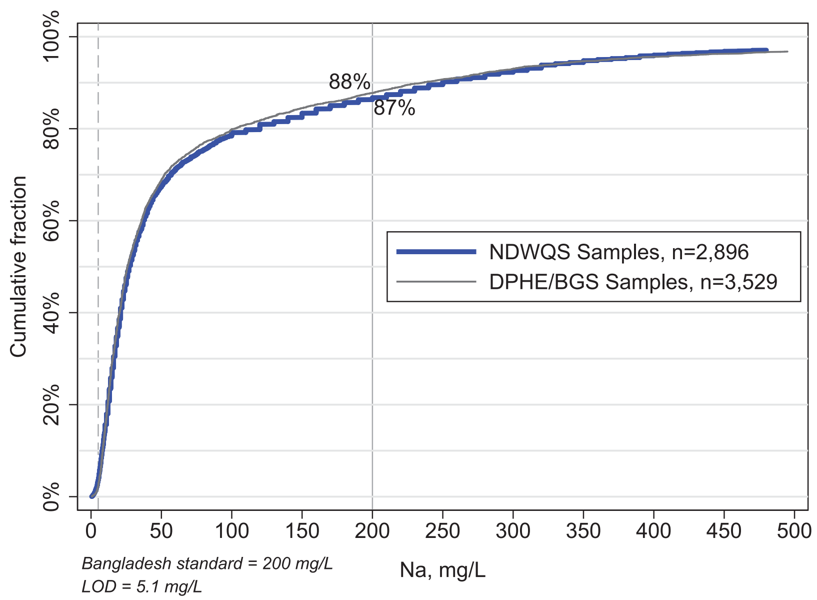
Table 7b: Geographic distribution of silicon, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	4	13	15	18	31	11	0.000	0.926	n.a.	n.a.
Chuadanga	23	12	15	19	22	22	16	0.000	0.870	n.a.	n.a.
Jessore	43	16	17	19	21	23	17	0.000	0.977	n.a.	n.a.
Jhenaidah	36	13	17	19	21	21	16	0.000	1.000	n.a.	n.a.
Khulna	64	11	14	19	25	31	15	0.000	0.859	n.a.	n.a.
Kushtia	35	17	19	20	21	22	18	0.000	0.971	n.a.	n.a.
Magura	27	17	19	20	22	22	18	0.000	0.889	n.a.	n.a.
Meherpur	22	10	12	14	16	20	12	0.000	1.000	n.a.	n.a.
Narail	21	17	18	19	20	34	18	0.000	0.905	n.a.	n.a.
Satkhira	39	10	15	19	22	31	15	0.000	0.897	n.a.	n.a.
Khulna Division	*364*	*12*	*16*	*19*	*21*	*34*	*15*	*0.000*	*0.926*	*n.a.*	*n.a.*
Bogra	72	19	21	24	25	26	21	0.000	0.542	n.a.	n.a.
Dinajpur	82	15	21	24	26	29	19	0.000	0.537	n.a.	n.a.
Gaibandha	40	14	18	22	25	28	18	0.000	0.725	n.a.	n.a.
Joypurhat	31	22	25	27	29	29	24	0.000	0.161	n.a.	n.a.
Kurigram	45	11	13	18	25	28	15	0.000	0.822	n.a.	n.a.
Lalmonirhat	33	10	11	14	18	24	13	0.000	0.939	n.a.	n.a.
Naogaon	57	19	22	25	26	31	22	0.000	0.456	n.a.	n.a.
Natore	37	19	20	22	24	25	20	0.000	0.703	n.a.	n.a.
Nawabganj	32	16	19	20	21	23	18	0.000	0.906	n.a.	n.a.
Nilphamari	34	12	14	18	24	28	15	0.000	0.824	n.a.	n.a.
Pabna	46	17	19	21	23	29	19	0.000	0.761	n.a.	n.a.
Panchagarh	32	12	14	18	21	26	15	0.000	0.906	n.a.	n.a.
Rajshahi	66	17	19	20	23	29	19	0.000	0.848	n.a.	n.a.
Rangpur	49	12	15	19	24	28	16	0.000	0.776	n.a.	n.a.
Sirajganj	42	15	19	21	23	25	18	0.000	0.786	n.a.	n.a.
Thakurgaon	33	12	14	20	21	27	15	0.000	0.909	n.a.	n.a.
Rajshahi Division	*731*	*14*	*19*	*22*	*25*	*31*	*18*	*0.000*	*0.705*	*n.a.*	*n.a.*
Habiganj	47	17	20	25	32	38	21	0.000	0.574	n.a.	n.a.
Maulvi Bazar	41	9	12	17	20	25	13	0.000	0.927	n.a.	n.a.
Sunamganj	65	11	14	17	19	36	14	0.000	0.938	n.a.	n.a.
Sylhet	64	7	12	19	24	28	13	0.000	0.875	n.a.	n.a.
Sylhet Division	*217*	*10*	*15*	*19*	*24*	*38*	*15*	*0.000*	*0.839*	*n.a.*	*n.a.*
Grand Total	***2896***	***13***	***17***	***22***	***27***	***40***	***18***	***0.000***	***0.740***	***n.a.***	***n.a.***

SODIUM (NA)

The Bangladesh standard for sodium is 200 mg/L. There is no WHO guideline value.

Figure 8: **Sodium distribution, with 87% of samples meeting the Bangladesh standard of 200 mg/L.**

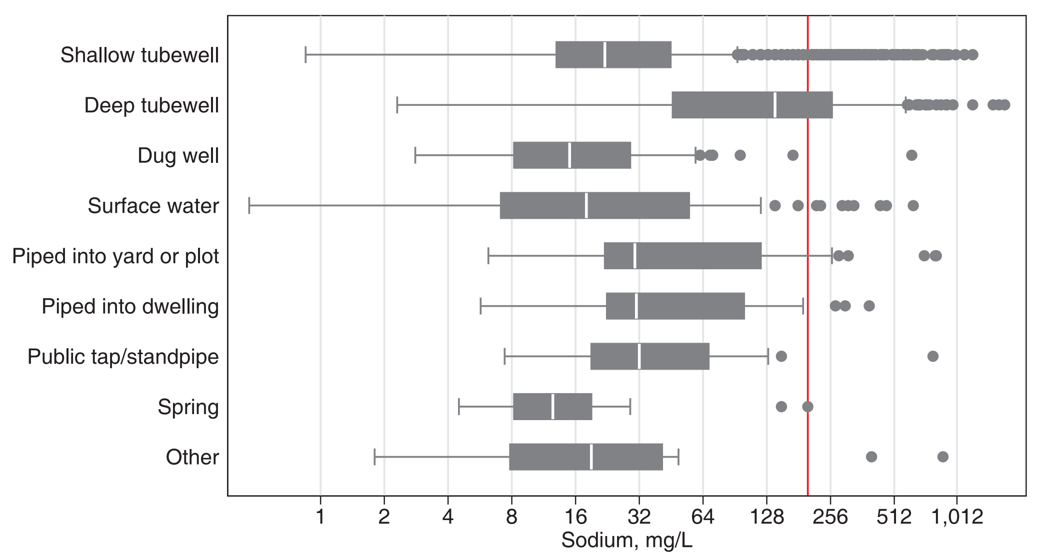


The NDWQS and DPHE/BGS distributions are not significantly different (p=0.18).

Table 8a: Sodium levels by water source

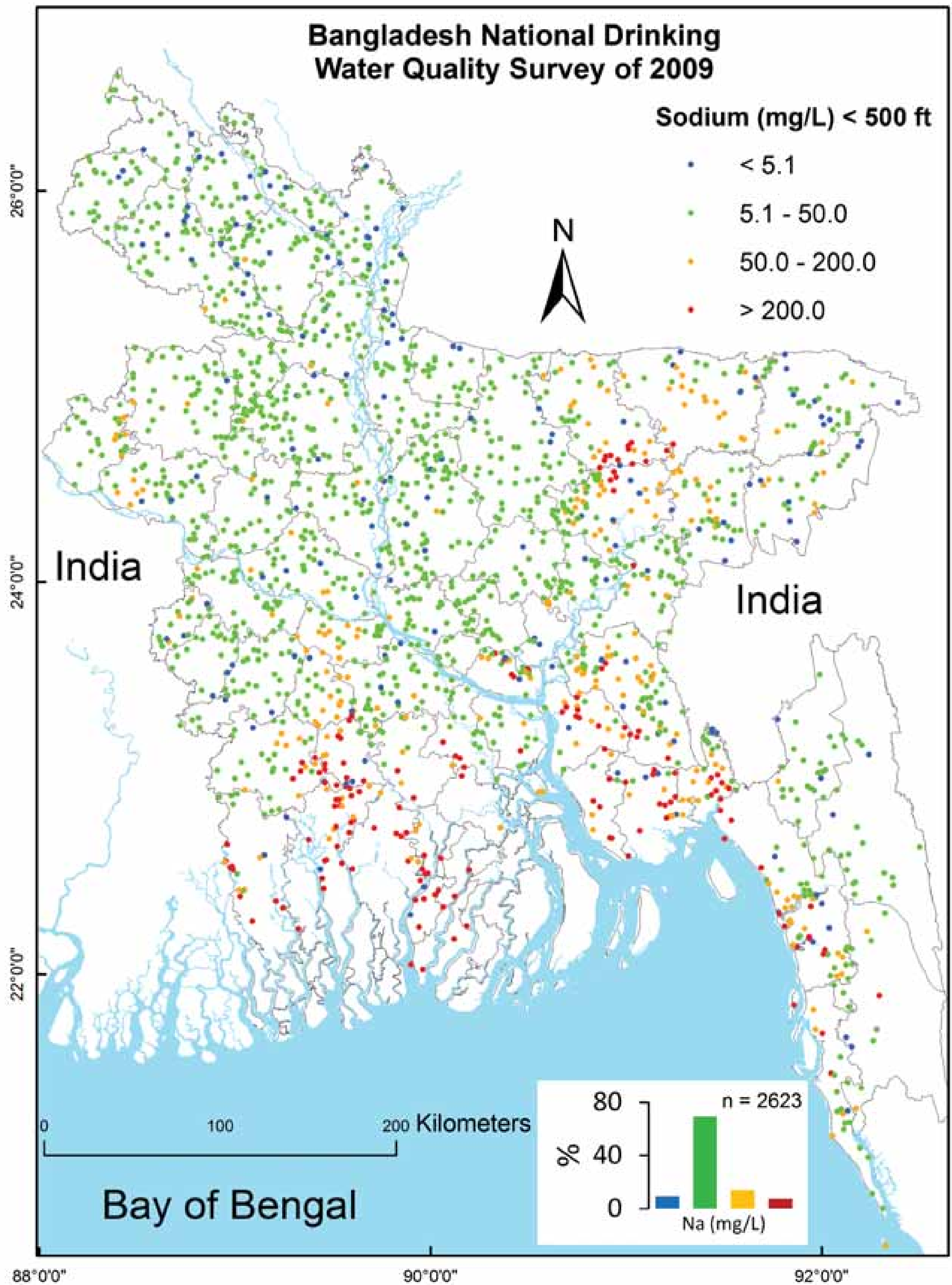
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	13	22	45	160	1200	64	0.000	0.041	n.a.	0.917
Deep tubewell	526	46	140	260	390	1700	186	0.000	0.008	n.a.	0.646
Dug well	59	8	15	29	69	620	34	0.000	0.068	n.a.	0.983
Surface water	67	7	18	55	230	630	71	0.000	0.134	n.a.	0.881
Piped into yard or plot	54	22	31	120	260	810	113	0.000	0.000	n.a.	0.796
Piped into dwelling	48	23	31	100	160	390	68	0.000	0.000	n.a.	0.938
Public tap/standpipe	44	19	32	68	120	780	62	0.000	0.000	n.a.	0.977
Spring	22	8	13	19	29	200	28	0.000	0.046	n.a.	1.000
Other	16	8	19	41	400	870	97	0.000	0.125	n.a.	0.875

Figure 8b: Sodium levels by water source



Bangladesh standard = 200 mg/L

Map 8a: **Sodium in shallow tubewells (< 150 m)**



Map 8b: **Sodium in deep tubewells (> 150 m)**

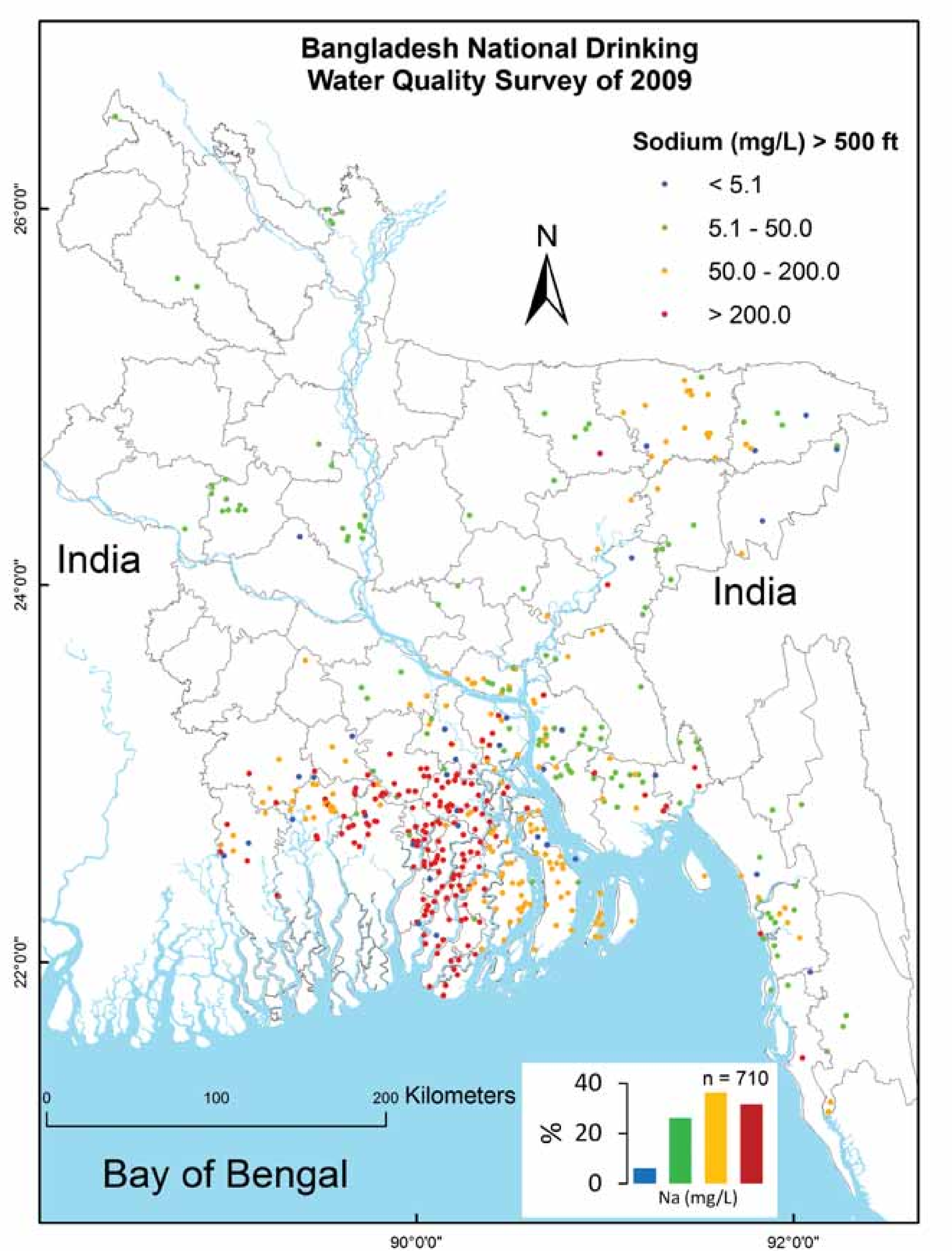


Table 8b: Geographic distribution of sodium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	250	280	430	670	1100	371	0.000	0.000	n.a.	0.057
Barisal	65	160	230	290	350	670	226	0.000	0.015	n.a.	0.431
Bhola	36	67	95	145	160	190	109	0.000	0.000	n.a.	1.000
Jhalokati	26	240	320	580	790	1500	446	0.000	0.000	n.a.	0.000
Patuakhali	46	150	190	260	320	390	210	0.000	0.000	n.a.	0.609
Pirojpur	40	125	310	450	685	1700	365	0.000	0.025	n.a.	0.300
Barisal Division	*248*	*145*	*230*	*320*	*480*	*1700*	*272*	*0.000*	*0.008*	*n.a.*	*0.427*
Bandarban	44	9	17	52	84	350	40	0.000	0.091	n.a.	0.977
Brahamanbaria	52	16	20	28	56	250	32	0.000	0.000	n.a.	0.981
Chandpur	47	36	64	190	400	920	146	0.000	0.000	n.a.	0.766
Chittagong	92	21	51	125	440	1200	148	0.000	0.043	n.a.	0.804
Comilla	86	20	44	94	160	780	76	0.000	0.000	n.a.	0.942
Cox's Bazar	38	22	40	96	310	690	97	0.000	0.026	n.a.	0.868
Feni	38	13	32	150	300	570	104	0.000	0.079	n.a.	0.816
Khagrachhari	47	7	10	15	19	90	13	0.000	0.064	n.a.	1.000
Lakshmipur	32	34	65	260	630	1200	226	0.000	0.000	n.a.	0.688
Noakhali	51	40	89	300	570	1100	202	0.000	0.000	n.a.	0.608
Rangamati	56	8	11	17	25	100	15	0.000	0.054	n.a.	1.000
Chittagong Division	*583*	*14*	*31*	*94*	*280*	*1200*	*98*	*0.000*	*0.031*	*n.a.*	*0.866*
Dhaka	74	19	26	33	51	130	33	0.000	0.000	n.a.	1.000
Faridpur	48	14	23	39	80	200	37	0.000	0.021	n.a.	1.000
Gazipur	33	17	21	29	37	72	24	0.000	0.000	n.a.	1.000
Gopalganj	31	24	150	600	800	970	304	0.000	0.000	n.a.	0.516
Jamalpur	39	8	13	20	31	38	15	0.000	0.103	n.a.	1.000
Kishoreganj	75	28	42	89	200	260	71	0.000	0.013	n.a.	0.907
Madaripur	22	19	53	230	350	360	126	0.000	0.000	n.a.	0.636
Manikganj	40	10	19	26	37	55	20	0.000	0.000	n.a.	1.000
Munshiganj	36	46	66	150	320	420	121	0.000	0.000	n.a.	0.778
Mymensingh	71	13	23	29	36	55	23	0.000	0.014	n.a.	1.000
Narayanganj	31	36	81	150	190	350	100	0.000	0.000	n.a.	0.903
Narsingdi	33	15	21	33	75	140	32	0.000	0.030	n.a.	1.000
Netrakona	53	30	52	120	240	280	88	0.000	0.019	n.a.	0.811
Rajbari	27	12	24	64	92	100	38	0.000	0.000	n.a.	1.000
Shariatpur	36	17	80	210	280	840	137	0.000	0.000	n.a.	0.722
Sherpur	31	7	14	21	25	44	14	0.000	0.129	n.a.	1.000
Tangail	73	10	16	20	27	61	16	0.000	0.068	n.a.	1.000
Dhaka Division	*753*	*15*	*25*	*51*	*160*	*970*	*61*	*0.000*	*0.024*	*n.a.*	*0.919*

Table 8b: Geographic distribution of sodium, continued

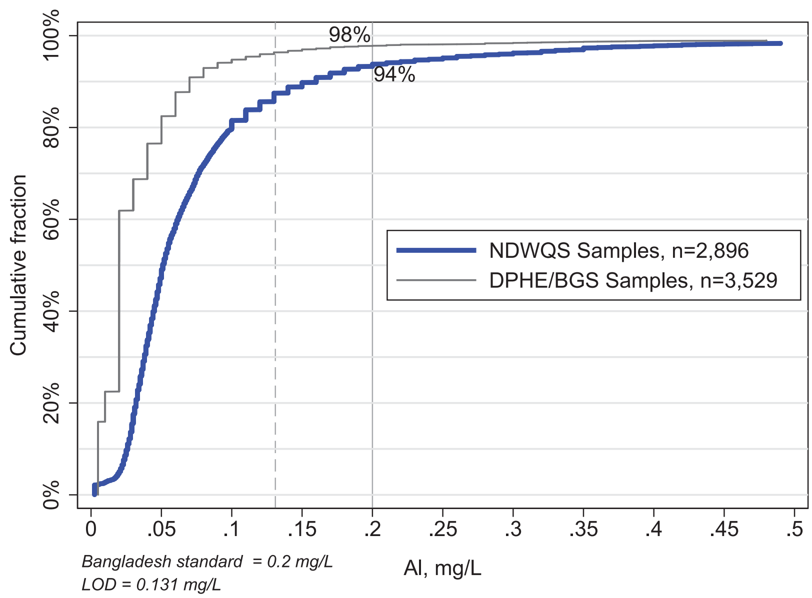
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	49	260	390	700	930	274	0.000	0.056	n.a.	0.426
Chuadanga	23	15	20	28	31	40	21	0.000	0.000	n.a.	1.000
Jessore	43	18	43	110	320	510	99	0.000	0.000	n.a.	0.791
Jhenaidah	36	12	18	31	38	57	21	0.000	0.028	n.a.	1.000
Khulna	64	140	250	435	630	1100	303	0.000	0.000	n.a.	0.453
Kushtia	35	18	23	31	37	120	29	0.000	0.000	n.a.	1.000
Magura	27	18	37	87	120	210	56	0.000	0.000	n.a.	0.963
Meherpur	22	17	40	49	58	87	38	0.000	0.000	n.a.	1.000
Narail	21	170	230	310	370	590	240	0.000	0.000	n.a.	0.429
Satkhira	39	28	110	260	460	910	189	0.000	0.026	n.a.	0.641
Khulna Division	*364*	*21*	*57*	*245*	*410*	*1100*	*153*	*0.000*	*0.014*	*n.a.*	*0.720*
Bogra	72	15	20	25	34	160	23	0.000	0.014	n.a.	1.000
Dinajpur	82	9	15	24	36	73	19	0.000	0.073	n.a.	1.000
Gaibandha	40	10	13	19	31	68	17	0.000	0.025	n.a.	1.000
Joypurhat	31	16	19	23	26	44	20	0.000	0.000	n.a.	1.000
Kurigram	45	6	11	14	21	44	13	0.000	0.200	n.a.	1.000
Lalmonirhat	33	6	9	15	23	45	12	0.000	0.182	n.a.	1.000
Naogaon	57	16	25	30	40	51	25	0.000	0.000	n.a.	1.000
Natore	37	23	33	42	45	69	33	0.000	0.000	n.a.	1.000
Nawabganj	32	32	40	50	60	87	40	0.000	0.000	n.a.	1.000
Nilphamari	34	7	10	17	46	100	19	0.000	0.088	n.a.	1.000
Pabna	46	18	31	38	43	79	30	0.000	0.022	n.a.	1.000
Panchagarh	32	6	7	12	16	34	10	0.000	0.156	n.a.	1.000
Rajshahi	66	25	32	39	49	120	34	0.000	0.000	n.a.	1.000
Rangpur	49	8	14	18	44	80	17	0.000	0.082	n.a.	1.000
Sirajganj	42	11	17	25	39	53	20	0.000	0.000	n.a.	1.000
Thakurgaon	33	8	10	20	39	51	16	0.000	0.091	n.a.	1.000
Rajshahi Division	*731*	*11*	*18*	*30*	*43*	*160*	*22*	*0.000*	*0.053*	*n.a.*	*1.000*
Habiganj	47	19	32	55	89	200	45	0.000	0.021	n.a.	1.000
Maulvi Bazar	41	7	15	24	52	92	22	0.000	0.171	n.a.	1.000
Sunamganj	65	28	62	89	120	220	65	0.000	0.046	n.a.	0.985
Sylhet	64	7	12	26	57	95	20	0.000	0.172	n.a.	1.000
Sylhet Division	*217*	*11*	*24*	*57*	*92*	*220*	*39*	*0.000*	*0.101*	*n.a.*	*0.995*
Grand Total	***2896***	***14***	***27***	***77***	***250***	***1700***	***87***	***0.000***	***0.036***	***n.a.***	***0.867***

MINOR ELEMENTS

ALUMINIUM (AL)

The Bangladesh national standard for aluminium in drinking water is 0.2 mg/L. WHO doesn't have a health-based guideline value, but notes that a health-based value of 0.9 mg/L could be derived, on the basis of a 2007 FAO/WHO report. WHO does recommends that in piped distribution systems aluminium levels should be kept below 0.1 mg/L (or 0.2 mg/L in small systems) to avoid aesthetic problems and deposition of aluminium floc in distribution systems (WHO, 2010).

Figure 9: **Aluminium distribution, with 94% of samples meeting the Bangladesh standard of 0.2 mg/L.**

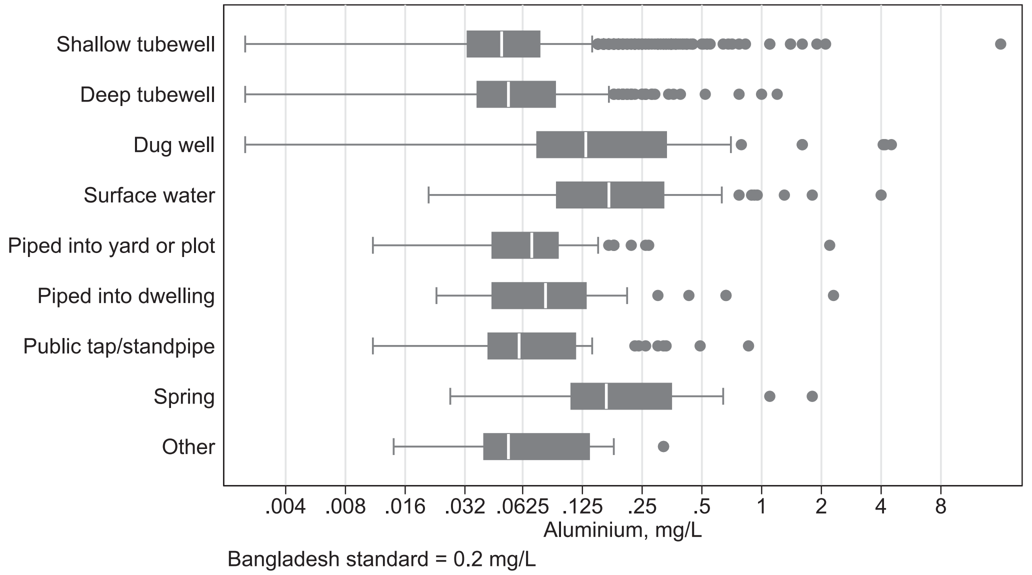


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 54.5% that the NDWQS distribution is greater than the DPHE/BGS distribution.

Table 9a: **Aluminiumlevels by water source**

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.03	0.05	0.08	0.13	16.00	0.08	0.022	0.911	n.a.	0.959
Deep tubewell	526	0.04	0.05	0.09	0.15	1.20	0.08	0.030	0.876	n.a.	0.958
Dug well	59	0.07	0.13	0.33	0.79	4.50	0.43	0.017	0.525	n.a.	0.695
Surface water	67	0.09	0.17	0.32	0.77	4.00	0.33	0.000	0.388	n.a.	0.582
Piped into yard or plot	54	0.04	0.07	0.09	0.18	2.20	0.12	0.000	0.833	n.a.	0.926
Piped into dwelling	48	0.04	0.08	0.13	0.30	2.30	0.17	0.000	0.771	n.a.	0.875
Public tap/standpipe	44	0.04	0.06	0.12	0.30	0.86	0.12	0.000	0.796	n.a.	0.818
Spring	22	0.11	0.17	0.35	0.64	1.80	0.32	0.000	0.409	n.a.	0.682
Other	16	0.04	0.05	0.14	0.32	0.32	0.10	0.000	0.750	*n.a.*	0.875

Figure 9b: **Aluminium levels by water source**



Bangladesh standard = 0.2 mg/L

Table 9b: Geographic distribution of aluminium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.02	0.07	0.14	0.20	0.33	0.09	0.114	0.743	n.a.	0.914
Barisal	65	0.03	0.06	0.08	0.14	1.90	0.10	0.031	0.877	n.a.	0.938
Bhola	36	0.05	0.06	0.10	0.19	0.39	0.09	0.000	0.861	n.a.	0.917
Jhalokati	26	0.03	0.05	0.08	0.11	0.20	0.06	0.000	0.923	n.a.	1.000
Patuakhali	46	0.05	0.08	0.13	0.16	0.26	0.09	0.022	0.783	n.a.	0.935
Pirojpur	40	0.04	0.08	0.14	0.22	0.66	0.11	0.050	0.725	n.a.	0.900
Barisal Division	*248*	*0.04*	*0.07*	*0.11*	*0.17*	*1.90*	*0.09*	*0.036*	*0.819*	*n.a.*	*0.931*
Bandarban	44	0.07	0.13	0.20	0.45	1.80	0.23	0.023	0.545	n.a.	0.773
Brahamanbaria	52	0.04	0.06	0.09	0.12	0.17	0.07	0.019	0.942	n.a.	1.000
Chandpur	47	0.04	0.05	0.08	0.36	0.92	0.12	0.021	0.872	n.a.	0.872
Chittagong	92	0.03	0.04	0.06	0.12	4.10	0.13	0.011	0.913	n.a.	0.935
Comilla	86	0.03	0.04	0.06	0.11	0.23	0.05	0.047	0.953	n.a.	0.988
Cox's Bazar	38	0.06	0.08	0.12	0.26	0.46	0.11	0.000	0.763	n.a.	0.868
Feni	38	0.03	0.04	0.05	0.08	0.17	0.05	0.000	0.974	n.a.	1.000
Khagrachhari	47	0.05	0.10	0.14	0.20	0.35	0.11	0.000	0.702	n.a.	0.915
Lakshmipur	32	0.03	0.05	0.07	0.10	0.18	0.06	0.000	0.938	n.a.	1.000
Noakhali	51	0.04	0.05	0.11	0.15	2.30	0.12	0.000	0.863	n.a.	0.941
Rangamati	56	0.06	0.10	0.18	0.50	1.60	0.20	0.000	0.589	n.a.	0.804
Chittagong Division	*583*	*0.04*	*0.05*	*0.10*	*0.18*	*4.10*	*0.11*	*0.014*	*0.834*	*n.a.*	*0.921*
Dhaka	74	0.05	0.08	0.11	0.17	0.32	0.09	0.000	0.865	n.a.	0.932
Faridpur	48	0.03	0.04	0.08	0.13	1.40	0.09	0.021	0.917	n.a.	0.938
Gazipur	33	0.04	0.05	0.08	0.12	0.22	0.07	0.000	0.939	n.a.	0.970
Gopalganj	31	0.03	0.05	0.10	0.15	0.26	0.07	0.032	0.806	n.a.	0.935
Jamalpur	39	0.04	0.05	0.06	0.10	0.42	0.07	0.000	0.949	n.a.	0.949
Kishoreganj	75	0.05	0.06	0.11	0.14	0.39	0.08	0.000	0.893	n.a.	0.960
Madaripur	22	0.03	0.04	0.06	0.07	0.19	0.05	0.000	0.955	n.a.	1.000
Manikganj	40	0.03	0.04	0.05	0.07	0.17	0.05	0.050	0.975	n.a.	1.000
Munshiganj	36	0.03	0.04	0.06	0.13	0.25	0.05	0.056	0.917	n.a.	0.972
Mymensingh	71	0.03	0.05	0.07	0.12	1.60	0.09	0.014	0.915	n.a.	0.958
Narayanganj	31	0.03	0.05	0.08	0.11	0.77	0.08	0.000	0.935	n.a.	0.935
Narsingdi	33	0.04	0.06	0.08	0.10	0.28	0.07	0.000	0.909	n.a.	0.970
Netrakona	53	0.04	0.06	0.08	0.14	2.10	0.11	0.019	0.887	n.a.	0.925
Rajbari	27	0.03	0.03	0.04	0.07	0.11	0.04	0.037	1.000	n.a.	1.000
Shariatpur	36	0.04	0.05	0.08	0.09	0.12	0.06	0.028	1.000	n.a.	1.000
Sherpur	31	0.04	0.06	0.09	0.13	0.42	0.09	0.032	0.903	n.a.	0.935
Tangail	73	0.04	0.05	0.08	0.16	0.40	0.08	0.055	0.890	n.a.	0.932
Dhaka Division	*753*	*0.04*	*0.05*	*0.08*	*0.13*	*2.10*	*0.08*	*0.020*	*0.914*	*n.a.*	*0.955*

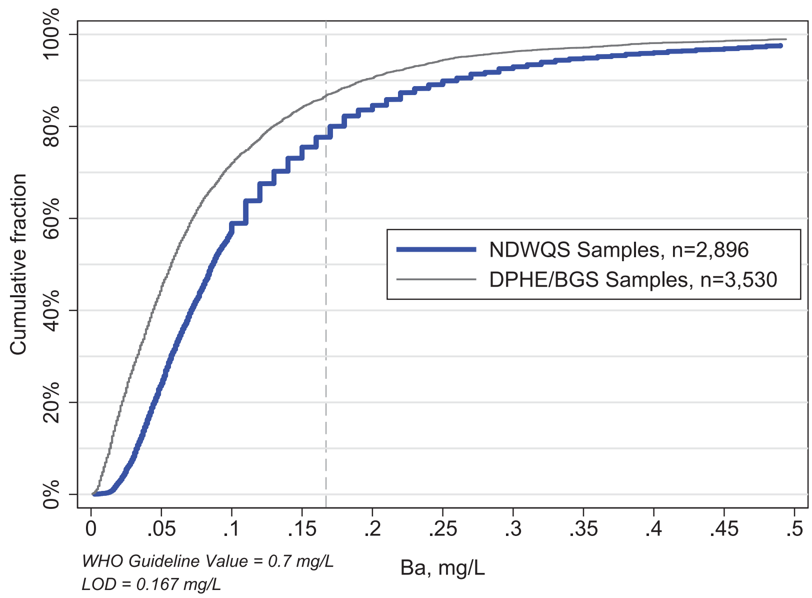
Table 9b: Geographic distribution of aluminium, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.05	0.09	0.19	0.45	1.30	0.18	0.037	0.667	n.a.	0.759
Chuadanga	23	0.03	0.04	0.06	0.07	0.08	0.05	0.043	1.000	n.a.	1.000
Jessore	43	0.05	0.06	0.09	0.13	0.35	0.08	0.047	0.907	n.a.	0.953
Jhenaidah	36	0.04	0.05	0.07	0.16	0.18	0.06	0.028	0.861	n.a.	1.000
Khulna	64	0.04	0.06	0.09	0.15	0.95	0.09	0.000	0.859	n.a.	0.938
Kushtia	35	0.03	0.04	0.08	0.20	1.10	0.10	0.086	0.886	n.a.	0.914
Magura	27	0.03	0.04	0.06	0.09	0.35	0.06	0.000	0.963	n.a.	0.963
Meherpur	22	0.03	0.03	0.05	0.06	0.31	0.05	0.000	0.955	n.a.	0.955
Narail	21	0.05	0.09	0.15	0.24	0.37	0.12	0.000	0.714	n.a.	0.810
Satkhira	39	0.05	0.08	0.13	0.28	1.00	0.14	0.000	0.795	n.a.	0.846
Khulna Division	*364*	*0.04*	*0.06*	*0.09*	*0.19*	*1.30*	*0.10*	*0.025*	*0.846*	*n.a.*	*0.907*
Bogra	72	0.03	0.04	0.05	0.09	0.33	0.05	0.000	0.958	n.a.	0.972
Dinajpur	82	0.04	0.04	0.07	0.13	4.20	0.11	0.000	0.902	n.a.	0.963
Gaibandha	40	0.03	0.04	0.06	0.08	0.25	0.05	0.050	0.950	n.a.	0.975
Joypurhat	31	0.04	0.04	0.07	0.13	0.42	0.07	0.032	0.903	n.a.	0.935
Kurigram	45	0.04	0.05	0.09	0.15	0.21	0.07	0.022	0.867	n.a.	0.978
Lalmonirhat	33	0.03	0.04	0.05	0.13	0.38	0.07	0.000	0.909	n.a.	0.939
Naogaon	57	0.03	0.05	0.07	0.14	16.00	0.35	0.035	0.895	n.a.	0.930
Natore	37	0.04	0.06	0.08	0.11	0.20	0.07	0.000	0.919	n.a.	1.000
Nawabganj	32	0.06	0.08	0.11	0.17	0.25	0.09	0.031	0.844	n.a.	0.969
Nilphamari	34	0.03	0.05	0.10	0.14	0.30	0.07	0.029	0.882	n.a.	0.971
Pabna	46	0.04	0.06	0.07	0.15	0.83	0.09	0.043	0.870	n.a.	0.957
Panchagarh	32	0.04	0.07	0.12	0.16	0.77	0.10	0.000	0.813	n.a.	0.969
Rajshahi	66	0.03	0.04	0.06	0.09	0.19	0.05	0.061	0.970	n.a.	1.000
Rangpur	49	0.03	0.04	0.08	0.13	0.21	0.06	0.020	0.959	n.a.	0.980
Sirajganj	42	0.03	0.05	0.09	0.21	0.64	0.10	0.000	0.810	n.a.	0.881
Thakurgaon	33	0.04	0.05	0.07	0.17	1.40	0.11	0.000	0.848	n.a.	0.909
Rajshahi Division	*731*	*0.03*	*0.05*	*0.08*	*0.13*	*16.00*	*0.10*	*0.021*	*0.902*	*n.a.*	*0.960*
Habiganj	47	0.03	0.04	0.06	0.10	0.30	0.06	0.043	0.915	n.a.	0.979
Maulvi Bazar	41	0.04	0.06	0.12	0.44	1.20	0.18	0.000	0.780	n.a.	0.805
Sunamganj	65	0.03	0.04	0.05	0.08	0.35	0.05	0.062	0.969	n.a.	0.985
Sylhet	64	0.04	0.06	0.11	0.32	4.50	0.24	0.000	0.797	n.a.	0.844
Sylhet Division	217	0.03	0.05	0.08	0.19	4.50	0.13	0.028	0.871	n.a.	0.908
Grand Total	***2896***	***0.04***	***0.05***	***0.09***	***0.16***	***16.00***	***0.10***	***0.021***	***0.875***	***n.a.***	***0.938***

BARIUM (BA)

The WHO guideline value for barium (Ba) is 0.7 mg/L. The Bangladesh standard for barium is set at 0.01 mg/L, apparently a typographical error. Since this is far below the method detection limit, it is impossible to say how many, if any, samples were below this level.

Figure 10: **Barium distribution, with 99% of samples meeting the WHO guideline value of 0.7 mg/L.**

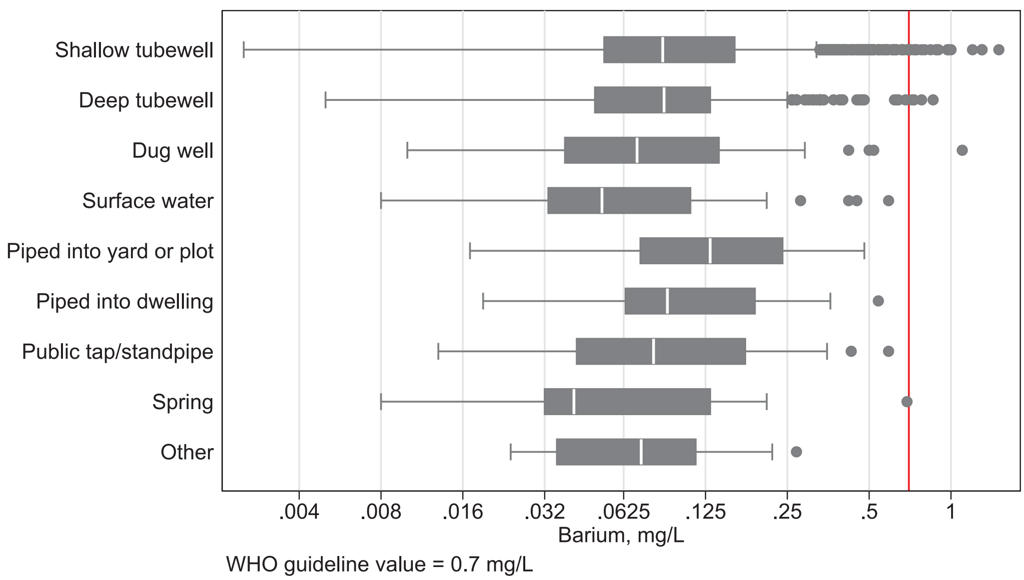


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 55.4% that the NDWQS distribution is greater than the DPHE/BGS distribution.

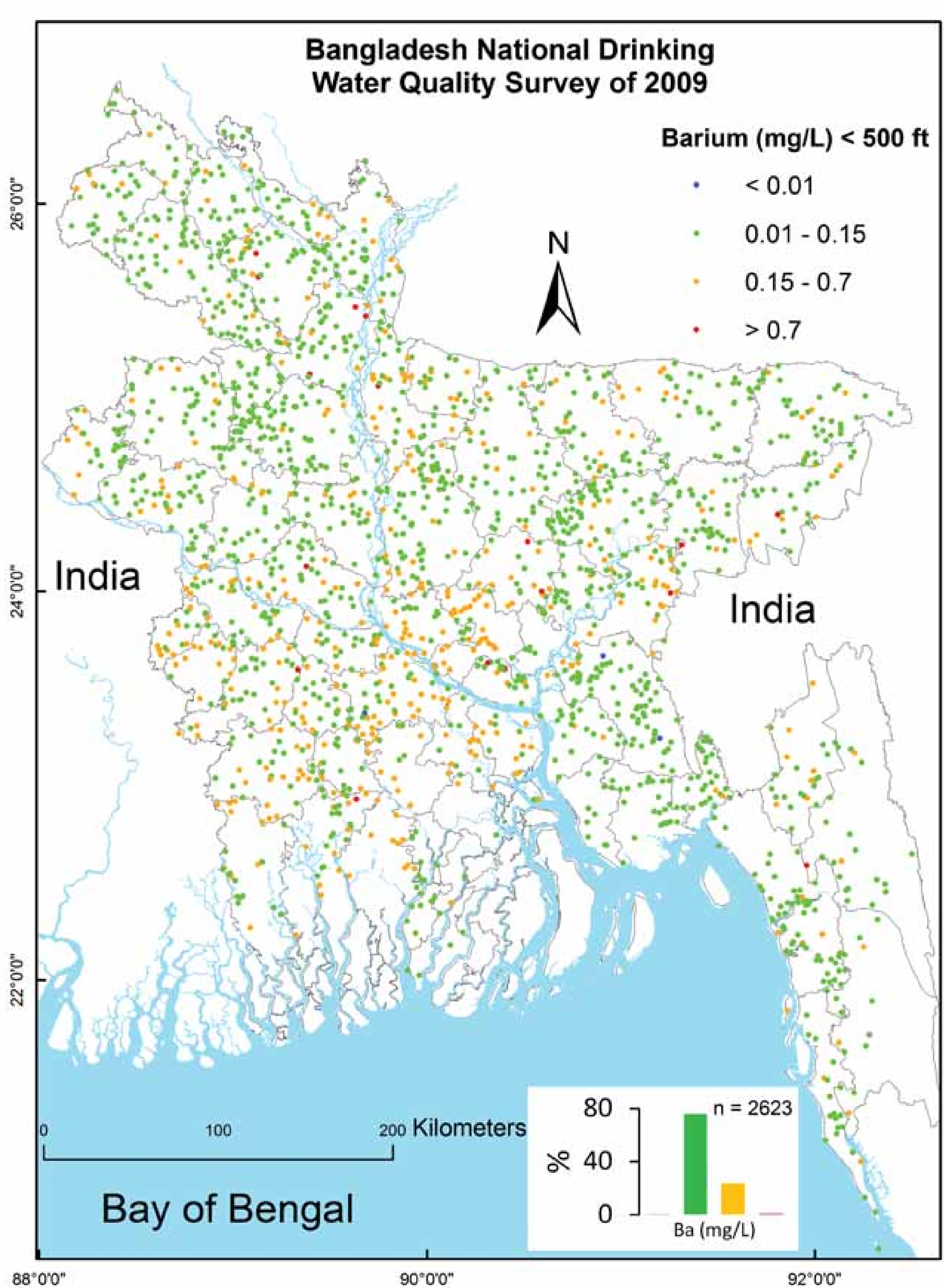
Table 10a: Barium levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.05	0.09	0.16	0.27	1.50	0.13	0.001	0.767	0.992	n.a.
Deep tubewell	526	0.05	0.09	0.13	0.22	0.86	0.11	0.002	0.823	0.992	n.a.
Dug well	59	0.04	0.07	0.14	0.23	1.10	0.13	0.000	0.780	0.983	n.a.
Surface water	67	0.03	0.05	0.11	0.20	0.59	0.09	0.000	0.881	1.000	n.a.
Piped into yard or plot	54	0.07	0.13	0.24	0.36	0.48	0.16	0.000	0.630	1.000	n.a.
Piped into dwelling	48	0.06	0.09	0.19	0.27	0.54	0.13	0.000	0.688	1.000	n.a.
Public tap/standpipe	44	0.04	0.08	0.18	0.25	0.59	0.12	0.000	0.727	1.000	n.a.
Spring	22	0.03	0.04	0.13	0.18	0.69	0.10	0.000	0.818	1.000	n.a.
Other	16	0.04	0.07	0.12	0.22	0.27	0.09	0.000	0.813	1.000	n.a.

Figure 10b: Barium levels by water source



Map 10a: **Barium in shallow tubewells (< 150 m)**



Map 10b: **Barium in deep tubewells (> 150 m)**

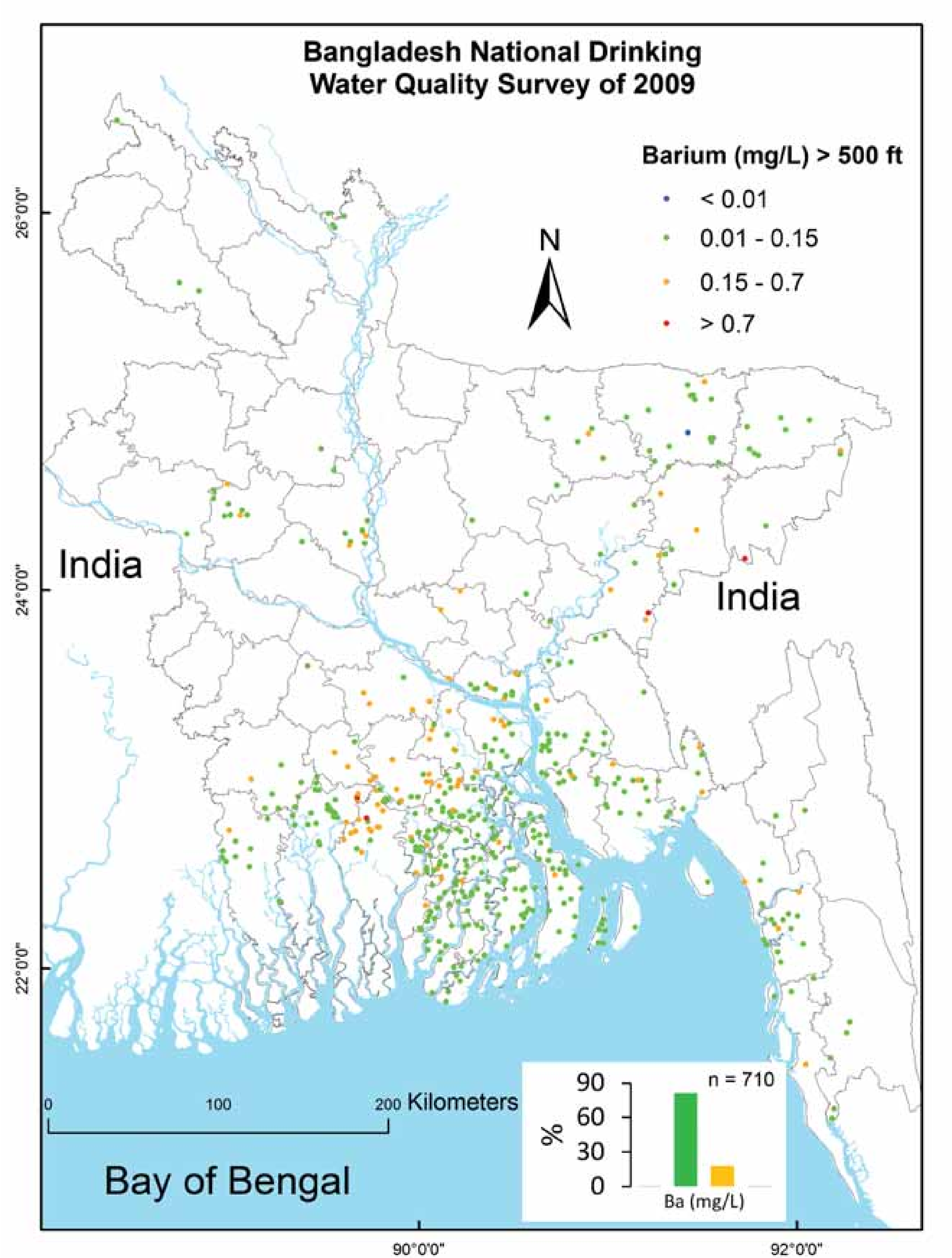


Table 10b: Geographic distribution of barium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.03	0.04	0.06	0.10	0.18	0.05	0.000	0.971	1.000	n.a.
Barisal	65	0.04	0.06	0.10	0.19	0.32	0.09	0.000	0.831	1.000	n.a.
Bhola	36	0.07	0.09	0.12	0.14	0.18	0.10	0.000	0.917	1.000	n.a.
Jhalokati	26	0.03	0.05	0.10	0.15	0.24	0.07	0.039	0.846	1.000	n.a.
Patuakhali	46	0.04	0.04	0.06	0.08	0.11	0.05	0.000	1.000	1.000	n.a.
Pirojpur	40	0.04	0.07	0.13	0.18	0.27	0.09	0.000	0.800	1.000	n.a.
Barisal Division	*248*	*0.04*	*0.06*	*0.10*	*0.15*	*0.32*	*0.08*	*0.004*	*0.891*	*1.000*	*n.a.*
Bandarban	44	0.03	0.07	0.17	0.29	0.69	0.13	0.000	0.705	1.000	n.a.
Brahamanbaria	52	0.09	0.23	0.44	0.58	0.98	0.28	0.000	0.346	0.942	n.a.
Chandpur	47	0.05	0.08	0.10	0.15	0.24	0.08	0.000	0.872	1.000	n.a.
Chittagong	92	0.03	0.05	0.08	0.14	0.68	0.08	0.000	0.902	1.000	n.a.
Comilla	86	0.04	0.06	0.08	0.14	0.43	0.08	0.012	0.907	1.000	n.a.
Cox's Bazar	38	0.02	0.03	0.04	0.12	0.28	0.05	0.000	0.921	1.000	n.a.
Feni	38	0.05	0.08	0.11	0.18	0.37	0.10	0.000	0.868	1.000	n.a.
Khagrachhari	47	0.04	0.08	0.18	0.28	0.89	0.14	0.000	0.702	0.979	n.a.
Lakshmipur	32	0.06	0.08	0.12	0.17	0.31	0.10	0.000	0.844	1.000	n.a.
Noakhali	51	0.04	0.06	0.09	0.14	0.25	0.07	0.000	0.902	1.000	n.a.
Rangamati	56	0.03	0.04	0.07	0.19	1.10	0.09	0.000	0.893	0.982	n.a.
Chittagong Division	*583*	*0.04*	*0.06*	*0.11*	*0.23*	*1.10*	*0.11*	*0.002*	*0.815*	*0.991*	*n.a.*
Dhaka	74	0.14	0.23	0.36	0.48	0.66	0.27	0.000	0.257	1.000	n.a.
Faridpur	48	0.12	0.18	0.22	0.28	0.43	0.18	0.000	0.333	1.000	n.a.
Gazipur	33	0.11	0.18	0.37	0.62	0.90	0.26	0.000	0.333	0.939	n.a.
Gopalganj	31	0.14	0.22	0.27	0.31	0.64	0.22	0.000	0.323	1.000	n.a.
Jamalpur	39	0.07	0.12	0.24	0.38	0.71	0.18	0.000	0.590	0.974	n.a.
Kishoreganj	75	0.06	0.08	0.13	0.20	0.56	0.11	0.000	0.787	1.000	n.a.
Madaripur	22	0.14	0.20	0.24	0.29	0.47	0.20	0.000	0.273	1.000	n.a.
Manikganj	40	0.10	0.13	0.19	0.22	0.43	0.16	0.000	0.550	1.000	n.a.
Munshiganj	36	0.07	0.10	0.16	0.36	1.50	0.19	0.000	0.722	0.944	n.a.
Mymensingh	71	0.04	0.07	0.10	0.18	0.70	0.10	0.000	0.817	1.000	n.a.
Narayanganj	31	0.06	0.09	0.16	0.54	0.86	0.17	0.000	0.710	0.968	n.a.
Narsingdi	33	0.05	0.07	0.11	0.18	0.52	0.11	0.000	0.849	1.000	n.a.
Netrakona	53	0.05	0.09	0.14	0.18	0.32	0.10	0.000	0.774	1.000	n.a.
Rajbari	27	0.06	0.12	0.22	0.27	0.30	0.14	0.000	0.667	1.000	n.a.
Shariatpur	36	0.11	0.15	0.19	0.21	0.33	0.15	0.000	0.500	1.000	n.a.
Sherpur	31	0.07	0.10	0.24	0.34	0.50	0.15	0.000	0.677	1.000	n.a.
Tangail	73	0.06	0.08	0.14	0.20	0.46	0.11	0.000	0.753	1.000	n.a.
Dhaka Division	*753*	*0.07*	*0.12*	*0.20*	*0.32*	*1.50*	*0.16*	*0.000*	*0.602*	*0.992*	*n.a.*

Table 10b: Geographic distribution of barium, continued

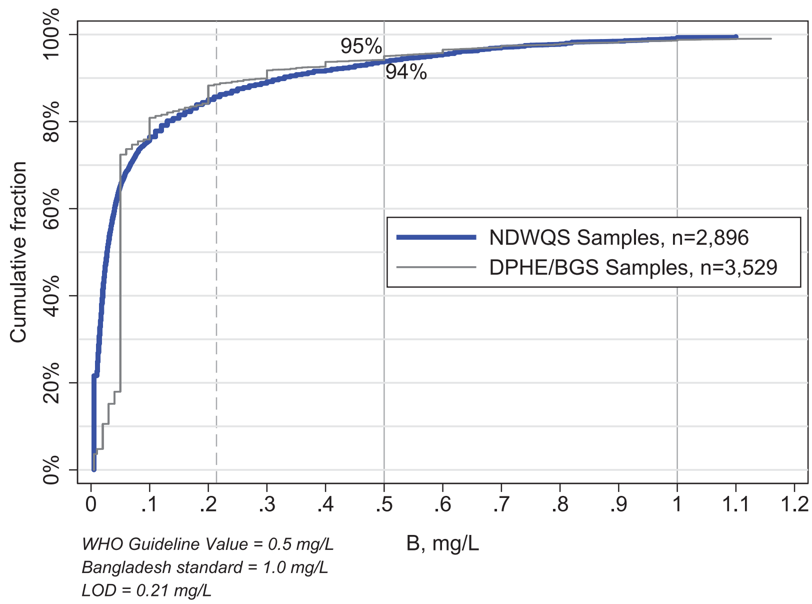
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.07	0.17	0.22	0.33	0.78	0.18	0.000	0.426	0.982	n.a.
Chuadanga	23	0.08	0.17	0.29	0.33	0.39	0.18	0.000	0.391	1.000	n.a.
Jessore	43	0.08	0.14	0.25	0.30	0.58	0.17	0.000	0.512	1.000	n.a.
Jhenaidah	36	0.09	0.13	0.17	0.29	0.84	0.16	0.000	0.667	0.972	n.a.
Khulna	64	0.06	0.10	0.16	0.31	0.74	0.16	0.000	0.672	0.984	n.a.
Kushtia	35	0.09	0.13	0.20	0.26	0.44	0.15	0.000	0.514	1.000	n.a.
Magura	27	0.08	0.11	0.18	0.23	0.43	0.14	0.000	0.630	1.000	n.a.
Meherpur	22	0.16	0.29	0.35	0.46	0.58	0.27	0.000	0.182	1.000	n.a.
Narail	21	0.10	0.14	0.24	0.31	0.57	0.19	0.000	0.524	1.000	n.a.
Satkhira	39	0.06	0.12	0.21	0.39	0.46	0.16	0.000	0.590	1.000	n.a.
Khulna Division	*364*	*0.08*	*0.13*	*0.22*	*0.33*	*0.84*	*0.17*	*0.000*	*0.533*	*0.992*	*n.a.*
Bogra	72	0.05	0.06	0.09	0.15	0.40	0.08	0.000	0.875	1.000	n.a.
Dinajpur	82	0.04	0.07	0.09	0.15	0.38	0.08	0.000	0.890	1.000	n.a.
Gaibandha	40	0.07	0.10	0.16	0.68	1.30	0.20	0.000	0.750	0.925	n.a.
Joypurhat	31	0.05	0.06	0.07	0.08	0.12	0.06	0.000	1.000	1.000	n.a.
Kurigram	45	0.07	0.10	0.13	0.22	0.24	0.11	0.000	0.822	1.000	n.a.
Lalmonirhat	33	0.04	0.05	0.10	0.24	0.46	0.10	0.000	0.788	1.000	n.a.
Naogaon	57	0.06	0.09	0.14	0.21	0.54	0.11	0.000	0.772	1.000	n.a.
Natore	37	0.08	0.10	0.14	0.30	0.45	0.13	0.000	0.784	1.000	n.a.
Nawabganj	32	0.09	0.12	0.17	0.32	0.40	0.15	0.000	0.656	1.000	n.a.
Nilphamari	34	0.03	0.05	0.07	0.18	0.26	0.07	0.000	0.853	1.000	n.a.
Pabna	46	0.06	0.08	0.14	0.21	0.75	0.12	0.000	0.761	0.978	n.a.
Panchagarh	32	0.03	0.05	0.07	0.08	0.26	0.06	0.000	0.938	1.000	n.a.
Rajshahi	66	0.06	0.08	0.14	0.23	0.44	0.11	0.000	0.788	1.000	n.a.
Rangpur	49	0.05	0.06	0.11	0.19	0.97	0.11	0.000	0.816	0.959	n.a.
Sirajganj	42	0.09	0.12	0.15	0.17	0.28	0.12	0.000	0.691	1.000	n.a.
Thakurgaon	33	0.04	0.06	0.11	0.26	0.49	0.11	0.000	0.818	1.000	n.a.
Rajshahi Division	*731*	*0.05*	*0.08*	*0.12*	*0.21*	*1.30*	*0.11*	*0.000*	*0.815*	*0.992*	*n.a.*
Habiganj	47	0.07	0.11	0.13	0.19	0.29	0.11	0.000	0.809	1.000	n.a.
Maulvi Bazar	41	0.09	0.11	0.18	0.21	1.20	0.16	0.000	0.659	0.951	n.a.
Sunamganj	65	0.07	0.09	0.12	0.16	0.38	0.10	0.000	0.846	1.000	n.a.
Sylhet	64	0.04	0.07	0.11	0.16	0.29	0.08	0.000	0.891	1.000	n.a.
Sylhet Division	*217*	*0.06*	*0.09*	*0.13*	*0.18*	*1.20*	*0.11*	*0.000*	*0.816*	*0.991*	*n.a.*
Grand Total	***2896***	***0.05***	***0.09***	***0.15***	***0.26***	***1.50***	***0.13***	***0.001***	***0.731***	***0.992***	***n.a.***

BORON (B)

The Bangladesh standard for boron is 1.0 mg/L. The WHO guideline value is 0.5 mg/L, based on studies which have shown that oral exposure to boron can cause testicular lesions in rats, mice and dogs. The guideline is designated as provisional because it will be difficult to achieve in areas with high natural boron levels with the treatment technology available.

The boron guideline value is currently under consideration by WHO. A draft revision (ref WHO/HSE/WSH/09.04/54) would increase the provisional guideline value to 2.4 mg/L.

Figure 11: **Boron distribution, with 94% samples meeting the Bangladesh standard of 1.0 mg/L.**



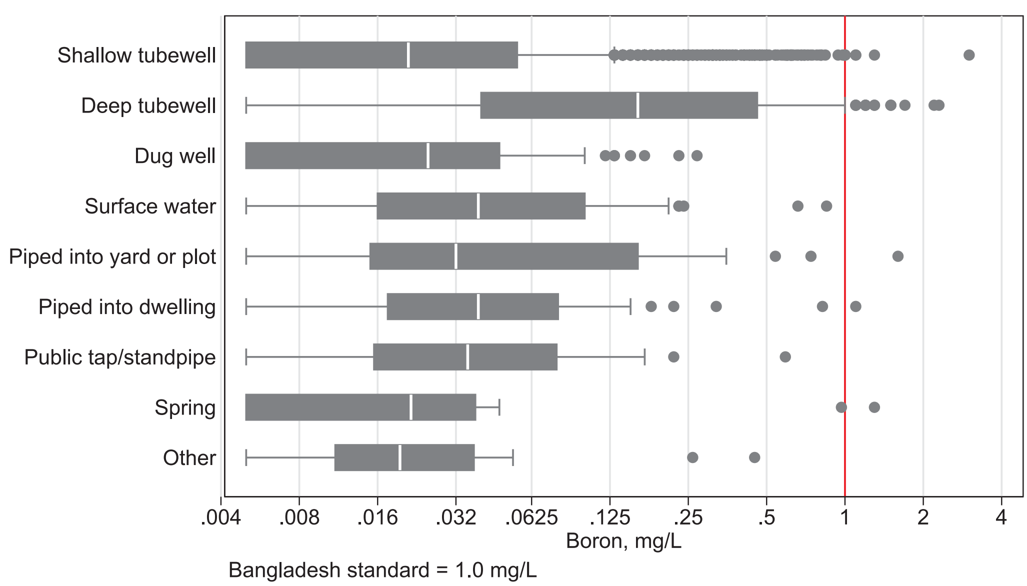
The NDWQS and DPHE/BGS distributions are not significantly different (p=0.058).

Barisal Division, and in particular Barguna District, has the widest prevalence of elevated boron, though individual samples in several districts (Pirojpur, Gopalganj, Comilla) had higher concentrations, in one case above the proposed new WHO guideline value.

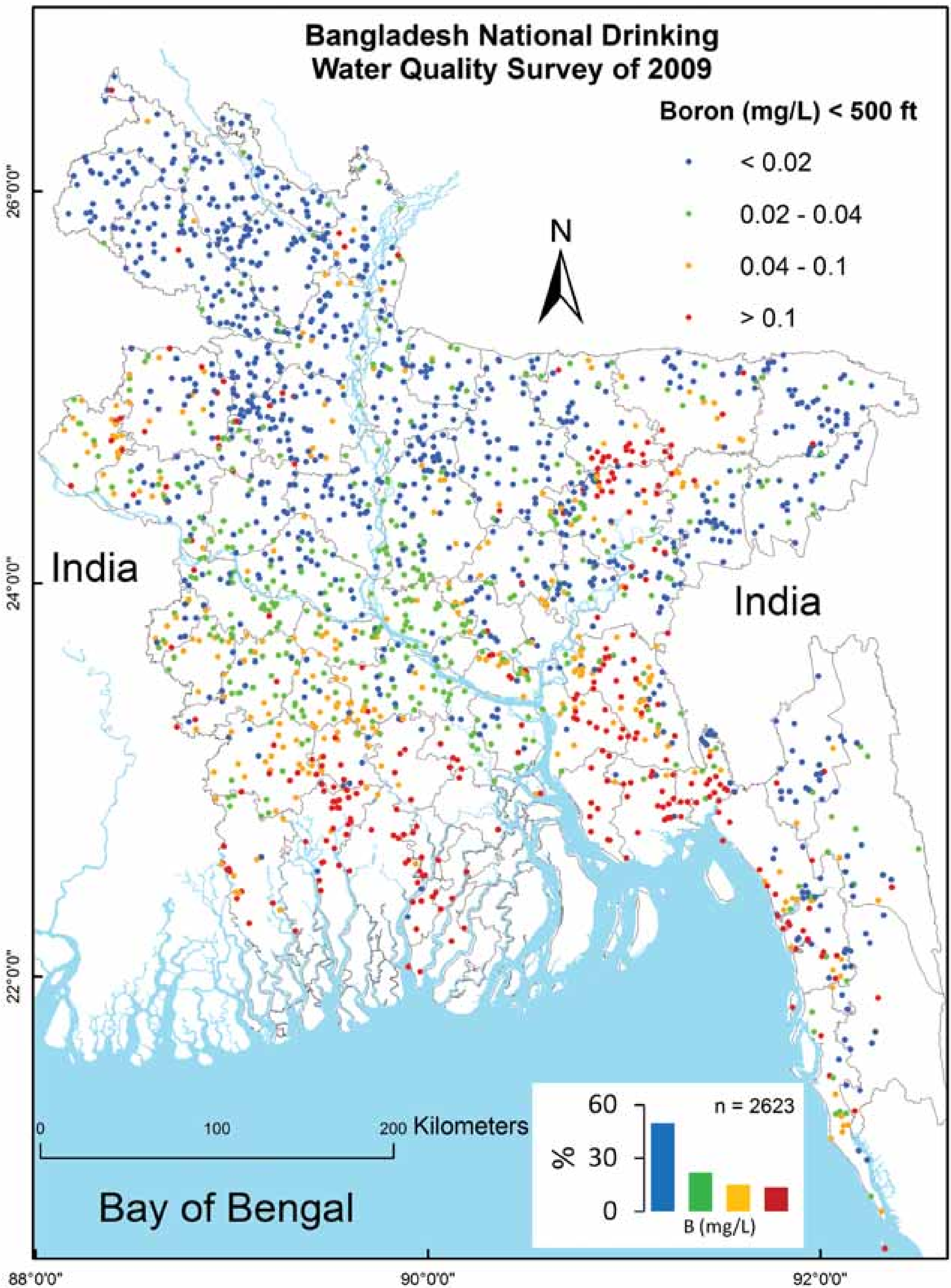
Table 11a: Boron levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.01	0.02	0.06	0.17	3.00	0.07	0.264	0.919	0.975	0.998
Deep tubewell	526	0.04	0.16	0.46	0.74	2.30	0.28	0.049	0.576	0.780	0.975
Dug well	59	0.01	0.03	0.05	0.13	0.27	0.04	0.356	0.966	1.000	1.000
Surface water	67	0.02	0.04	0.10	0.20	0.85	0.08	0.119	0.925	0.970	1.000
Piped into yard or plot	54	0.02	0.03	0.16	0.32	1.60	0.12	0.148	0.852	0.944	0.982
Piped into dwelling	48	0.02	0.04	0.08	0.18	1.10	0.09	0.104	0.917	0.958	0.979
Public tap/standpipe	44	0.02	0.04	0.08	0.12	0.59	0.06	0.182	0.955	0.977	1.000
Spring	22	0.01	0.02	0.04	0.05	1.30	0.12	0.273	0.909	0.909	0.955
Other	16	0.01	0.02	0.04	0.26	0.45	0.06	0.188	0.875	1.000	1.000

Figure 11b: Boron levels by water source



Map 11a: **Boron in shallow tubewells (< 150 m)**



Map 11b: **Boron in deep tube wells (> 150 m)**

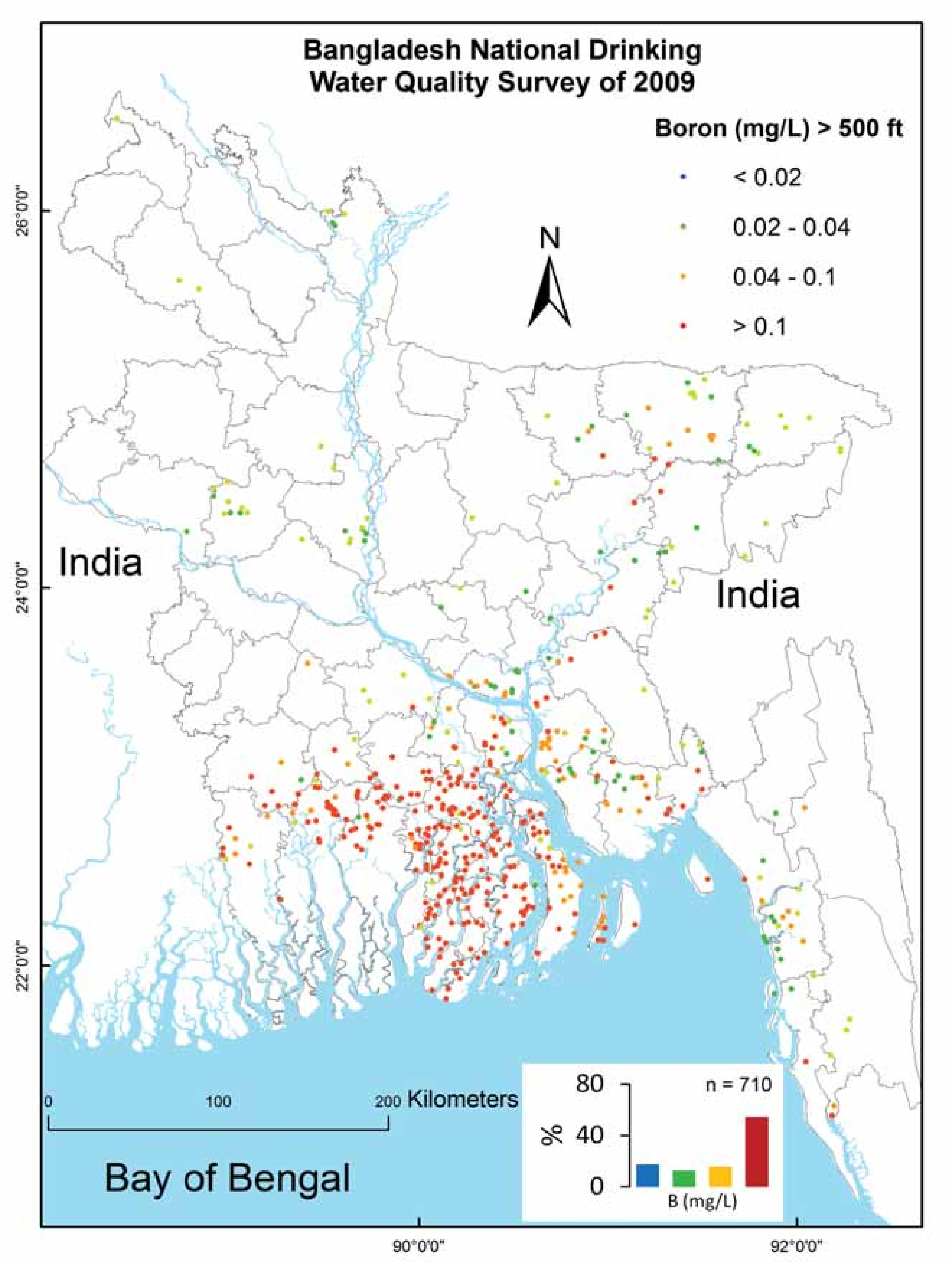


Table 11b: Geographic distribution of boron

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.580	0.730	0.870	0.980	1.500	0.727	0.000	0.029	0.057	0.971
Barisal	65	0.220	0.450	0.620	0.700	1.300	0.426	0.000	0.077	0.615	0.969
Bhola	36	0.100	0.120	0.240	0.300	0.380	0.168	0.000	0.139	1.000	1.000
Jhalokati	26	0.480	0.660	0.820	0.930	0.990	0.658	0.000	0.000	0.346	1.000
Patuakhali	46	0.240	0.380	0.580	0.890	1.100	0.453	0.000	0.022	0.609	0.978
Pirojpur	40	0.125	0.465	0.865	1.200	2.200	0.580	0.000	0.100	0.550	0.825
Barisal Division	*248*	*0.210*	*0.470*	*0.680*	*0.920*	*2.200*	*0.485*	*0.000*	*0.065*	*0.552*	*0.956*
Bandarban	44	0.005	0.018	0.045	0.200	1.300	0.102	0.341	0.818	0.932	0.977
Brahamanbaria	52	0.012	0.022	0.041	0.140	0.430	0.057	0.173	0.827	1.000	1.000
Chandpur	47	0.047	0.064	0.150	0.330	0.660	0.126	0.000	0.575	0.979	1.000
Chittagong	92	0.015	0.051	0.140	0.430	1.600	0.153	0.152	0.641	0.913	0.978
Comilla	86	0.026	0.067	0.120	0.240	3.000	0.124	0.058	0.628	0.988	0.988
Cox's Bazar	38	0.030	0.047	0.100	0.210	1.100	0.130	0.026	0.632	0.921	0.974
Feni	38	0.012	0.036	0.130	0.330	0.700	0.102	0.132	0.658	0.974	1.000
Khagrachhari	47	0.005	0.005	0.019	0.047	0.150	0.019	0.511	0.957	1.000	1.000
Lakshmipur	32	0.039	0.120	0.320	0.630	0.990	0.224	0.000	0.469	0.844	1.000
Noakhali	51	0.059	0.200	0.440	0.620	1.000	0.273	0.000	0.353	0.824	1.000
Rangamati	56	0.013	0.023	0.040	0.071	0.210	0.032	0.214	0.946	1.000	1.000
Chittagong Division	*583*	*0.016*	*0.042*	*0.120*	*0.320*	*3.000*	*0.121*	*0.146*	*0.684*	*0.947*	*0.991*
Dhaka	74	0.013	0.019	0.033	0.056	0.160	0.029	0.122	0.960	1.000	1.000
Faridpur	48	0.021	0.033	0.053	0.085	0.150	0.041	0.021	0.896	1.000	1.000
Gazipur	33	0.005	0.017	0.037	0.075	0.110	0.027	0.333	0.939	1.000	1.000
Gopalganj	31	0.071	0.220	0.460	0.590	2.300	0.335	0.000	0.323	0.807	0.936
Jamalpur	39	0.005	0.011	0.019	0.027	0.056	0.014	0.462	1.000	1.000	1.000
Kishoreganj	75	0.015	0.027	0.130	0.400	1.000	0.120	0.120	0.680	0.973	1.000
Madaripur	22	0.030	0.045	0.290	0.450	0.570	0.162	0.000	0.591	0.955	1.000
Manikganj	40	0.023	0.027	0.033	0.039	0.077	0.030	0.000	1.000	1.000	1.000
Munshiganj	36	0.039	0.049	0.100	0.150	0.480	0.083	0.000	0.667	1.000	1.000
Mymensingh	71	0.005	0.011	0.018	0.024	0.170	0.015	0.465	0.986	1.000	1.000
Narayanganj	31	0.037	0.049	0.120	0.170	0.210	0.078	0.000	0.710	1.000	1.000
Narsingdi	33	0.005	0.015	0.025	0.053	0.087	0.022	0.273	0.970	1.000	1.000
Netrakona	53	0.014	0.033	0.220	0.500	0.810	0.158	0.132	0.660	0.906	1.000
Rajbari	27	0.020	0.032	0.047	0.069	0.086	0.037	0.000	0.963	1.000	1.000
Shariatpur	36	0.025	0.094	0.295	0.450	1.100	0.190	0.028	0.500	0.917	0.972
Sherpur	31	0.005	0.015	0.023	0.033	0.048	0.017	0.290	1.000	1.000	1.000
Tangail	73	0.011	0.018	0.025	0.033	0.068	0.019	0.233	1.000	1.000	1.000
Dhaka Division	*753*	*0.013*	*0.024*	*0.049*	*0.180*	*2.300*	*0.073*	*0.165*	*0.835*	*0.977*	*0.996*

Table 11b: Geographic distribution of boron, continued

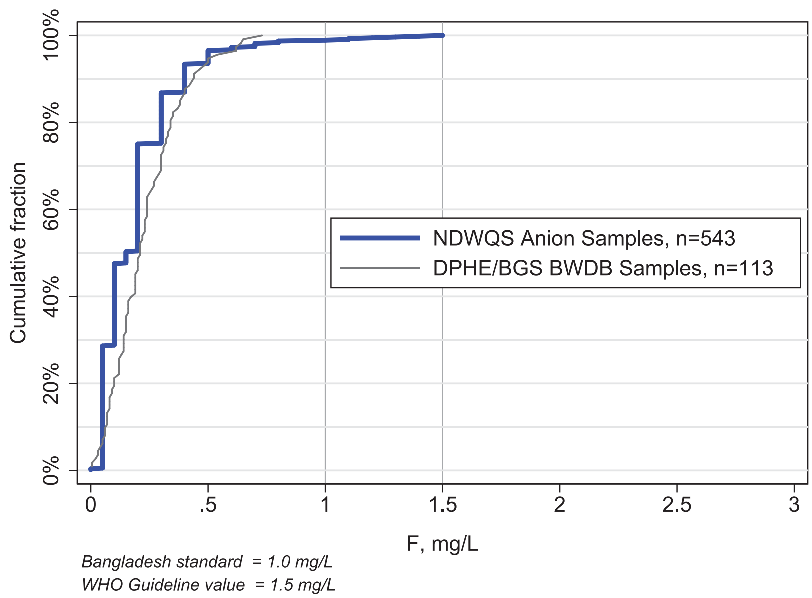
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.061	0.180	0.270	0.360	0.540	0.191	0.019	0.296	0.944	1.000
Chuadanga	23	0.022	0.029	0.054	0.071	0.097	0.038	0.000	0.957	1.000	1.000
Jessore	43	0.045	0.068	0.120	0.170	0.530	0.098	0.000	0.628	0.977	1.000
Jhenaidah	36	0.019	0.032	0.062	0.130	0.420	0.057	0.028	0.833	1.000	1.000
Khulna	64	0.130	0.190	0.275	0.470	1.100	0.254	0.000	0.063	0.906	0.984
Kushtia	35	0.020	0.024	0.028	0.034	0.270	0.039	0.029	0.943	1.000	1.000
Magura	27	0.031	0.040	0.059	0.089	0.100	0.047	0.000	0.889	1.000	1.000
Meherpur	22	0.028	0.063	0.110	0.190	0.220	0.078	0.000	0.682	1.000	1.000
Narail	21	0.073	0.110	0.150	0.220	0.680	0.140	0.000	0.333	0.952	1.000
Satkhira	39	0.048	0.094	0.240	0.440	0.620	0.163	0.000	0.462	0.923	1.000
Khulna Division	*364*	*0.032*	*0.074*	*0.180*	*0.300*	*1.100*	*0.130*	*0.008*	*0.539*	*0.962*	*0.997*
Bogra	72	0.005	0.005	0.022	0.060	0.600	0.031	0.514	0.931	0.986	1.000
Dinajpur	82	0.005	0.005	0.013	0.023	0.320	0.014	0.720	0.988	1.000	1.000
Gaibandha	40	0.005	0.013	0.021	0.047	0.099	0.020	0.425	0.950	1.000	1.000
Joypurhat	31	0.005	0.005	0.005	0.011	0.017	0.007	0.774	1.000	1.000	1.000
Kurigram	45	0.005	0.012	0.026	0.098	0.130	0.027	0.356	0.889	1.000	1.000
Lalmonirhat	33	0.005	0.005	0.005	0.014	0.031	0.007	0.879	1.000	1.000	1.000
Naogaon	57	0.005	0.020	0.058	0.110	0.550	0.047	0.351	0.877	0.983	1.000
Natore	37	0.014	0.018	0.022	0.030	0.043	0.019	0.054	1.000	1.000	1.000
Nawabganj	32	0.040	0.060	0.094	0.120	0.220	0.071	0.000	0.656	1.000	1.000
Nilphamari	34	0.005	0.005	0.005	0.041	0.068	0.012	0.794	1.000	1.000	1.000
Pabna	46	0.015	0.020	0.029	0.036	0.055	0.023	0.044	1.000	1.000	1.000
Panchagarh	32	0.005	0.005	0.021	0.073	0.360	0.037	0.594	0.906	1.000	1.000
Rajshahi	66	0.019	0.023	0.033	0.054	0.620	0.040	0.000	0.924	0.985	1.000
Rangpur	49	0.005	0.005	0.012	0.019	0.230	0.014	0.653	0.980	1.000	1.000
Sirajganj	42	0.005	0.014	0.020	0.026	0.036	0.015	0.381	1.000	1.000	1.000
Thakurgaon	33	0.005	0.005	0.011	0.024	0.040	0.010	0.697	1.000	1.000	1.000
Rajshahi Division	*731*	*0.005*	*0.012*	*0.024*	*0.050*	*0.620*	*0.025*	*0.442*	*0.945*	*0.996*	*1.000*
Habiganj	47	0.005	0.014	0.039	0.063	0.330	0.036	0.298	0.915	1.000	1.000
Maulvi Bazar	41	0.005	0.005	0.014	0.025	0.057	0.012	0.585	1.000	1.000	1.000
Sunamganj	65	0.011	0.024	0.050	0.120	0.540	0.059	0.200	0.892	0.969	1.000
Sylhet	64	0.005	0.005	0.015	0.027	0.200	0.014	0.656	0.969	1.000	1.000
Sylhet Division	217	0.005	0.012	0.026	0.056	0.540	0.032	0.429	0.940	0.991	1.000
Grand Total	***2896***	***0.012***	***0.027***	***0.094***	***0.330***	***3.000***	***0.110***	***0.217***	***0.737***	***0.939***	***0.993***

FLUORIDE (F)

The Bangladesh standard for fluoride is 1.0 mg/L. The WHO guideline value is 1.5 mg/L.

Fluoride is absorbed by bone tissue in the body. Excess fluoride intake can lead to discolouration and mottling of teeth (dental fluorosis). At higher doses, skeletal fluorosis can occur.

Figure 12: **Fluoride distribution, with 99% samples meeting Bangladesh drinking water standard of 1.0 mg/L.**



Only low levels of fluoride were found throughout the country. Six samples (1%) exceeded the Bangladesh standard, and ranged from 1.1 to 1.5 mg/L. The fluoride distribution matches the distribution from the earlier BWDB survey well. Since the fluoride survey was decoupled from the MICS survey, no disaggregation of the data by water source is possible.

Map 12: **Fluoride in household drinking water (lab data only)**

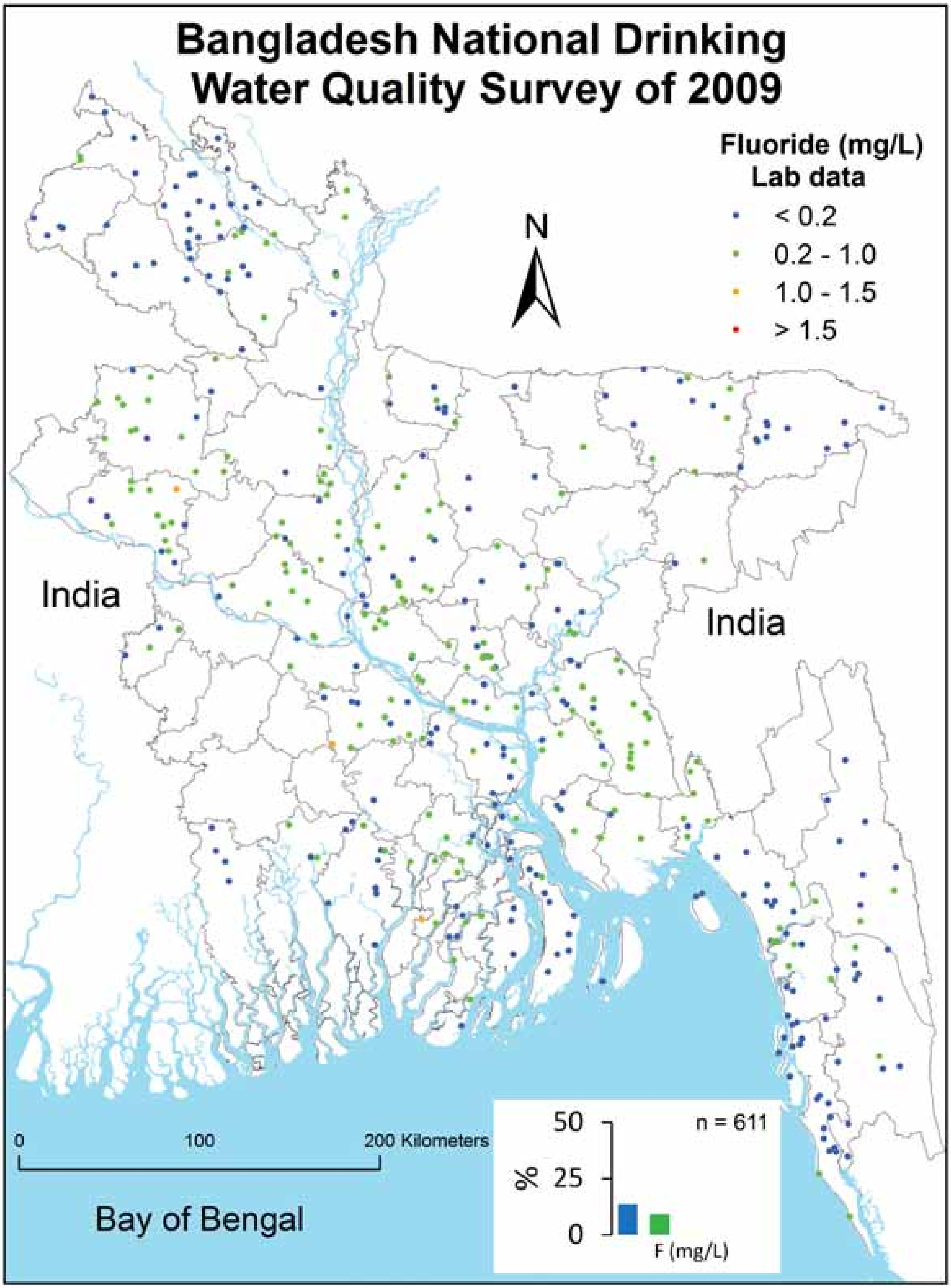


Table 12: Geographic distribution of fluoride

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 1.5 mg/L	Below 1.0 mg/L
Barguna	0	0.00	0.00	0.00	0.00	0.0	0.00	0.000	1.000	1.000	1.000
Barisal	11	0.10	0.20	0.20	0.20	0.3	0.17	0.091	1.000	1.000	1.000
Bhola	7	0.05	0.10	0.10	0.20	0.2	0.09	0.429	1.000	1.000	1.000
Jhalokati	6	0.20	0.30	0.40	1.20	1.2	0.43	0.000	0.667	1.000	0.833
Patuakhali	7	0.05	0.10	0.20	0.20	0.2	0.11	0.429	1.000	1.000	1.000
Pirojpur	4	0.13	0.25	0.35	0.40	0.4	0.24	0.250	0.750	1.000	1.000
Barisal Division	*35*	*0.08*	*0.20*	*0.20*	*0.30*	*1.2*	*0.19*	*0.229*	*0.917*	*1.000*	*0.972*
Bandarban	15	0.05	0.05	0.10	0.20	0.2	0.08	0.667	1.000	1.000	1.000
Brahamanbaria	8	0.13	0.20	0.20	0.30	0.3	0.18	0.250	1.000	1.000	1.000
Chandpur	9	0.10	0.10	0.20	0.70	0.7	0.19	0.222	0.889	1.000	1.000
Chittagong	16	0.05	0.08	0.15	0.30	0.3	0.11	0.500	1.000	1.000	1.000
Comilla	18	0.10	0.20	0.20	0.40	0.5	0.19	0.222	0.889	1.000	1.000
Cox's Bazar	8	0.08	0.10	0.15	0.30	0.3	0.13	0.250	1.000	1.000	1.000
Feni	9	0.05	0.20	0.20	0.50	0.5	0.21	0.333	0.778	1.000	1.000
Khagrachhari	0	0.00	0.00	0.00	0.00	0.0	0.00	0.000	1.000	1.000	1.000
Lakshmipur	5	0.10	0.10	0.20	0.20	0.2	0.14	0.000	1.000	1.000	1.000
Noakhali	10	0.10	0.30	0.30	0.35	0.4	0.24	0.100	0.900	1.000	1.000
Rangamati	10	0.05	0.05	0.10	0.15	0.2	0.08	0.700	1.000	1.000	1.000
Chittagong Division	*108*	*0.05*	*0.10*	*0.20*	*0.30*	*0.7*	*0.15*	*0.361*	*0.945*	*1.000*	*1.000*
Dhaka	16	0.10	0.20	0.20	0.30	0.3	0.18	0.000	1.000	1.000	1.000
Faridpur	11	0.10	0.20	0.30	0.30	1.1	0.27	0.091	0.909	1.000	0.909
Gazipur	5	0.05	0.30	0.30	0.40	0.4	0.22	0.400	0.800	1.000	1.000
Gopalganj	7	0.05	0.10	0.20	0.20	0.2	0.12	0.429	1.000	1.000	1.000
Jamalpur	10	0.10	0.15	0.30	0.35	0.4	0.19	0.100	0.900	1.000	1.000
Kishoreganj	10	0.05	0.18	0.20	0.30	0.3	0.16	0.400	1.000	1.000	1.000
Madaripur	6	0.05	0.10	0.10	0.20	0.2	0.10	0.333	1.000	1.000	1.000
Manikganj	9	0.20	0.30	0.30	0.40	0.4	0.25	0.111	0.778	1.000	1.000
Munshiganj	6	0.20	0.20	0.30	0.40	0.4	0.25	0.000	0.833	1.000	1.000
Mymensingh	12	0.05	0.20	0.25	0.40	0.4	0.18	0.333	0.833	1.000	1.000
Narayanganj	6	0.30	0.40	1.30	1.40	1.4	0.67	0.000	0.333	1.000	0.667
Narsingdi	6	0.05	0.25	0.30	0.40	0.4	0.22	0.333	0.833	1.000	1.000
Netrakona	5	0.20	0.30	0.40	0.50	0.5	0.32	0.000	0.600	1.000	1.000
Rajbari	5	0.10	0.10	0.30	0.40	0.4	0.19	0.200	0.800	1.000	1.000
Shariatpur	8	0.05	0.05	0.10	0.20	0.2	0.08	0.625	1.000	1.000	1.000
Sherpur	6	0.10	0.10	0.20	0.20	0.2	0.13	0.167	1.000	1.000	1.000
Tangail	11	0.15	0.20	0.30	0.40	0.4	0.22	0.273	0.818	1.000	1.000
Dhaka Division	*139*	*0.10*	*0.20*	*0.30*	*0.40*	*1.4*	*0.21*	*0.216*	*0.871*	*1.000*	*0.978*

Table 12: Geographic distribution of fluoride, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 1.5 mg/L	Below 1.0 mg/L
Bagerhat	9	0.05	0.10	0.15	0.20	0.2	0.11	0.556	1.000	1.000	1.000
Chuadanga	7	0.05	0.20	0.50	0.50	0.5	0.24	0.286	0.714	1.000	1.000
Jessore	9	0.05	0.10	0.20	0.40	0.4	0.14	0.444	0.889	1.000	1.000
Jhenaidah	6	0.20	0.20	0.30	0.60	0.6	0.26	0.167	0.833	1.000	1.000
Khulna	15	0.05	0.10	0.10	0.20	0.2	0.09	0.467	1.000	1.000	1.000
Kushtia	7	0.15	0.30	0.40	0.50	0.5	0.28	0.143	0.714	1.000	1.000
Magura	6	0.20	0.20	0.30	0.40	0.4	0.23	0.000	0.833	1.000	1.000
Meherpur	5	0.10	0.20	0.20	0.30	0.3	0.18	0.000	1.000	1.000	1.000
Narail	6	0.05	0.08	0.20	0.20	0.2	0.11	0.500	1.000	1.000	1.000
Satkhira	7	0.05	0.15	0.20	0.20	0.2	0.14	0.429	1.000	1.000	1.000
Khulna Division	*77*	*0.05*	*0.10*	*0.20*	*0.30*	*0.6*	*0.17*	*0.338*	*0.909*	*1.000*	*1.000*
Bogra	12	0.23	0.40	0.55	0.70	0.7	0.39	0.083	0.417	1.000	1.000
Dinajpur	12	0.05	0.10	0.13	0.20	0.3	0.11	0.417	1.000	1.000	1.000
Gaibandha	10	0.10	0.15	0.20	0.25	0.3	0.16	0.100	1.000	1.000	1.000
Joypurhat	5	0.05	0.10	0.20	0.30	0.3	0.14	0.400	1.000	1.000	1.000
Kurigram	9	0.10	0.10	0.20	0.40	0.4	0.15	0.333	0.889	1.000	1.000
Lalmonirhat	7	0.05	0.05	0.10	0.20	0.2	0.08	0.714	1.000	1.000	1.000
Naogaon	10	0.20	0.30	0.40	0.60	0.7	0.35	0.100	0.600	1.000	1.000
Natore	9	0.30	0.40	0.60	0.80	0.8	0.48	0.000	0.333	1.000	1.000
Nawabganj	7	0.05	0.15	0.20	0.20	0.2	0.13	0.571	1.000	1.000	1.000
Nilphamari	8	0.05	0.05	0.08	0.20	0.2	0.08	0.750	1.000	1.000	1.000
Pabna	12	0.40	0.45	0.50	0.50	1.5	0.50	0.083	0.167	1.000	0.917
Panchagarh	7	0.05	0.05	0.20	0.20	0.2	0.10	0.571	1.000	1.000	1.000
Rajshahi	10	0.30	0.55	0.80	1.05	1.1	0.56	0.100	0.400	1.000	0.900
Rangpur	11	0.05	0.10	0.20	0.20	0.2	0.13	0.273	1.000	1.000	1.000
Sirajganj	10	0.20	0.30	0.50	0.50	0.5	0.31	0.100	0.700	1.000	1.000
Thakurgaon	6	0.05	0.05	0.05	0.10	0.1	0.06	0.833	1.000	1.000	1.000
Rajshahi Division	*145*	*0.05*	*0.20*	*0.40*	*0.50*	*1.5*	*0.25*	*0.297*	*0.745*	*1.000*	*0.986*
Habiganj	9	0.20	0.20	0.20	0.30	0.3	0.18	0.111	1.000	1.000	1.000
Maulvi Bazar	2	0.05	0.13	0.20	0.20	0.2	0.13	0.500	1.000	1.000	1.000
Sunamganj	13	0.05	0.10	0.20	0.30	0.4	0.14	0.462	0.923	1.000	1.000
Sylhet	15	0.05	0.05	0.05	0.15	0.2	0.06	1.000	1.000	1.000	1.000
Sylhet Division	39	0.05	0.05	0.20	0.20	0.4	0.12	0.590	0.974	1.000	1.000
Grand Total	***543***	***0.05***	***0.15***	***0.20***	***0.40***	***1.5***	***0.20***	***0.311***	***0.868***	***1.000***	***0.989***

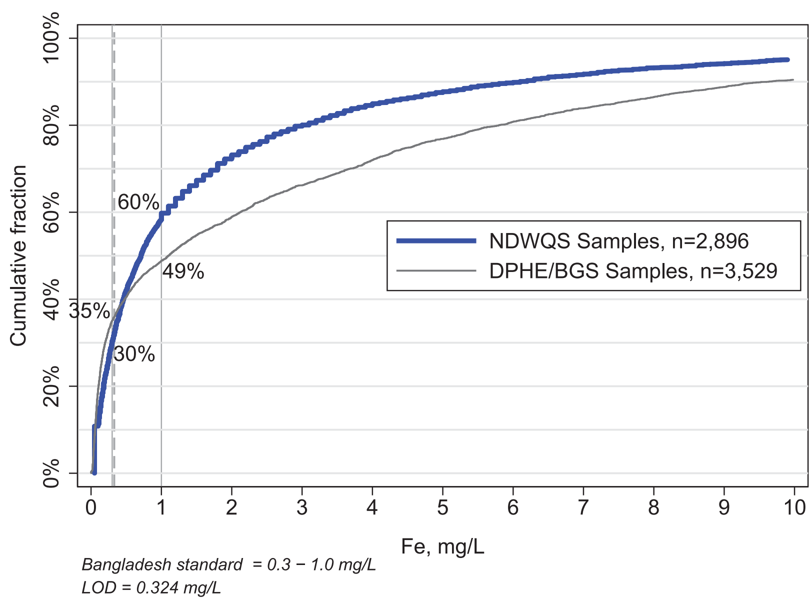
IRON (FE)

The Bangladesh standard for iron in drinking water is 0.3 - 1.0 mg/L. There is no health-based WHO guideline value for iron.

The 1958 WHO International Standards for Drinking-water suggested that concentrations of iron greater than 1.0 mg/litre would markedly impair the potability of the water. The 1963 and 1971 International Standards retained this value as a maximum allowable or permissible concentration. In the first edition of the Guidelines for Drinking-water Quality, published in 1984, a guideline value of 0.3 mg/litre was established, as a compromise between iron's use in water treatment and aesthetic considerations.

No health-based guideline value for iron in drinking-water was proposed in the 1993 Guidelines, but it was mentioned that a value of about 2 mg/litre can be derived from the Provisional Maximum Tolerable Daily Intake established in 1983 as a precaution against storage in the body of excessive iron. Iron stains laundry and plumbing fixtures at levels above 0.3 mg/litre. The 1993 Guidelines suggested that there is usually no noticeable taste at iron concentrations below 0.3 mg/litre, and concentrations of 1–3 mg/litre can be acceptable for people accustomed to drinking anaerobic well water.

Figure 13: **Iron distribution, with 60% of samples meeting Bangladesh standard of 1.0 mg/L.**

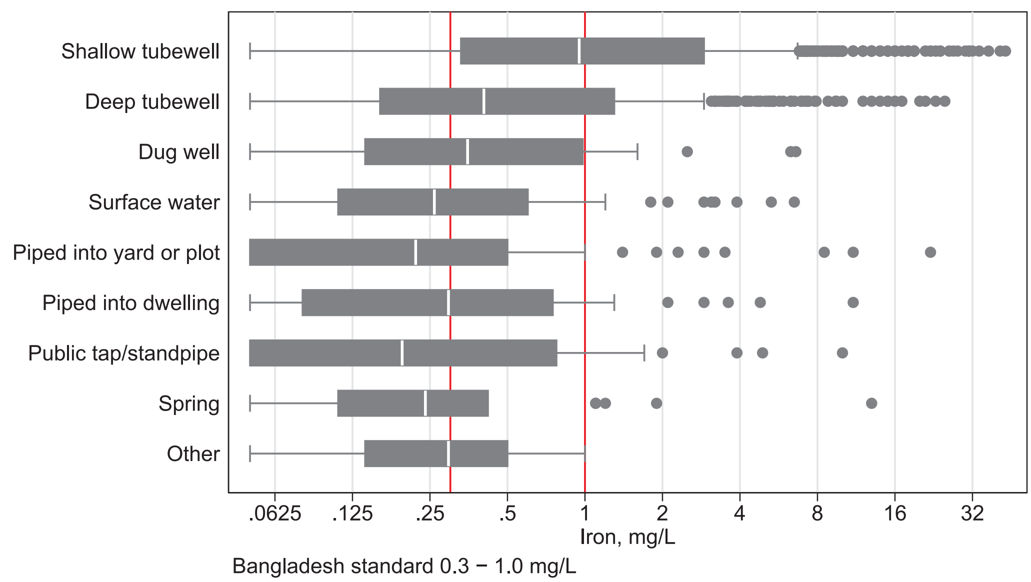


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 54.5% that the DPHE/BGS distribution is greater than the NDWQS distribution. In the high-Fe samples (>0.3 mg/L), the probability that the DPHE/BGS distribution is greater is 64.7%.

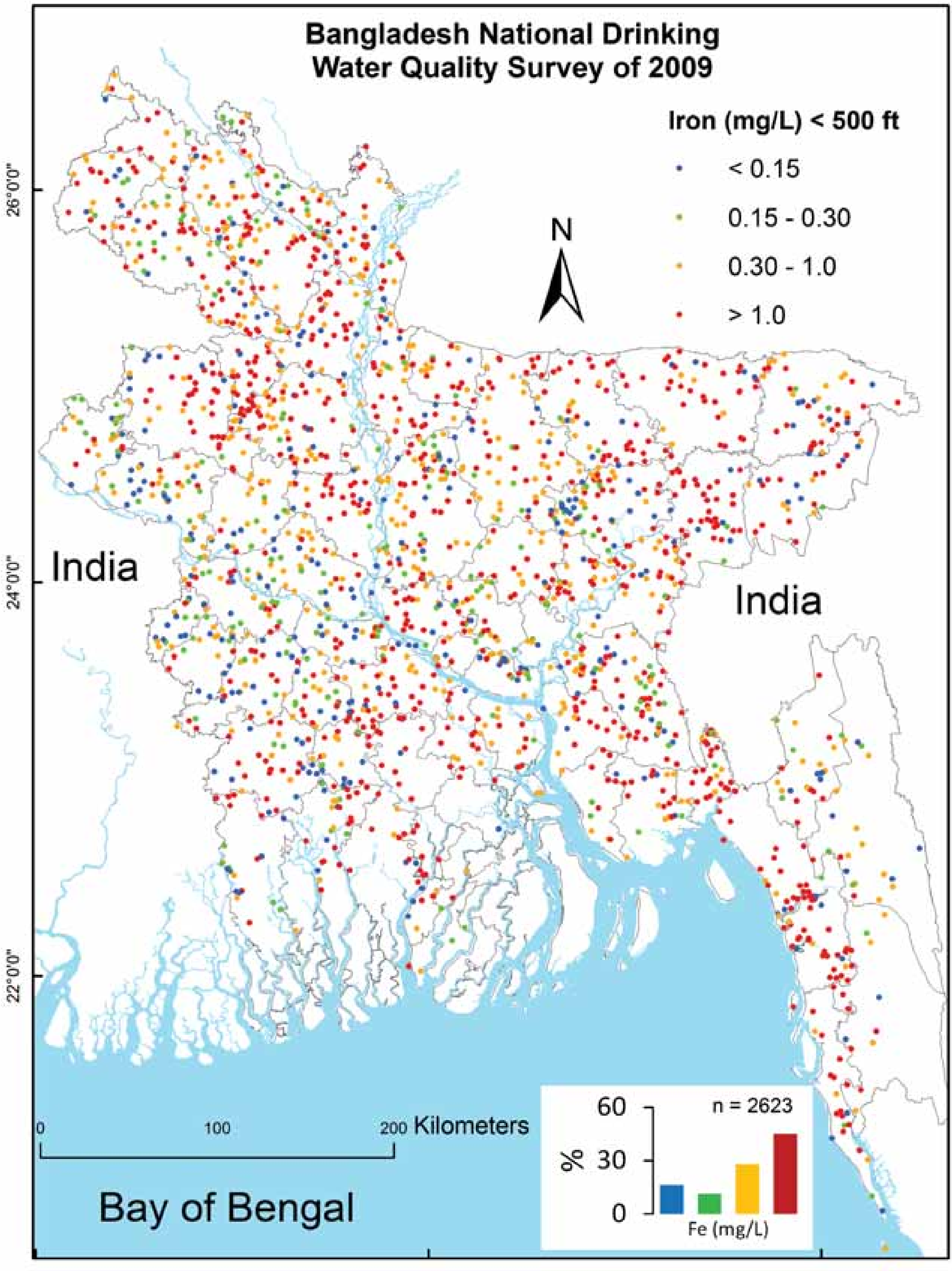
Table 13a: Iron levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below 0.3 mg/L	Below 1.0 mg/L
Shallow tubewell	2060	0.33	0.95	2.90	7.20	43.00	2.65	0.085	0.248	0.237	0.531
Deep tubewell	526	0.16	0.41	1.30	3.50	25.00	1.37	0.124	0.435	0.420	0.719
Dug well	59	0.14	0.35	0.98	1.60	6.60	0.74	0.170	0.458	0.441	0.780
Surface water	67	0.11	0.26	0.60	2.10	6.50	0.69	0.224	0.612	0.582	0.866
Piped into yard or plot	54	0.05	0.22	0.50	2.30	22.00	1.20	0.315	0.593	0.574	0.852
Piped into dwelling	48	0.08	0.30	0.75	2.10	11.00	0.84	0.250	0.563	0.542	0.833
Public tap/standpipe	44	0.05	0.20	0.78	1.70	10.00	0.78	0.318	0.614	0.614	0.841
Spring	22	0.11	0.24	0.42	1.20	13.00	0.98	0.227	0.636	0.636	0.773
Other	16	0.14	0.30	0.50	0.89	1.00	0.35	0.188	0.500	0.500	1.000

Figure 13b: Iron levels by water source



Map 13a: **Iron in shallow tubewells (< 150 m)**



Map 13b: **Iron in deep tubewells (> 150 m)**

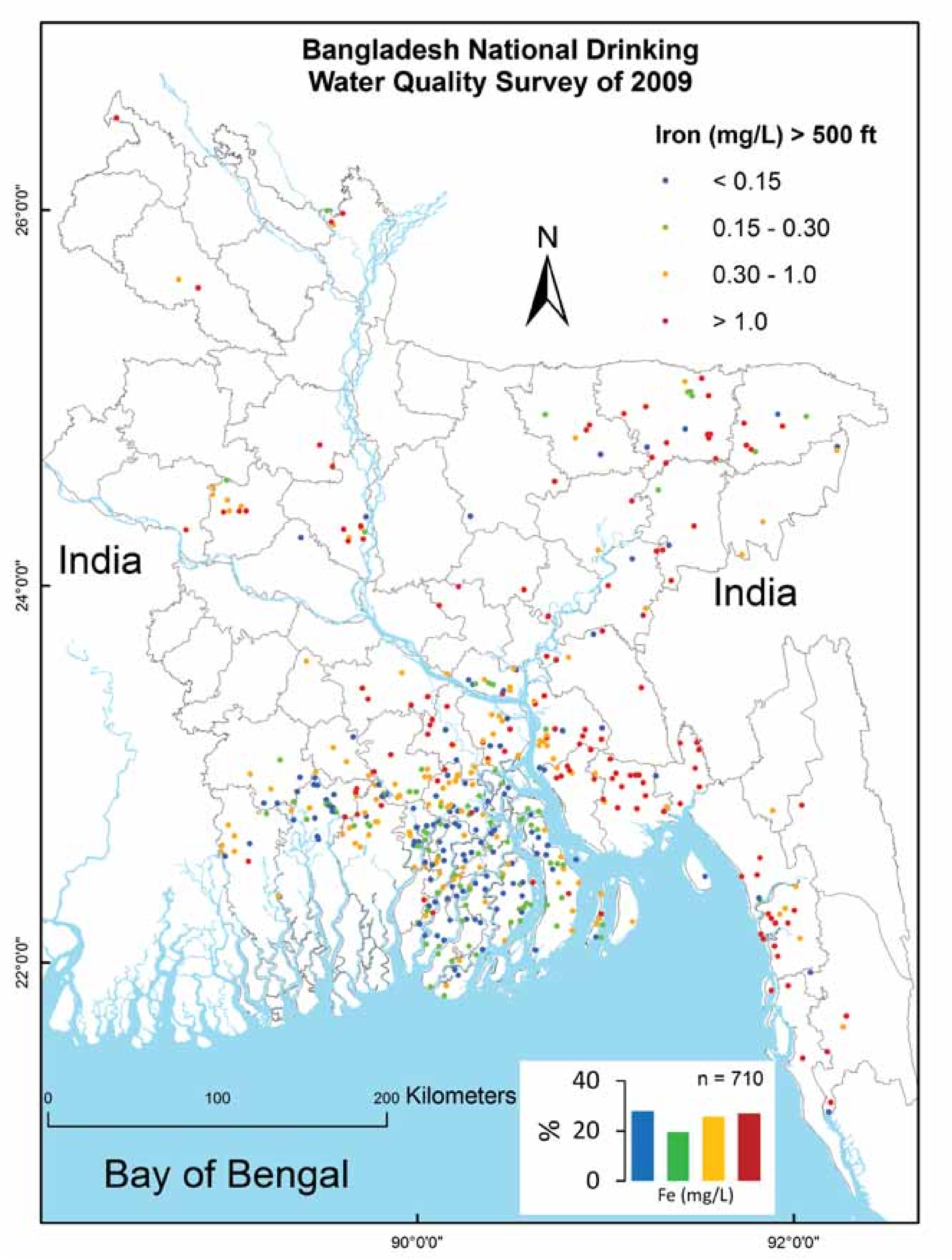


Table 13b: Geographic distribution of iron

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.05	0.18	0.26	0.39	2.2	0.28	0.286	0.857	0.829	0.943
Barisal	65	0.11	0.21	0.35	0.95	4.1	0.41	0.231	0.692	0.615	0.923
Bhola	36	0.18	0.29	0.49	0.78	1.7	0.41	0.083	0.583	0.556	0.917
Jhalokati	26	0.10	0.20	0.52	1.60	8.8	0.88	0.269	0.654	0.654	0.885
Patuakhali	46	0.13	0.17	0.26	0.44	1.5	0.24	0.109	0.804	0.804	0.978
Pirojpur	40	0.05	0.21	1.06	2.65	9.5	0.91	0.300	0.600	0.600	0.750
Barisal Division	*248*	*0.12*	*0.19*	*0.39*	*1.00*	*9.5*	*0.49*	*0.210*	*0.702*	*0.673*	*0.903*
Bandarban	44	0.11	0.37	1.09	4.50	22.0	1.77	0.227	0.477	0.432	0.750
Brahamanbaria	52	0.47	1.25	2.70	4.80	10.0	2.02	0.019	0.154	0.154	0.481
Chandpur	47	0.61	1.00	3.10	5.20	12.0	2.10	0.085	0.128	0.128	0.511
Chittagong	92	0.84	2.45	5.60	9.60	19.0	3.86	0.076	0.141	0.141	0.293
Comilla	86	0.30	1.20	2.90	4.60	43.0	2.49	0.070	0.279	0.256	0.488
Cox's Bazar	38	0.36	1.20	3.90	7.50	9.8	2.53	0.053	0.211	0.211	0.474
Feni	38	1.70	3.15	5.10	11.00	14.0	4.24	0.000	0.053	0.053	0.184
Khagrachhari	47	0.21	0.35	0.64	4.30	12.0	1.32	0.106	0.468	0.362	0.787
Lakshmipur	32	0.75	1.45	2.55	3.30	10.0	1.98	0.000	0.094	0.094	0.438
Noakhali	51	0.67	1.10	2.80	3.50	7.5	1.85	0.000	0.078	0.059	0.471
Rangamati	56	0.05	0.23	0.65	1.20	3.0	0.49	0.286	0.571	0.554	0.804
Chittagong Division	*583*	*0.34*	*1.00*	*2.90*	*6.10*	*43.0*	*2.32*	*0.087*	*0.245*	*0.226*	*0.508*
Dhaka	74	0.18	0.36	0.70	2.30	25.0	1.13	0.108	0.473	0.446	0.824
Faridpur	48	0.65	1.85	5.80	8.90	14.0	3.28	0.021	0.063	0.063	0.396
Gazipur	33	0.42	0.86	1.70	5.50	9.1	1.66	0.061	0.212	0.212	0.576
Gopalganj	31	0.31	1.40	5.40	7.90	13.0	3.19	0.065	0.290	0.226	0.484
Jamalpur	39	0.51	1.10	4.50	13.00	19.0	3.47	0.077	0.154	0.154	0.487
Kishoreganj	75	0.24	0.63	1.90	4.80	11.0	1.65	0.093	0.320	0.293	0.640
Madaripur	22	0.47	1.20	2.10	3.30	9.3	1.75	0.000	0.045	0.045	0.409
Manikganj	40	0.20	1.20	6.55	15.00	19.0	4.35	0.150	0.300	0.300	0.475
Munshiganj	36	0.17	0.61	1.30	2.70	6.5	1.07	0.139	0.389	0.333	0.694
Mymensingh	71	0.35	0.81	1.80	5.10	8.8	1.64	0.085	0.225	0.211	0.606
Narayanganj	31	0.05	0.26	0.95	1.20	7.0	0.87	0.258	0.548	0.516	0.839
Narsingdi	33	0.38	1.00	2.00	3.10	16.0	2.09	0.030	0.182	0.121	0.515
Netrakona	53	0.45	1.80	4.90	9.50	18.0	3.35	0.057	0.189	0.189	0.415
Rajbari	27	0.13	0.31	0.79	2.00	18.0	1.23	0.185	0.519	0.481	0.815
Shariatpur	36	0.39	0.79	1.35	2.70	7.3	1.29	0.028	0.167	0.111	0.639
Sherpur	31	0.42	0.95	2.10	4.60	18.0	2.08	0.032	0.161	0.161	0.516
Tangail	73	0.29	0.74	1.80	6.70	31.0	2.37	0.096	0.288	0.274	0.630
Dhaka Division	*753*	*0.30*	*0.74*	*2.10*	*6.30*	*31.0*	*2.14*	*0.088*	*0.274*	*0.252*	*0.596*

Table 13b: Geographic distribution of iron, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.11	0.26	0.65	3.20	13.0	0.97	0.241	0.574	0.519	0.796
Chuadanga	23	0.13	0.31	0.65	2.50	8.4	1.00	0.217	0.522	0.478	0.826
Jessore	43	0.13	0.47	3.40	5.60	9.1	1.83	0.186	0.419	0.395	0.581
Jhenaidah	36	0.17	0.56	1.80	3.20	6.5	1.29	0.139	0.361	0.333	0.611
Khulna	64	0.15	0.40	1.35	2.50	12.0	1.01	0.125	0.484	0.484	0.734
Kushtia	35	0.15	0.44	1.40	3.60	8.6	1.30	0.200	0.486	0.486	0.657
Magura	27	0.22	0.59	1.60	2.70	7.1	1.18	0.074	0.444	0.407	0.704
Meherpur	22	0.05	0.22	0.70	0.93	1.3	0.39	0.273	0.591	0.591	0.955
Narail	21	0.32	0.79	1.20	4.10	6.5	1.33	0.048	0.286	0.238	0.667
Satkhira	39	0.05	0.38	0.95	4.20	24.0	1.54	0.256	0.487	0.487	0.769
Khulna Division	*364*	*0.14*	*0.40*	*1.25*	*3.60*	*24.0*	*1.21*	*0.179*	*0.473*	*0.451*	*0.723*
Bogra	72	0.49	1.20	2.55	5.80	28.0	2.38	0.028	0.167	0.139	0.458
Dinajpur	82	0.31	0.89	2.50	7.00	23.0	2.34	0.037	0.268	0.232	0.573
Gaibandha	40	0.39	1.65	10.40	20.00	26.0	6.12	0.100	0.225	0.200	0.475
Joypurhat	31	0.97	2.00	3.70	4.30	10.0	2.61	0.032	0.129	0.097	0.258
Kurigram	45	0.48	1.40	6.40	19.00	32.0	4.88	0.044	0.178	0.178	0.444
Lalmonirhat	33	0.24	0.89	2.50	11.00	16.0	2.51	0.061	0.333	0.333	0.545
Naogaon	57	0.36	1.20	2.10	3.50	16.0	1.92	0.105	0.211	0.211	0.439
Natore	37	0.21	0.49	0.94	1.80	4.0	0.72	0.081	0.378	0.351	0.838
Nawabganj	32	0.15	0.32	0.79	1.40	2.9	0.59	0.156	0.500	0.500	0.813
Nilphamari	34	0.44	0.73	1.30	3.70	15.0	1.68	0.088	0.176	0.176	0.706
Pabna	46	0.22	0.45	0.85	2.70	13.0	1.30	0.152	0.457	0.391	0.804
Panchagarh	32	0.58	0.96	2.90	6.50	9.0	2.33	0.063	0.094	0.094	0.531
Rajshahi	66	0.12	0.31	0.60	1.30	8.1	0.74	0.197	0.515	0.500	0.894
Rangpur	49	0.42	1.10	3.60	16.00	37.0	4.40	0.061	0.204	0.163	0.490
Sirajganj	42	0.63	2.30	11.00	19.00	24.0	5.83	0.048	0.167	0.167	0.333
Thakurgaon	33	0.30	0.89	2.70	7.20	15.0	2.33	0.091	0.273	0.273	0.515
Rajshahi Division	*731*	*0.30*	*0.83*	*2.20*	*7.80*	*37.0*	*2.63*	*0.083*	*0.271*	*0.252*	*0.573*
Habiganj	47	2.50	5.00	7.30	13.00	23.0	5.85	0.043	0.106	0.106	0.128
Maulvi Bazar	41	0.35	1.30	6.10	15.00	34.0	5.15	0.049	0.220	0.220	0.488
Sunamganj	65	1.30	2.40	4.70	10.00	41.0	4.74	0.062	0.123	0.108	0.215
Sylhet	64	0.18	0.79	3.25	12.00	16.0	2.91	0.188	0.344	0.344	0.625
Sylhet Division	*217*	*0.48*	*2.30*	*5.50*	*13.00*	*41.0*	*4.52*	*0.092*	*0.203*	*0.198*	*0.369*
Grand Total	***2896***	***0.24***	***0.71***	***2.30***	***6.10***	***43.0***	***2.22***	***0.109***	***0.324***	***0.304***	***0.598***

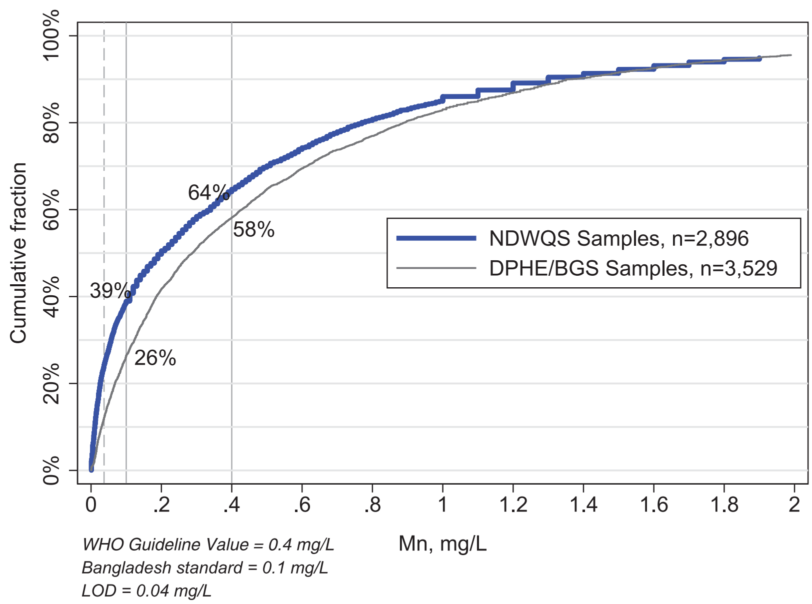
MANGANESE (MN)

More than one third (39%) of NDWQS samples met the Bangladesh drinking water standard for Mn of 0.1 mg/L. The Bangladesh drinking water limit for Mn is stricter than the WHO guideline value of 0.4 mg/L, which was met in two thirds (65%) of NDWQS samples. Some samples exceeded the WHO guideline value by a factor of ten; these are shaded dark blue in Table 14a and 14b.

Manganese is an essential element for humans, but a growing body of research suggests that exposure to high levels in drinking water can lead to adverse neurological effects, particularly in children. Concentrations below 0.05–0.1 mg/L are usually acceptable to consumers from a taste perspective but may sometimes still give rise to the deposition of black deposits in pipes.

Field blanks showed very little Mn, confirming that sample collection, transport and storage did not introduce significant Mn contamination.

Figure 14: **Manganese distribution, with 64% of samples meeting the WHO guideline value of 0.4 mg/L.**

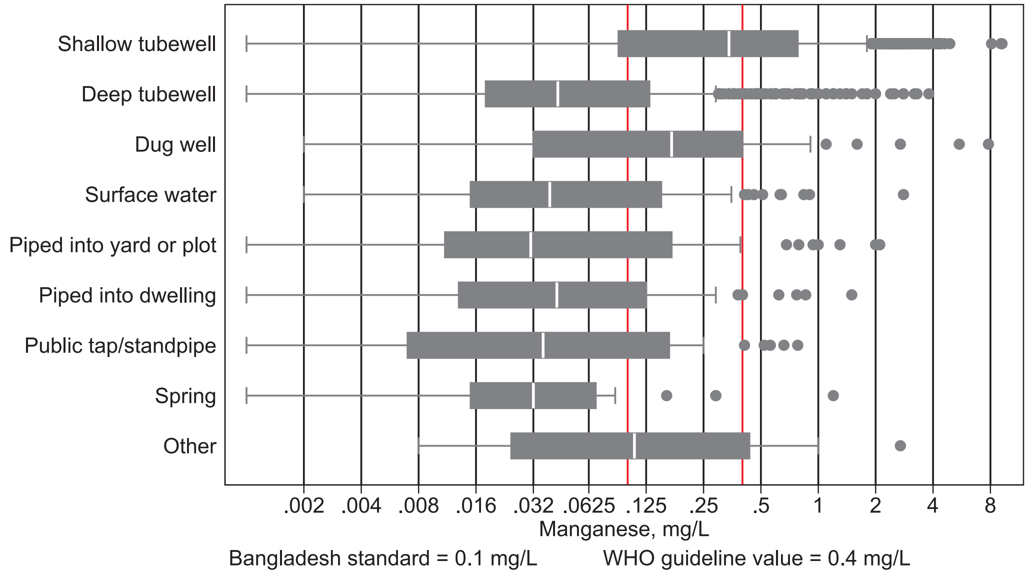


In the DPHE/BGS tube well survey, somewhat higher levels of Mn were found than in the 2009 NDWQS: only 26% and 58% of samples met with Bangladesh standard and WHO guideline value, respectively. The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 56.5% that the DPHE/BGS distribution is greater than the NDWQS distribution.

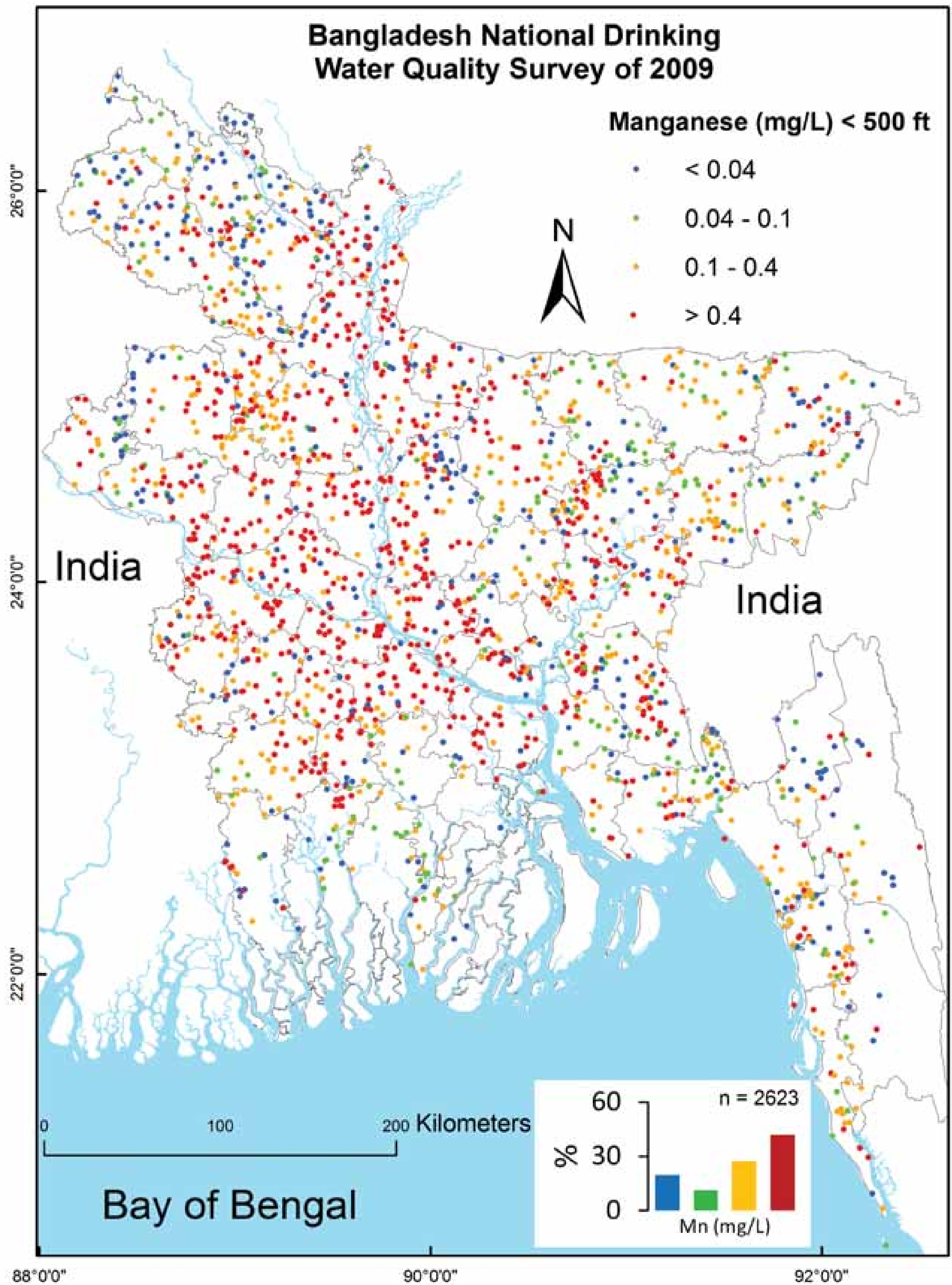
Table 14a: Manganese levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.09	0.34	0.78	1.50	9.20	0.61	0.018	0.148	0.556	0.269
Deep tubewell	526	0.02	0.04	0.13	0.51	3.80	0.19	0.029	0.460	0.880	0.715
Dug well	59	0.03	0.17	0.40	0.91	7.80	0.50	0.000	0.271	0.763	0.458
Surface water	67	0.02	0.04	0.15	0.46	2.80	0.17	0.000	0.493	0.866	0.687
Piped into yard or plot	54	0.01	0.03	0.17	0.94	2.10	0.25	0.056	0.537	0.852	0.685
Piped into dwelling	48	0.01	0.04	0.13	0.40	1.50	0.15	0.104	0.500	0.917	0.688
Public tap/standpipe	44	0.01	0.04	0.17	0.41	0.78	0.12	0.046	0.500	0.886	0.636
Spring	22	0.02	0.03	0.07	0.29	1.20	0.11	0.046	0.546	0.955	0.818
Other	16	0.02	0.11	0.44	1.00	2.70	0.38	0.000	0.375	0.750	0.500

Figure 14b: Manganese levels by water source



Map 14a: **Manganese in shallow tubewells (< 150 m)**



Map 14b: **Manganese in deep tubewells (> 150 m)**

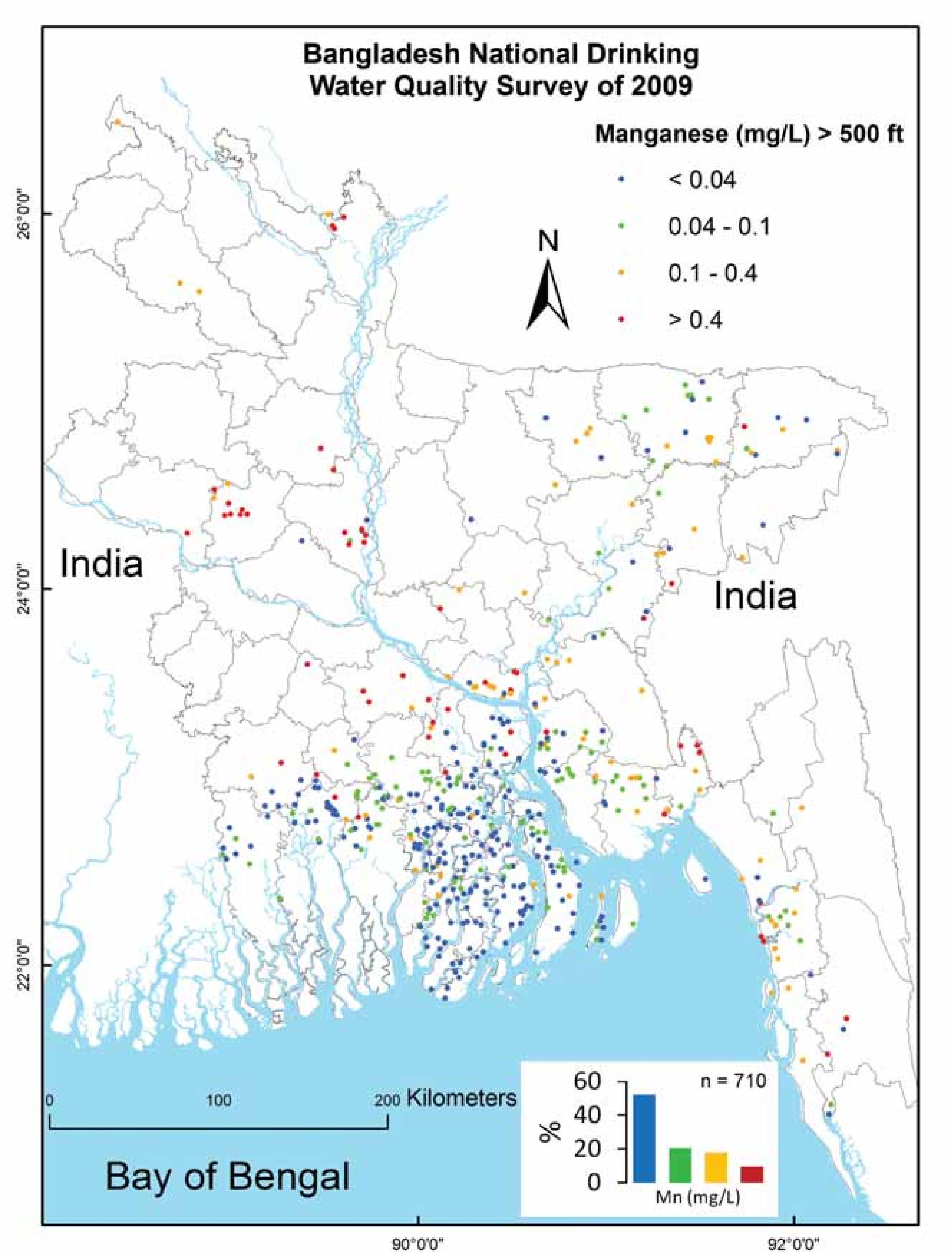


Table 14b: Geographic distribution of manganese

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.01	0.02	0.05	0.07	0.2	0.03	0.114	0.743	1.000	0.971
Barisal	65	0.02	0.02	0.04	0.09	1.7	0.10	0.000	0.708	0.954	0.908
Bhola	36	0.03	0.04	0.05	0.07	0.3	0.05	0.028	0.500	1.000	0.944
Jhalokati	26	0.01	0.02	0.07	0.11	0.2	0.04	0.000	0.654	1.000	0.846
Patuakhali	46	0.01	0.01	0.02	0.03	0.3	0.02	0.022	0.913	1.000	0.978
Pirojpur	40	0.02	0.03	0.09	0.20	1.4	0.11	0.025	0.525	0.950	0.775
Barisal Division	*248*	*0.01*	*0.02*	*0.05*	*0.09*	*1.7*	*0.06*	*0.028*	*0.685*	*0.980*	*0.907*
Bandarban	44	0.01	0.06	0.31	0.68	2.7	0.29	0.000	0.386	0.795	0.659
Brahamanbaria	52	0.13	0.35	0.98	1.80	3.8	0.71	0.000	0.096	0.596	0.192
Chandpur	47	0.03	0.09	0.27	0.93	3.8	0.37	0.085	0.255	0.830	0.553
Chittagong	92	0.07	0.19	0.37	0.63	2.8	0.29	0.022	0.196	0.783	0.326
Comilla	86	0.09	0.26	0.63	1.80	4.1	0.58	0.000	0.116	0.547	0.291
Cox's Bazar	38	0.06	0.16	0.41	0.60	2.1	0.32	0.000	0.158	0.737	0.316
Feni	38	0.06	0.16	0.32	0.54	0.9	0.22	0.000	0.184	0.842	0.421
Khagrachhari	47	0.02	0.05	0.18	0.65	3.6	0.22	0.000	0.426	0.872	0.660
Lakshmipur	32	0.07	0.10	0.45	1.80	3.1	0.49	0.031	0.125	0.750	0.531
Noakhali	51	0.06	0.22	0.45	0.74	2.5	0.33	0.000	0.176	0.725	0.412
Rangamati	56	0.01	0.09	0.29	0.66	7.8	0.36	0.036	0.411	0.821	0.518
Chittagong Division	*583*	*0.05*	*0.15*	*0.43*	*0.90*	*7.8*	*0.39*	*0.015*	*0.225*	*0.741*	*0.422*
Dhaka	74	0.03	0.10	0.40	1.00	3.2	0.35	0.014	0.311	0.757	0.514
Faridpur	48	0.45	0.74	1.20	1.60	3.1	0.86	0.021	0.042	0.188	0.042
Gazipur	33	0.03	0.16	0.26	0.41	4.6	0.30	0.000	0.303	0.879	0.394
Gopalganj	31	0.05	0.08	0.18	0.39	1.3	0.16	0.032	0.226	0.903	0.645
Jamalpur	39	0.13	0.58	1.30	1.80	2.7	0.79	0.026	0.154	0.359	0.231
Kishoreganj	75	0.07	0.40	0.97	2.20	3.8	0.74	0.013	0.147	0.507	0.293
Madaripur	22	0.02	0.56	1.10	1.30	2.1	0.60	0.000	0.409	0.455	0.409
Manikganj	40	0.43	0.68	1.25	1.95	2.8	0.90	0.000	0.075	0.225	0.100
Munshiganj	36	0.22	0.64	1.40	2.10	3.8	0.92	0.056	0.083	0.417	0.139
Mymensingh	71	0.08	0.18	0.60	1.20	9.1	0.55	0.014	0.155	0.704	0.268
Narayanganj	31	0.11	0.29	1.40	2.30	3.8	0.78	0.000	0.097	0.516	0.226
Narsingdi	33	0.11	0.32	0.83	1.60	2.8	0.64	0.030	0.091	0.545	0.212
Netrakona	53	0.05	0.11	0.28	0.87	3.1	0.31	0.019	0.075	0.792	0.491
Rajbari	27	0.46	1.30	1.50	1.70	2.8	1.02	0.037	0.074	0.222	0.148
Shariatpur	36	0.02	0.06	0.84	1.20	3.4	0.47	0.000	0.417	0.611	0.556
Sherpur	31	0.06	0.43	1.30	2.10	3.8	0.86	0.000	0.226	0.484	0.290
Tangail	73	0.03	0.51	0.93	1.30	3.0	0.63	0.096	0.274	0.493	0.288
Dhaka Division	*753*	*0.06*	*0.32*	*0.91*	*1.60*	*9.1*	*0.62*	*0.024*	*0.185*	*0.548*	*0.312*

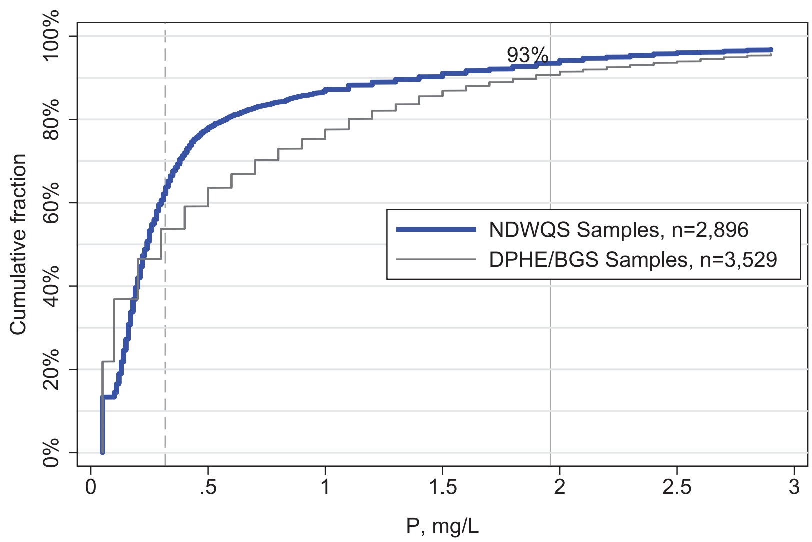
Table 14b: Geographic distribution of manganese, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Stan-dard
Bagerhat	54	0.01	0.04	0.09	0.18	2.8	0.13	0.093	0.444	0.944	0.796
Chuadanga	23	0.31	0.55	0.95	1.60	1.9	0.73	0.000	0.000	0.435	0.043
Jessore	43	0.14	0.24	0.85	1.10	2.1	0.49	0.023	0.140	0.581	0.209
Jhenaidah	36	0.24	0.48	0.87	2.00	3.7	0.79	0.000	0.111	0.472	0.139
Khulna	64	0.02	0.05	0.14	0.75	3.8	0.29	0.000	0.422	0.813	0.688
Kushtia	35	0.37	0.67	0.98	1.30	2.5	0.74	0.029	0.086	0.286	0.086
Magura	27	0.28	0.67	0.91	1.00	2.8	0.68	0.000	0.000	0.333	0.037
Meherpur	22	0.39	0.56	0.71	0.95	2.4	0.62	0.045	0.045	0.364	0.091
Narail	21	0.19	0.50	1.00	1.90	2.6	0.75	0.000	0.048	0.429	0.143
Satkhira	39	0.02	0.04	0.23	0.87	1.6	0.22	0.051	0.487	0.846	0.615
Khulna Division	*364*	*0.04*	*0.24*	*0.70*	*1.10*	*3.8*	*0.48*	*0.027*	*0.234*	*0.615*	*0.371*
Bogra	72	0.24	0.37	0.61	1.10	4.4	0.61	0.014	0.069	0.583	0.125
Dinajpur	82	0.04	0.19	0.43	0.72	3.1	0.32	0.024	0.256	0.732	0.366
Gaibandha	40	0.15	0.86	1.20	2.25	9.2	1.08	0.000	0.200	0.325	0.250
Joypurhat	31	0.25	0.39	0.62	0.99	1.9	0.48	0.000	0.097	0.516	0.097
Kurigram	45	0.53	1.10	1.60	2.50	4.3	1.19	0.000	0.111	0.244	0.133
Lalmonirhat	33	0.01	0.03	0.47	0.77	2.2	0.29	0.061	0.515	0.697	0.606
Naogaon	57	0.11	0.33	0.87	1.40	4.3	0.60	0.018	0.175	0.544	0.246
Natore	37	0.47	0.66	1.00	1.50	2.6	0.79	0.000	0.000	0.135	0.000
Nawabganj	32	0.02	0.11	0.49	1.00	2.0	0.34	0.063	0.313	0.719	0.500
Nilphamari	34	0.02	0.08	0.44	0.78	4.4	0.46	0.059	0.353	0.735	0.529
Pabna	46	0.57	0.72	1.10	2.20	2.8	0.91	0.043	0.065	0.174	0.065
Panchagarh	32	0.04	0.07	0.17	0.24	2.1	0.16	0.000	0.219	0.969	0.594
Rajshahi	66	0.16	0.74	1.20	1.70	3.3	0.84	0.030	0.121	0.333	0.197
Rangpur	49	0.03	0.15	0.59	1.70	8.1	0.67	0.000	0.265	0.673	0.347
Sirajganj	42	0.51	1.15	2.00	2.80	3.8	1.29	0.000	0.048	0.190	0.071
Thakurgaon	33	0.01	0.07	0.21	0.43	1.8	0.18	0.000	0.394	0.879	0.576
Rajshahi Division	*731*	*0.08*	*0.38*	*0.85*	*1.60*	*9.2*	*0.65*	*0.019*	*0.187*	*0.520*	*0.274*
Habiganj	47	0.13	0.24	0.34	0.53	4.2	0.35	0.043	0.064	0.809	0.213
Maulvi Bazar	41	0.04	0.11	0.30	0.57	1.5	0.21	0.000	0.220	0.878	0.463
Sunamganj	65	0.08	0.12	0.25	0.42	5.5	0.26	0.015	0.092	0.877	0.400
Sylhet	64	0.01	0.11	0.35	0.63	4.6	0.30	0.047	0.359	0.781	0.484
Sylhet Division	*217*	*0.06*	*0.13*	*0.31*	*0.54*	*5.5*	*0.28*	*0.028*	*0.189*	*0.834*	*0.396*
Grand Total	***2896***	***0.04***	***0.20***	***0.63***	***1.30***	***9.2***	***0.49***	***0.022***	***0.243***	***0.647***	***0.389***

PHOSPHORUS (P)

Phosphorus in groundwater is mostly present in the form of PO_4, or phosphate. NDWQS data are presented in terms of milligrams of phosphorus per litre of water. To convert to phosphate, phosphorus levels must be multiplied by 3.1. There is no WHO guideline value for phosphorus. Bangladesh has a drinking water standard of 6 mg/L for phosphate (PO_4), which is equivalent to 1.96 mg P/L, if it is assumed that phosphorus is present entirely as phosphate. This is a reasonable approximation for groundwater, though a small fraction of dissolved phosphorus is probably present in other forms. The geochemical behavior of phosphate is similar to that of arsenic in that both have strong affinities to sorb onto iron oxyhydroxide. Thus, they are released to water upon reductive dissolution of iron oxyhyroxide, and are removed from water by iron oxyhyroxides through co-precipitation or sorption.

Figure 15: **Phosphorus distribution, with 93% of samples meeting equivalent Bangladesh standard of 1.96 mg/L.**



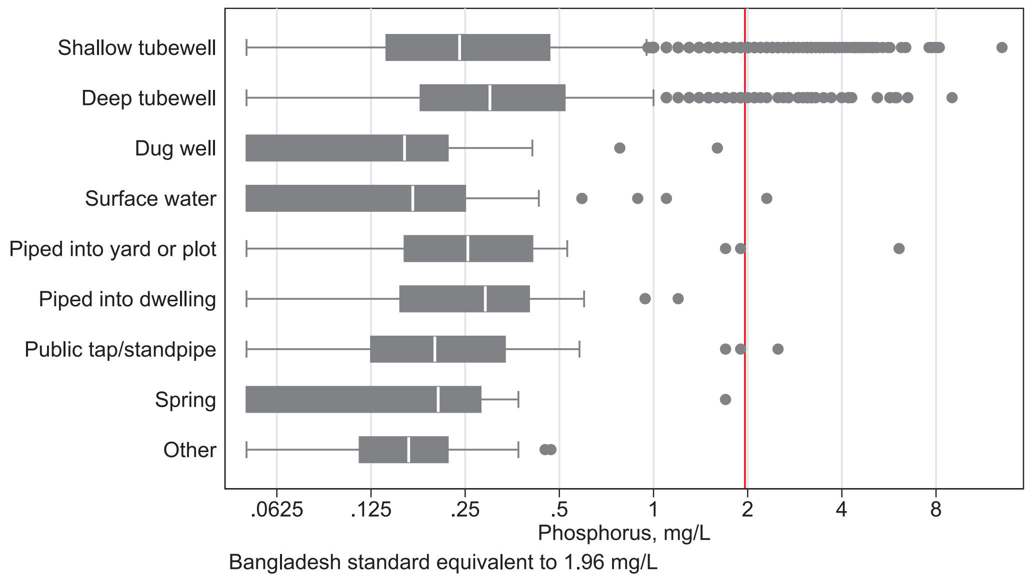
Bangladesh standard of 6 mg PO4/L is equivalent to 1.96 mg P/L
LOD = 0.32 mg/L

The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 56.5% that the DPHE/BGS distribution is greater than the NDWQS distribution.

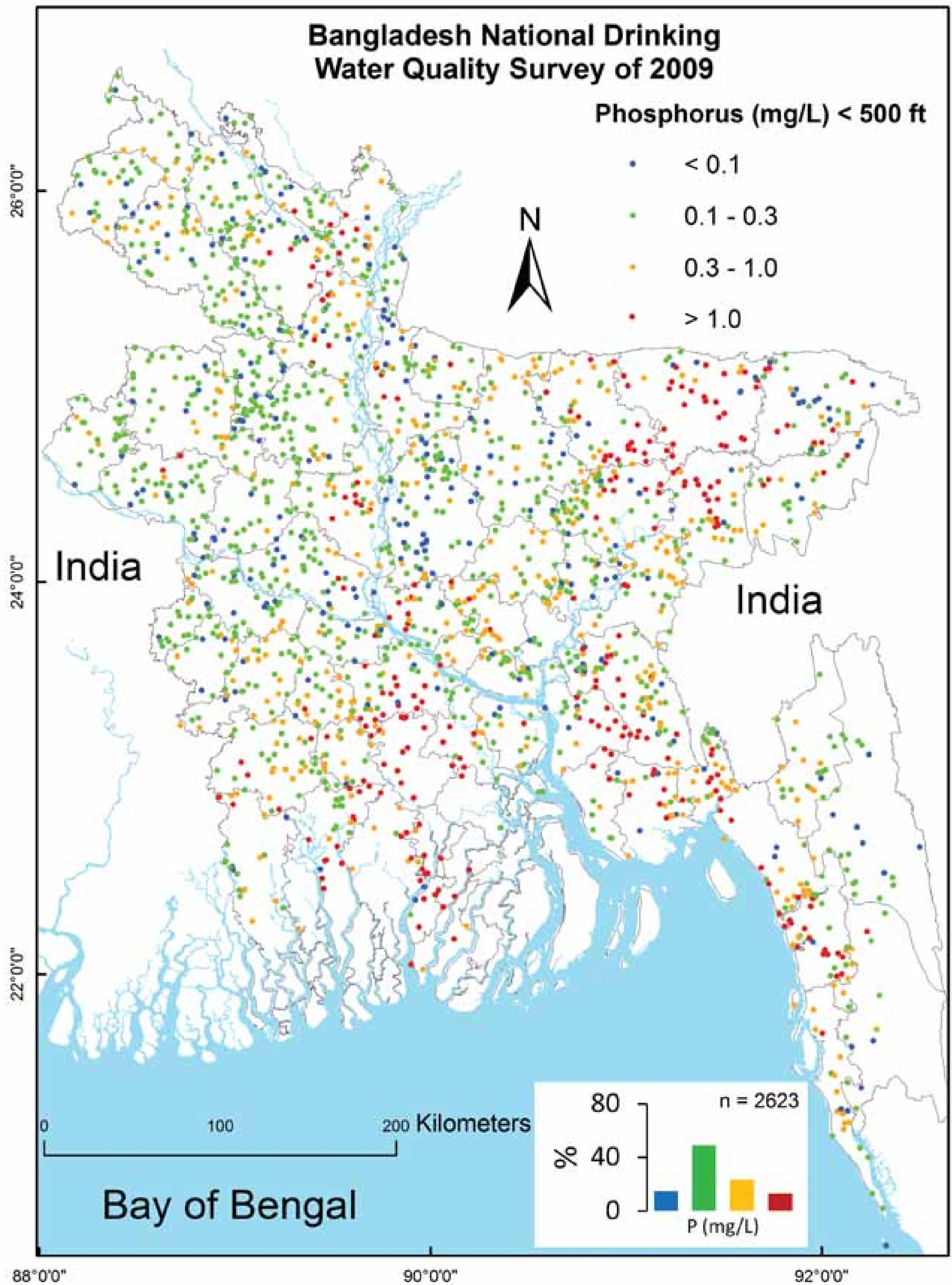
Table 15a: Phosphorus levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.14	0.24	0.47	1.50	13.00	0.56	0.129	0.624	n.a.	0.928
Deep tubewell	526	0.18	0.30	0.52	1.50	9.00	0.62	0.108	0.529	n.a.	0.930
Dug well	59	0.05	0.16	0.22	0.33	1.60	0.20	0.254	0.898	n.a.	1.000
Surface water	67	0.05	0.17	0.25	0.40	2.30	0.23	0.269	0.881	n.a.	0.985
Piped into yard or plot	54	0.16	0.26	0.41	0.48	6.10	0.42	0.185	0.593	n.a.	0.982
Piped into dwelling	48	0.16	0.29	0.40	0.48	1.20	0.31	0.125	0.604	n.a.	1.000
Public tap/standpipe	44	0.13	0.20	0.34	0.50	2.50	0.34	0.205	0.705	n.a.	0.977
Spring	22	0.05	0.21	0.28	0.36	1.70	0.26	0.273	0.818	n.a.	1.000
Other	16	0.12	0.17	0.22	0.45	0.47	0.20	0.125	0.813	n.a.	1.000

Figure 15b: Phosphorus levels by water source



Map 15a: **Phosphorus in shallow tube wells (< 150 m)**



Map 15b: **Phosphorus in deep tube wells (> 150 m)**

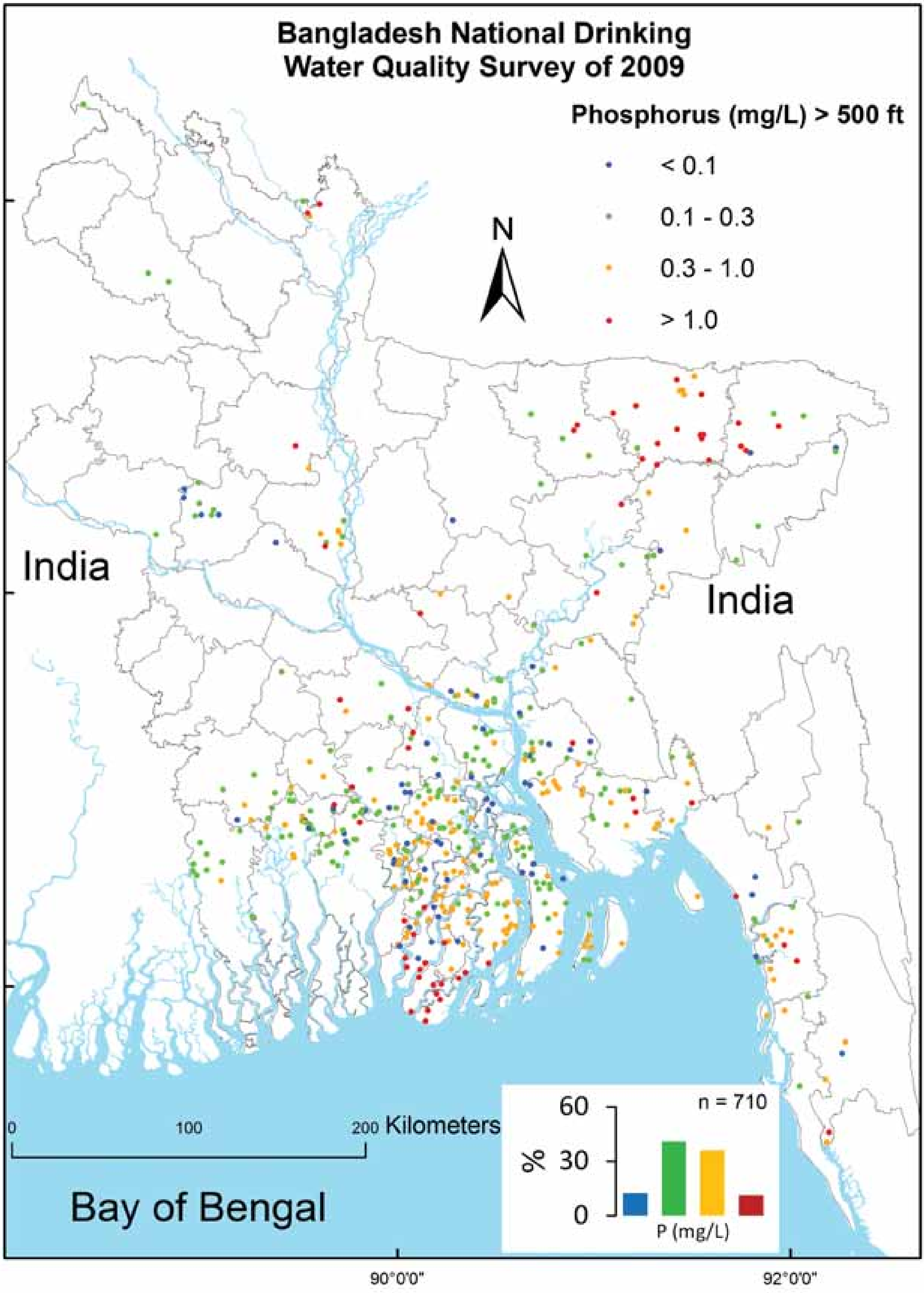


Table 15b: Geographic distribution of phosphorus

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.42	0.88	1.50	1.90	7.7	1.14	0.114	0.143	n.a.	0.943
Barisal	65	0.18	0.26	0.35	0.50	2.1	0.32	0.077	0.662	n.a.	0.985
Bhola	36	0.22	0.30	0.40	0.52	1.5	0.33	0.083	0.528	n.a.	1.000
Jhalokati	26	0.24	0.38	1.40	4.10	5.7	1.11	0.192	0.346	n.a.	0.769
Patuakhali	46	0.43	0.63	0.99	1.90	6.0	0.99	0.022	0.130	n.a.	0.913
Pirojpur	40	0.09	0.32	0.80	2.20	8.2	0.87	0.275	0.500	n.a.	0.875
Barisal Division	*248*	*0.23*	*0.35*	*0.72*	*1.80*	*8.2*	*0.73*	*0.117*	*0.411*	*n.a.*	*0.927*
Bandarban	44	0.15	0.21	0.30	0.66	1.9	0.31	0.182	0.773	n.a.	1.000
Brahamanbaria	52	0.24	0.33	0.45	0.69	6.5	0.59	0.058	0.462	n.a.	0.942
Chandpur	47	0.11	0.18	1.80	4.10	8.1	1.21	0.213	0.638	n.a.	0.766
Chittagong	92	0.22	0.46	1.20	2.80	13.0	1.09	0.109	0.359	n.a.	0.826
Comilla	86	0.19	0.27	0.51	2.20	6.1	0.77	0.116	0.581	n.a.	0.872
Cox's Bazar	38	0.14	0.25	0.65	1.00	2.0	0.46	0.105	0.553	n.a.	0.974
Feni	38	0.15	0.37	0.64	1.60	5.6	0.65	0.079	0.421	n.a.	0.921
Khagrachhari	47	0.18	0.22	0.31	0.42	0.6	0.26	0.021	0.766	n.a.	1.000
Lakshmipur	32	0.22	0.33	0.49	2.30	4.7	0.76	0.000	0.438	n.a.	0.875
Noakhali	51	0.22	0.41	1.00	2.20	6.2	0.94	0.039	0.392	n.a.	0.863
Rangamati	56	0.05	0.12	0.21	0.27	0.4	0.14	0.446	0.964	n.a.	1.000
Chittagong Division	*583*	*0.15*	*0.27*	*0.52*	*1.90*	*13.0*	*0.69*	*0.130*	*0.569*	*n.a.*	*0.904*
Dhaka	74	0.31	0.37	0.46	0.69	4.6	0.55	0.014	0.257	n.a.	0.959
Faridpur	48	0.17	0.34	1.45	2.00	2.8	0.77	0.104	0.458	n.a.	0.875
Gazipur	33	0.25	0.30	0.38	0.56	0.7	0.33	0.000	0.515	n.a.	1.000
Gopalganj	31	0.10	0.70	1.90	2.80	3.8	1.12	0.226	0.419	n.a.	0.774
Jamalpur	39	0.13	0.21	0.39	1.10	1.5	0.35	0.205	0.641	n.a.	1.000
Kishoreganj	75	0.15	0.25	0.54	1.80	3.5	0.55	0.120	0.560	n.a.	0.933
Madaripur	22	0.17	0.19	0.53	1.30	5.4	0.65	0.045	0.636	n.a.	0.909
Manikganj	40	0.13	0.22	0.81	1.85	2.2	0.56	0.175	0.625	n.a.	0.925
Munshiganj	36	0.13	0.18	0.30	0.43	1.0	0.23	0.139	0.778	n.a.	1.000
Mymensingh	71	0.13	0.21	0.32	0.51	0.9	0.26	0.169	0.746	n.a.	1.000
Narayanganj	31	0.14	0.29	0.48	0.58	1.0	0.32	0.097	0.548	n.a.	1.000
Narsingdi	33	0.10	0.16	0.29	0.47	1.1	0.22	0.242	0.848	n.a.	1.000
Netrakona	53	0.24	0.50	2.30	3.40	5.7	1.26	0.075	0.377	n.a.	0.717
Rajbari	27	0.05	0.18	0.27	0.45	1.9	0.25	0.259	0.815	n.a.	1.000
Shariatpur	36	0.13	0.19	0.25	0.45	5.0	0.34	0.194	0.806	n.a.	0.972
Sherpur	31	0.14	0.18	0.35	0.45	1.3	0.27	0.161	0.677	n.a.	1.000
Tangail	73	0.05	0.13	0.25	0.46	1.0	0.21	0.342	0.849	n.a.	1.000
Dhaka Division	*753*	*0.14*	*0.25*	*0.43*	*1.30*	*5.7*	*0.49*	*0.151*	*0.607*	*n.a.*	*0.944*

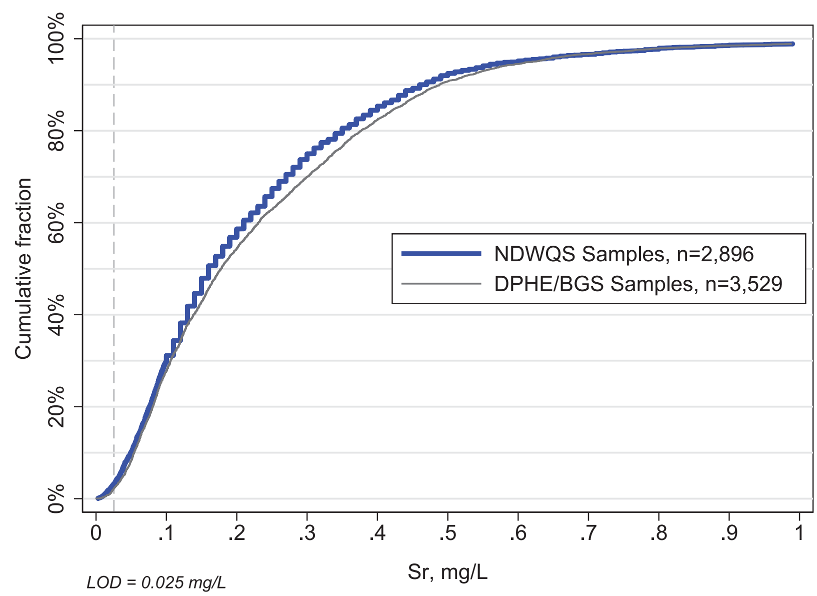
Table 15b: Geographic distribution of phosphorus, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.16	0.22	0.31	0.89	2.8	0.40	0.148	0.778	n.a.	0.944
Chuadanga	23	0.13	0.19	0.25	0.43	0.7	0.23	0.130	0.826	n.a.	1.000
Jessore	43	0.22	0.32	0.53	1.40	1.8	0.50	0.023	0.488	n.a.	1.000
Jhenaidah	36	0.20	0.28	0.40	0.71	0.9	0.35	0.056	0.556	n.a.	1.000
Khulna	64	0.16	0.24	0.74	2.20	5.2	0.78	0.031	0.578	n.a.	0.859
Kushtia	35	0.05	0.17	0.30	0.45	1.0	0.23	0.286	0.771	n.a.	1.000
Magura	27	0.18	0.24	0.43	0.47	1.5	0.32	0.074	0.630	n.a.	1.000
Meherpur	22	0.13	0.16	0.21	0.24	0.3	0.16	0.136	1.000	n.a.	1.000
Narail	21	0.17	0.31	0.38	0.76	3.8	0.51	0.000	0.524	n.a.	0.952
Satkhira	39	0.15	0.22	0.35	0.99	1.6	0.38	0.103	0.667	n.a.	1.000
Khulna Division	*364*	*0.16*	*0.24*	*0.37*	*0.94*	*5.2*	*0.43*	*0.096*	*0.665*	*n.a.*	*0.964*
Bogra	72	0.13	0.17	0.23	0.33	1.5	0.22	0.111	0.861	n.a.	1.000
Dinajpur	82	0.14	0.18	0.26	0.39	0.7	0.21	0.134	0.854	n.a.	1.000
Gaibandha	40	0.14	0.23	0.61	1.60	2.5	0.53	0.150	0.550	n.a.	0.925
Joypurhat	31	0.11	0.14	0.22	0.28	0.5	0.17	0.194	0.935	n.a.	1.000
Kurigram	45	0.16	0.26	0.49	1.20	2.3	0.44	0.133	0.578	n.a.	0.978
Lalmonirhat	33	0.13	0.17	0.28	0.71	1.7	0.31	0.182	0.788	n.a.	1.000
Naogaon	57	0.16	0.19	0.27	0.38	0.8	0.22	0.070	0.807	n.a.	1.000
Natore	37	0.10	0.16	0.22	0.27	0.5	0.16	0.243	0.919	n.a.	1.000
Nawabganj	32	0.17	0.19	0.24	0.35	0.4	0.20	0.094	0.875	n.a.	1.000
Nilphamari	34	0.12	0.16	0.28	0.43	0.6	0.20	0.176	0.824	n.a.	1.000
Pabna	46	0.11	0.19	0.24	0.44	2.4	0.27	0.217	0.848	n.a.	0.978
Panchagarh	32	0.16	0.23	0.30	0.42	0.8	0.26	0.094	0.781	n.a.	1.000
Rajshahi	66	0.11	0.16	0.21	0.31	2.0	0.23	0.182	0.909	n.a.	0.985
Rangpur	49	0.12	0.20	0.36	1.30	2.0	0.38	0.143	0.653	n.a.	0.980
Sirajganj	42	0.20	0.32	0.75	1.30	2.0	0.54	0.000	0.476	n.a.	0.976
Thakurgaon	33	0.14	0.20	0.28	0.35	0.6	0.22	0.182	0.848	n.a.	1.000
Rajshahi Division	*731*	*0.13*	*0.18*	*0.28*	*0.52*	*2.5*	*0.28*	*0.141*	*0.787*	*n.a.*	*0.989*
Habiganj	47	0.31	0.85	1.90	2.50	3.2	1.16	0.064	0.277	n.a.	0.766
Maulvi Bazar	41	0.12	0.21	0.50	1.20	2.6	0.46	0.122	0.585	n.a.	0.976
Sunamganj	65	0.90	1.90	3.30	4.60	9.0	2.30	0.092	0.123	n.a.	0.508
Sylhet	64	0.05	0.19	0.63	2.10	5.2	0.62	0.266	0.719	n.a.	0.875
Sylhet Division	217	0.14	0.61	1.90	3.20	9.0	1.21	0.143	0.419	n.a.	0.760
Grand Total	***2896***	***0.15***	***0.24***	***0.44***	***1.40***	***13.0***	***0.54***	***0.134***	***0.621***	***n.a.***	***0.935***

STRONTIUM (SR)

There is no Bangladesh standard,nor is there any WHO guideline value for strontium.

Figure 16: **Strontium distribution**

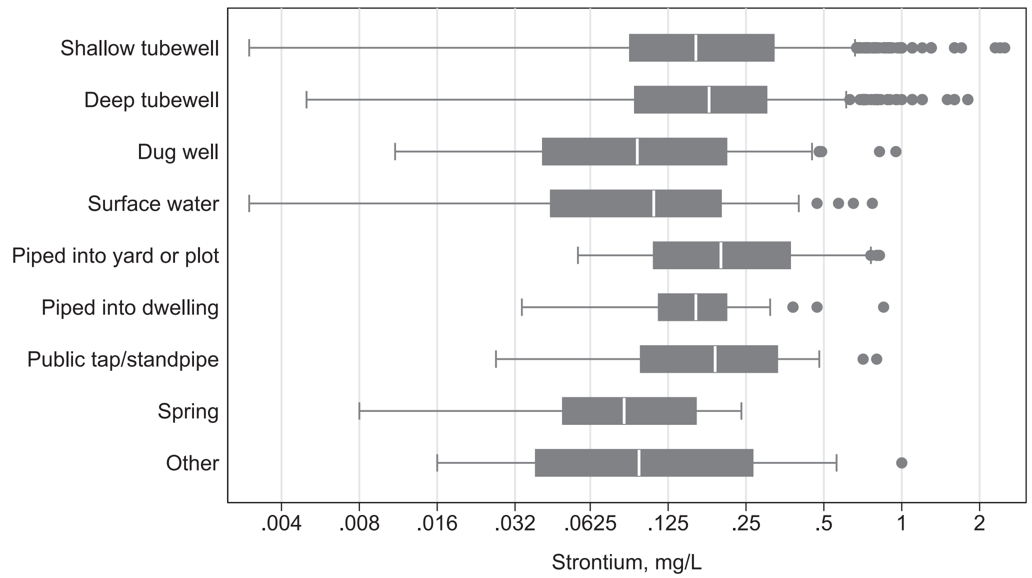


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 52.4% that the DPHE/BGS distribution is greater than the NDWQS distribution. However, the magnitiude of the difference is small.

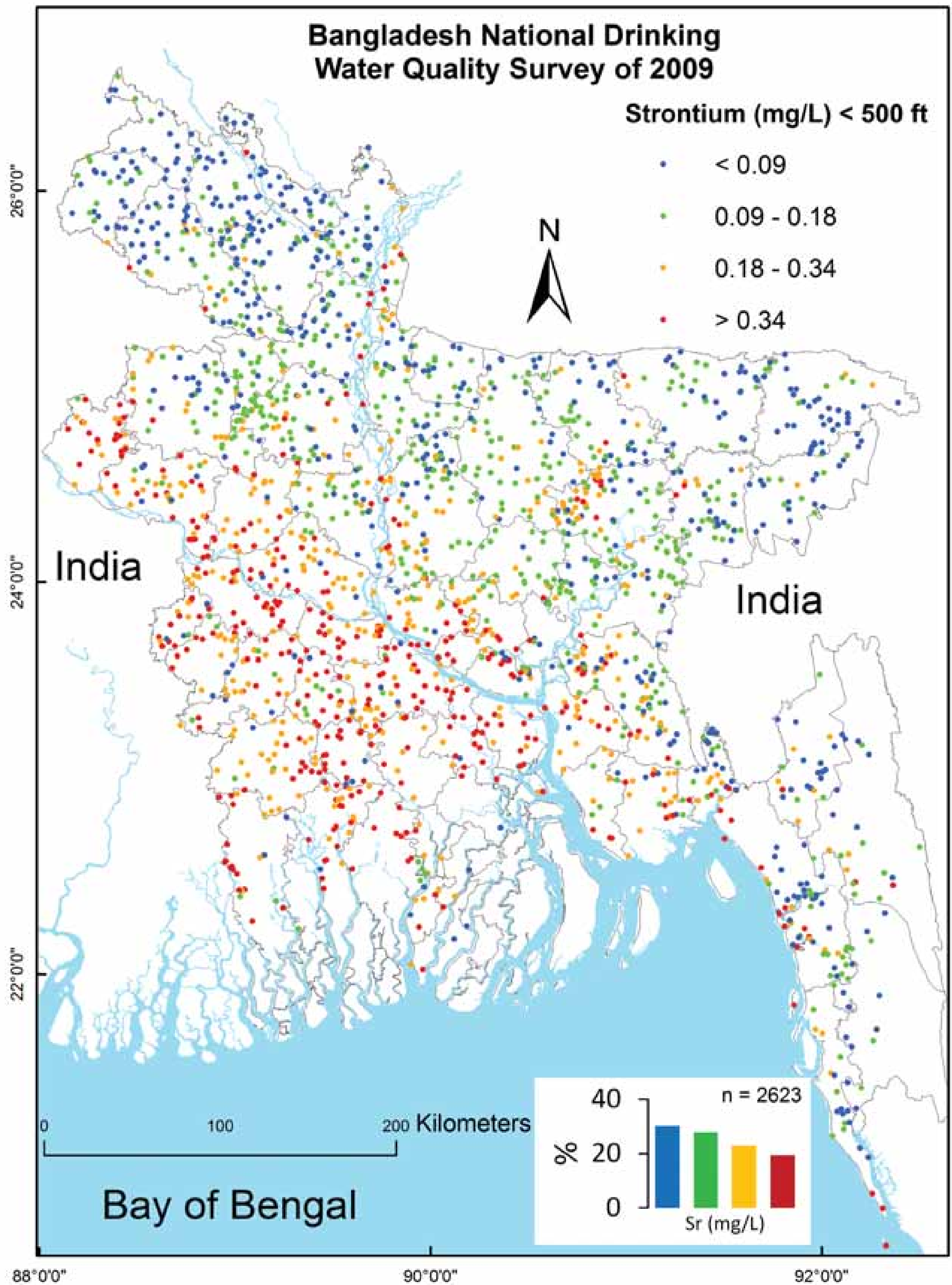
Table 16a: Strontium levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.09	0.16	0.32	0.47	2.50	0.23	0.000	0.031	n.a.	n.a.
Deep tubewell	526	0.09	0.18	0.30	0.48	1.80	0.25	0.000	0.013	n.a.	n.a.
Dug well	59	0.04	0.10	0.21	0.48	0.95	0.17	0.000	0.119	n.a.	n.a.
Surface water	67	0.04	0.11	0.20	0.38	0.77	0.16	0.000	0.164	n.a.	n.a.
Piped into yard or plot	54	0.11	0.20	0.37	0.56	0.82	0.26	0.000	0.000	n.a.	n.a.
Piped into dwelling	48	0.12	0.16	0.21	0.31	0.85	0.18	0.000	0.000	n.a.	n.a.
Public tap/standpipe	44	0.10	0.19	0.33	0.42	0.80	0.23	0.000	0.000	n.a.	n.a.
Spring	22	0.05	0.08	0.16	0.19	0.24	0.10	0.000	0.091	n.a.	n.a.
Other	16	0.04	0.10	0.27	0.56	1.00	0.20	0.000	0.188	n.a.	n.a.

Figure 16b: Strontium levels by water source



Map 16a: **Strontium in shallow tube wells (< 150 m)**



Map 16b: **Strontium in deep tube wells (> 150 m)**

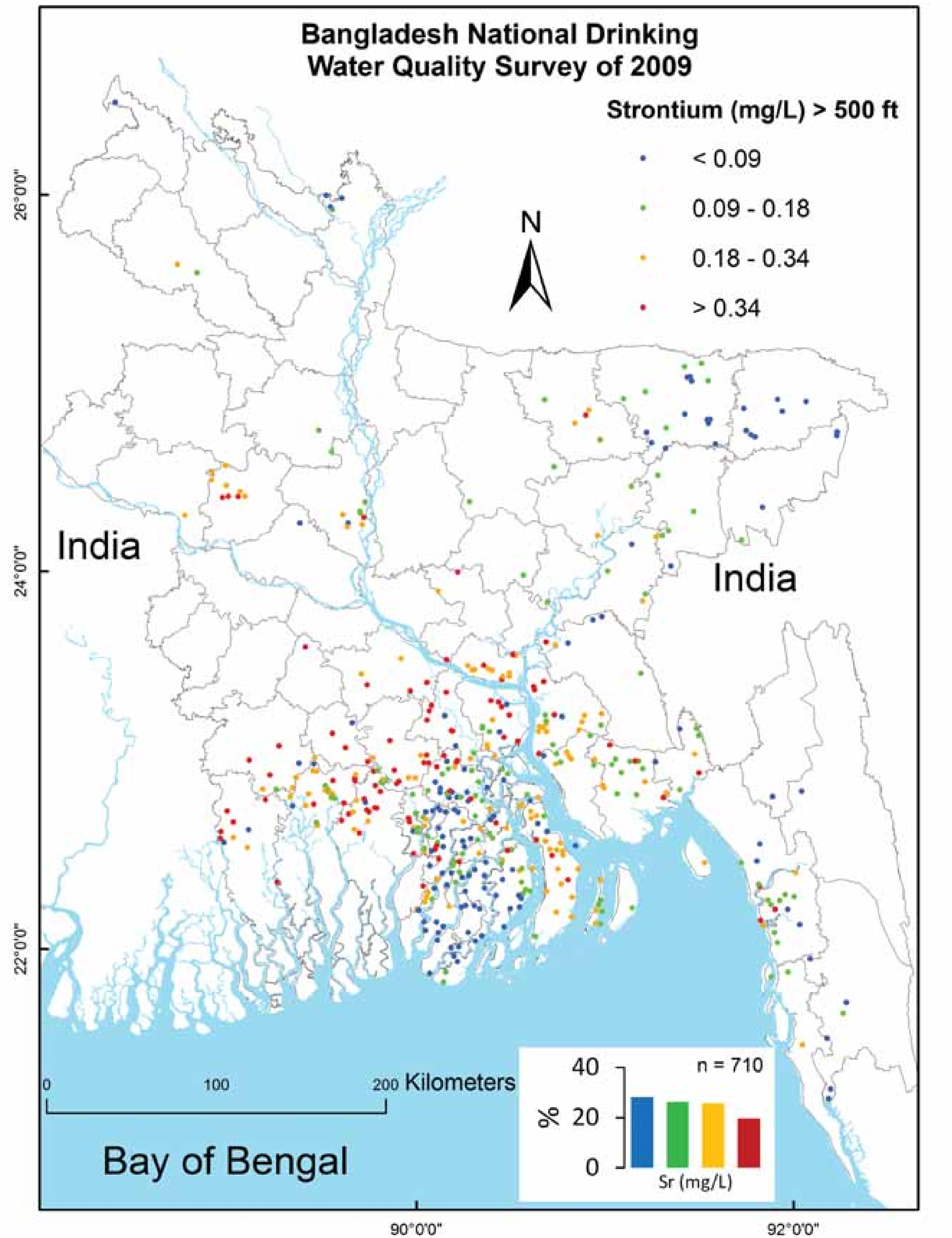


Table 16b: Geographic distribution of strontium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.06	0.06	0.18	0.29	1.20	0.15	0.000	0.029	n.a.	n.a.
Barisal	65	0.07	0.11	0.24	0.48	1.10	0.20	0.000	0.015	n.a.	n.a.
Bhola	36	0.18	0.23	0.29	0.33	0.44	0.23	0.000	0.000	n.a.	n.a.
Jhalokati	26	0.07	0.10	0.25	0.73	1.50	0.24	0.000	0.000	n.a.	n.a.
Patuakhali	46	0.07	0.08	0.10	0.16	0.42	0.10	0.000	0.000	n.a.	n.a.
Pirojpur	40	0.14	0.19	0.31	0.46	1.80	0.28	0.000	0.025	n.a.	n.a.
Barisal Division	*248*	*0.07*	*0.12*	*0.25*	*0.39*	*1.80*	*0.20*	*0.000*	*0.012*	*n.a.*	*n.a.*
Bandarban	44	0.05	0.08	0.15	0.19	0.24	0.10	0.000	0.136	n.a.	n.a.
Brahamanbaria	52	0.10	0.14	0.19	0.32	0.55	0.17	0.000	0.000	n.a.	n.a.
Chandpur	47	0.19	0.25	0.39	0.56	1.10	0.32	0.000	0.000	n.a.	n.a.
Chittagong	92	0.08	0.12	0.21	0.48	1.00	0.19	0.000	0.043	n.a.	n.a.
Comilla	86	0.10	0.15	0.29	0.44	0.75	0.20	0.000	0.035	n.a.	n.a.
Cox's Bazar	38	0.08	0.15	0.36	0.96	2.50	0.33	0.000	0.026	n.a.	n.a.
Feni	38	0.07	0.10	0.15	0.30	0.55	0.13	0.000	0.026	n.a.	n.a.
Khagrachhari	47	0.04	0.08	0.15	0.33	0.95	0.14	0.000	0.064	n.a.	n.a.
Lakshmipur	32	0.18	0.23	0.32	0.55	1.60	0.35	0.000	0.000	n.a.	n.a.
Noakhali	51	0.18	0.23	0.32	0.49	0.85	0.29	0.000	0.000	n.a.	n.a.
Rangamati	56	0.06	0.10	0.15	0.25	0.88	0.14	0.000	0.089	n.a.	n.a.
Chittagong Division	*583*	*0.08*	*0.14*	*0.25*	*0.42*	*2.50*	*0.21*	*0.000*	*0.039*	*n.a.*	*n.a.*
Dhaka	74	0.17	0.22	0.34	0.51	1.30	0.28	0.000	0.000	n.a.	n.a.
Faridpur	48	0.30	0.40	0.52	0.65	1.10	0.42	0.000	0.000	n.a.	n.a.
Gazipur	33	0.13	0.15	0.19	0.24	0.35	0.17	0.000	0.000	n.a.	n.a.
Gopalganj	31	0.30	0.41	0.66	0.76	1.60	0.50	0.000	0.000	n.a.	n.a.
Jamalpur	39	0.08	0.11	0.17	0.30	0.34	0.14	0.000	0.026	n.a.	n.a.
Kishoreganj	75	0.12	0.17	0.26	0.34	0.88	0.20	0.000	0.000	n.a.	n.a.
Madaripur	22	0.36	0.41	0.49	0.64	0.80	0.42	0.000	0.000	n.a.	n.a.
Manikganj	40	0.19	0.27	0.34	0.46	0.54	0.28	0.000	0.000	n.a.	n.a.
Munshiganj	36	0.21	0.35	0.51	0.60	0.99	0.38	0.000	0.000	n.a.	n.a.
Mymensingh	71	0.09	0.14	0.17	0.20	0.34	0.14	0.000	0.014	n.a.	n.a.
Narayanganj	31	0.17	0.27	0.41	0.44	0.82	0.29	0.000	0.000	n.a.	n.a.
Narsingdi	33	0.09	0.12	0.16	0.22	0.48	0.14	0.000	0.000	n.a.	n.a.
Netrakona	53	0.09	0.12	0.18	0.32	0.47	0.15	0.000	0.019	n.a.	n.a.
Rajbari	27	0.27	0.38	0.43	0.60	0.67	0.39	0.000	0.000	n.a.	n.a.
Shariatpur	36	0.26	0.37	0.48	0.77	1.00	0.41	0.000	0.000	n.a.	n.a.
Sherpur	31	0.06	0.09	0.12	0.13	0.13	0.09	0.000	0.065	n.a.	n.a.
Tangail	73	0.09	0.15	0.21	0.32	0.65	0.17	0.000	0.014	n.a.	n.a.
Dhaka Division	*753*	*0.12*	*0.19*	*0.34*	*0.48*	*1.60*	*0.25*	*0.000*	*0.008*	*n.a.*	*n.a.*

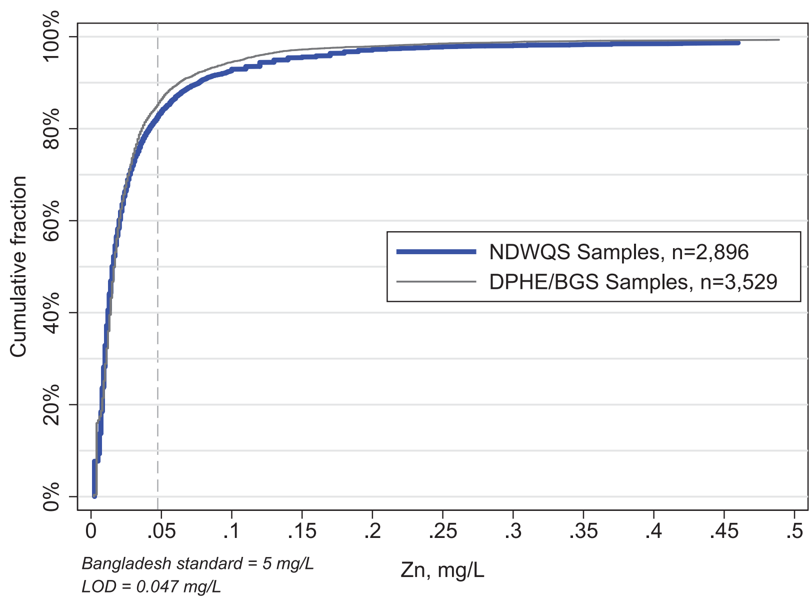
Table 16b: Geographic distribution of strontium, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Stan-dard
Bagerhat	54	0.15	0.37	0.47	0.71	1.80	0.40	0.000	0.074	n.a.	n.a.
Chuadanga	23	0.28	0.32	0.44	0.47	0.49	0.34	0.000	0.000	n.a.	n.a.
Jessore	43	0.24	0.29	0.40	0.54	0.82	0.34	0.000	0.000	n.a.	n.a.
Jhenaidah	36	0.24	0.32	0.42	0.49	0.55	0.32	0.000	0.000	n.a.	n.a.
Khulna	64	0.22	0.27	0.53	0.90	2.30	0.43	0.000	0.000	n.a.	n.a.
Kushtia	35	0.33	0.40	0.50	0.56	1.10	0.42	0.000	0.000	n.a.	n.a.
Magura	27	0.23	0.35	0.45	0.52	0.85	0.35	0.000	0.000	n.a.	n.a.
Meherpur	22	0.34	0.45	0.54	0.65	0.78	0.44	0.000	0.000	n.a.	n.a.
Narail	21	0.37	0.56	0.80	0.90	1.20	0.61	0.000	0.000	n.a.	n.a.
Satkhira	39	0.27	0.38	0.56	0.81	2.40	0.48	0.000	0.026	n.a.	n.a.
Khulna Division	*364*	*0.25*	*0.36*	*0.48*	*0.73*	*2.40*	*0.41*	*0.000*	*0.014*	*n.a.*	*n.a.*
Bogra	72	0.10	0.13	0.20	0.27	0.88	0.17	0.000	0.000	n.a.	n.a.
Dinajpur	82	0.05	0.10	0.14	0.22	0.46	0.12	0.000	0.049	n.a.	n.a.
Gaibandha	40	0.08	0.12	0.15	0.24	0.47	0.14	0.000	0.000	n.a.	n.a.
Joypurhat	31	0.09	0.12	0.15	0.17	0.26	0.12	0.000	0.000	n.a.	n.a.
Kurigram	45	0.08	0.10	0.18	0.35	0.56	0.15	0.000	0.022	n.a.	n.a.
Lalmonirhat	33	0.04	0.05	0.07	0.09	0.58	0.07	0.000	0.182	n.a.	n.a.
Naogaon	57	0.10	0.14	0.20	0.38	1.60	0.19	0.000	0.000	n.a.	n.a.
Natore	37	0.24	0.28	0.43	0.51	0.79	0.35	0.000	0.000	n.a.	n.a.
Nawabganj	32	0.26	0.37	0.46	0.57	0.62	0.36	0.000	0.000	n.a.	n.a.
Nilphamari	34	0.04	0.07	0.12	0.22	0.39	0.10	0.000	0.059	n.a.	n.a.
Pabna	46	0.28	0.33	0.44	0.55	0.79	0.36	0.000	0.000	n.a.	n.a.
Panchagarh	32	0.03	0.04	0.06	0.13	0.20	0.06	0.000	0.219	n.a.	n.a.
Rajshahi	66	0.25	0.34	0.41	0.46	0.63	0.33	0.000	0.000	n.a.	n.a.
Rangpur	49	0.04	0.07	0.10	0.21	0.32	0.09	0.000	0.041	n.a.	n.a.
Sirajganj	42	0.12	0.18	0.26	0.41	0.49	0.21	0.000	0.000	n.a.	n.a.
Thakurgaon	33	0.05	0.08	0.11	0.25	0.47	0.11	0.000	0.061	n.a.	n.a.
Rajshahi Division	*731*	*0.08*	*0.13*	*0.26*	*0.41*	*1.60*	*0.19*	*0.000*	*0.033*	*n.a.*	*n.a.*
Habiganj	47	0.08	0.11	0.14	0.24	0.42	0.13	0.000	0.021	n.a.	n.a.
Maulvi Bazar	41	0.03	0.07	0.10	0.13	0.21	0.07	0.000	0.171	n.a.	n.a.
Sunamganj	65	0.05	0.09	0.12	0.15	0.62	0.09	0.000	0.123	n.a.	n.a.
Sylhet	64	0.02	0.05	0.09	0.15	0.34	0.07	0.000	0.297	n.a.	n.a.
Sylhet Division	*217*	*0.05*	*0.08*	*0.13*	*0.15*	*0.62*	*0.09*	*0.000*	*0.161*	*n.a.*	*n.a.*
Grand Total	***2896***	***0.09***	***0.16***	***0.31***	***0.47***	***2.50***	***0.23***	***0.000***	***0.033***	***n.a.***	***n.a.***

ZINC (ZN)

The Bangladesh standard for zinc in drinking water is 5 mg/L. There is no WHO guideline value for zinc, though in 1984 a guideline value of 5.0 mg/L was set based on taste considerations. The 1993 edition of the Guidelines for Drinking Water Quality removed this guideline value, while noting that drinking-water containing zinc at levels above 3 mg/litre may not be acceptable to consumers.

Figure 17: **Zinc distribution, with 100% of samples meeting the Bangladesh standard of 5.0 mg/L.**



The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 51.4% that the NDWQS distribution is greater than the DPHE/BGS distribution. However, the magnitude of the difference is small.

Table 17a: Zinc levels by water source

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.01	0.02	0.03	0.08	5.50	0.04	0.074	0.828	1.000	1.000
Deep tubewell	526	0.01	0.01	0.02	0.06	1.90	0.03	0.103	0.873	1.000	1.000
Dug well	59	0.01	0.02	0.04	0.10	1.20	0.06	0.068	0.780	1.000	1.000
Surface water	67	0.01	0.02	0.05	0.27	2.00	0.13	0.090	0.746	1.000	1.000
Piped into yard or plot	54	0.01	0.03	0.05	0.08	0.20	0.04	0.074	0.796	1.000	1.000
Piped into dwelling	48	0.02	0.05	0.17	0.61	1.80	0.21	0.042	0.479	1.000	1.000
Public tap/standpipe	44	0.02	0.03	0.04	0.08	0.68	0.05	0.023	0.796	1.000	1.000
Spring	22	0.02	0.02	0.03	0.37	0.58	0.08	0.046	0.818	1.000	1.000
Other	16	0.01	0.02	0.15	0.91	1.10	0.18	0.063	0.688	1.000	1.000

Figure 17b: Zinc levels by water source

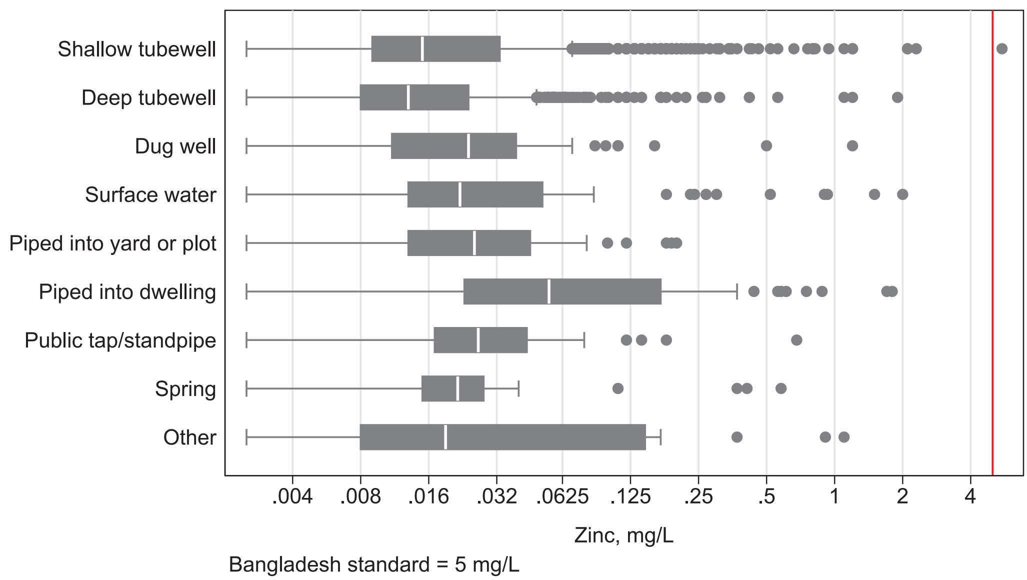


Table 17b: Geographic distribution of zinc

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.006	0.009	0.019	0.029	0.310	0.021	0.200	0.943	n.a.	1.000
Barisal	65	0.006	0.009	0.017	0.056	0.300	0.026	0.123	0.862	n.a.	1.000
Bhola	36	0.009	0.014	0.033	0.058	0.220	0.031	0.028	0.833	n.a.	1.000
Jhalokati	26	0.006	0.009	0.014	0.022	0.027	0.010	0.231	1.000	n.a.	1.000
Patuakhali	46	0.007	0.010	0.015	0.024	0.052	0.012	0.152	0.978	n.a.	1.000
Pirojpur	40	0.006	0.014	0.020	0.041	0.900	0.038	0.225	0.925	n.a.	1.000
Barisal Division	*248*	*0.006*	*0.010*	*0.018*	*0.042*	*0.900*	*0.024*	*0.153*	*0.915*	*n.a.*	*1.000*
Bandarban	44	0.014	0.023	0.035	0.063	0.930	0.065	0.045	0.841	n.a.	1.000
Brahamanbaria	52	0.024	0.035	0.061	0.100	1.200	0.068	0.019	0.654	n.a.	1.000
Chandpur	47	0.010	0.014	0.031	0.076	0.560	0.041	0.085	0.830	n.a.	1.000
Chittagong	92	0.007	0.012	0.022	0.078	1.200	0.048	0.087	0.859	n.a.	1.000
Comilla	86	0.007	0.016	0.039	0.120	1.800	0.073	0.093	0.814	n.a.	1.000
Cox's Bazar	38	0.006	0.015	0.038	0.044	0.250	0.032	0.184	0.921	n.a.	1.000
Feni	38	0.008	0.014	0.022	0.100	5.500	0.198	0.026	0.868	n.a.	0.974
Khagrachhari	47	0.017	0.026	0.045	0.083	0.370	0.043	0.000	0.787	n.a.	1.000
Lakshmipur	32	0.009	0.015	0.026	0.078	0.180	0.031	0.063	0.844	n.a.	1.000
Noakhali	51	0.009	0.016	0.056	0.120	1.100	0.056	0.039	0.725	n.a.	1.000
Rangamati	56	0.010	0.021	0.030	0.110	0.580	0.048	0.107	0.804	n.a.	1.000
Chittagong Division	*583*	*0.009*	*0.018*	*0.037*	*0.085*	*5.500*	*0.062*	*0.070*	*0.811*	*n.a.*	*0.998*
Dhaka	74	0.033	0.050	0.072	0.130	0.580	0.072	0.000	0.486	n.a.	1.000
Faridpur	48	0.010	0.013	0.028	0.062	0.230	0.028	0.042	0.833	n.a.	1.000
Gazipur	33	0.028	0.041	0.069	0.095	0.190	0.052	0.000	0.636	n.a.	1.000
Gopalganj	31	0.007	0.011	0.016	0.029	0.059	0.014	0.129	0.968	n.a.	1.000
Jamalpur	39	0.010	0.020	0.034	0.068	0.220	0.032	0.026	0.795	n.a.	1.000
Kishoreganj	75	0.010	0.016	0.032	0.110	0.820	0.047	0.027	0.773	n.a.	1.000
Madaripur	22	0.008	0.012	0.028	0.120	0.800	0.067	0.000	0.818	n.a.	1.000
Manikganj	40	0.008	0.011	0.021	0.043	0.140	0.019	0.075	0.900	n.a.	1.000
Munshiganj	36	0.013	0.022	0.055	0.150	0.350	0.055	0.056	0.722	n.a.	1.000
Mymensingh	71	0.006	0.011	0.023	0.051	1.100	0.036	0.183	0.873	n.a.	1.000
Narayanganj	31	0.019	0.034	0.060	0.120	0.190	0.049	0.000	0.677	n.a.	1.000
Narsingdi	33	0.012	0.019	0.052	0.078	0.370	0.044	0.030	0.727	n.a.	1.000
Netrakona	53	0.009	0.014	0.045	0.073	0.180	0.032	0.057	0.792	n.a.	1.000
Rajbari	27	0.003	0.007	0.011	0.013	0.210	0.016	0.296	0.926	n.a.	1.000
Shariatpur	36	0.012	0.018	0.038	0.093	2.100	0.087	0.056	0.833	n.a.	1.000
Sherpur	31	0.015	0.020	0.035	0.051	0.310	0.038	0.065	0.871	n.a.	1.000
Tangail	73	0.010	0.015	0.023	0.047	0.180	0.024	0.082	0.904	n.a.	1.000
Dhaka Division	*753*	*0.010*	*0.018*	*0.040*	*0.081*	*2.100*	*0.042*	*0.065*	*0.788*	*n.a.*	*1.000*

Table 17b: Geographic distribution of zinc, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.010	0.020	0.038	0.230	2.000	0.127	0.074	0.759	n.a.	1.000
Chuadanga	23	0.003	0.013	0.026	0.037	0.067	0.018	0.304	0.913	n.a.	1.000
Jessore	43	0.010	0.020	0.037	0.061	0.140	0.029	0.070	0.860	n.a.	1.000
Jhenaidah	36	0.008	0.017	0.024	0.034	0.048	0.018	0.083	0.972	n.a.	1.000
Khulna	64	0.010	0.017	0.030	0.055	1.900	0.070	0.063	0.875	n.a.	1.000
Kushtia	35	0.007	0.011	0.028	0.043	0.430	0.032	0.143	0.914	n.a.	1.000
Magura	27	0.009	0.014	0.023	0.027	2.300	0.103	0.000	0.926	n.a.	1.000
Meherpur	22	0.009	0.014	0.040	0.081	0.120	0.031	0.000	0.773	n.a.	1.000
Narail	21	0.013	0.022	0.054	0.097	0.170	0.041	0.048	0.714	n.a.	1.000
Satkhira	39	0.008	0.014	0.021	0.041	0.210	0.023	0.128	0.923	n.a.	1.000
Khulna Division	*364*	*0.009*	*0.015*	*0.029*	*0.061*	*2.300*	*0.055*	*0.088*	*0.865*	*n.a.*	*1.000*
Bogra	72	0.011	0.016	0.041	0.170	1.200	0.066	0.028	0.792	n.a.	1.000
Dinajpur	82	0.009	0.014	0.023	0.053	0.420	0.027	0.049	0.866	n.a.	1.000
Gaibandha	40	0.007	0.011	0.047	0.095	0.200	0.032	0.125	0.775	n.a.	1.000
Joypurhat	31	0.008	0.014	0.037	0.080	0.800	0.051	0.065	0.774	n.a.	1.000
Kurigram	45	0.010	0.016	0.023	0.046	0.140	0.024	0.044	0.911	n.a.	1.000
Lalmonirhat	33	0.008	0.013	0.023	0.036	0.130	0.020	0.091	0.939	n.a.	1.000
Naogaon	57	0.011	0.019	0.028	0.060	0.120	0.027	0.070	0.842	n.a.	1.000
Natore	37	0.009	0.014	0.036	0.078	0.160	0.030	0.027	0.811	n.a.	1.000
Nawabganj	32	0.016	0.039	0.120	0.170	0.760	0.090	0.031	0.531	n.a.	1.000
Nilphamari	34	0.010	0.013	0.036	0.048	0.560	0.037	0.059	0.853	n.a.	1.000
Pabna	46	0.009	0.018	0.031	0.064	0.230	0.034	0.065	0.804	n.a.	1.000
Panchagarh	32	0.008	0.016	0.021	0.028	0.037	0.015	0.063	1.000	n.a.	1.000
Rajshahi	66	0.010	0.016	0.035	0.160	0.420	0.043	0.076	0.818	n.a.	1.000
Rangpur	49	0.007	0.010	0.034	0.090	2.100	0.069	0.102	0.776	n.a.	1.000
Sirajganj	42	0.008	0.016	0.033	0.054	0.170	0.026	0.119	0.857	n.a.	1.000
Thakurgaon	33	0.008	0.018	0.027	0.060	0.190	0.028	0.091	0.818	n.a.	1.000
Rajshahi Division	*731*	*0.009*	*0.015*	*0.033*	*0.078*	*2.100*	*0.039*	*0.067*	*0.825*	*n.a.*	*1.000*
Habiganj	47	0.010	0.015	0.029	0.049	0.140	0.025	0.043	0.894	n.a.	1.000
Maulvi Bazar	41	0.014	0.032	0.048	0.083	0.680	0.069	0.024	0.732	n.a.	1.000
Sunamganj	65	0.006	0.008	0.014	0.028	0.940	0.033	0.169	0.923	n.a.	1.000
Sylhet	64	0.011	0.022	0.056	0.170	1.700	0.090	0.031	0.734	n.a.	1.000
Sylhet Division	*217*	*0.008*	*0.015*	*0.035*	*0.079*	*1.700*	*0.055*	*0.074*	*0.825*	*n.a.*	*1.000*
Grand Total	***2896***	***0.009***	***0.015***	***0.034***	***0.077***	***5.500***	***0.046***	***0.078***	***0.825***	***n.a.***	***1.000***

TRACE ELEMENTS

For many of the trace elements measured, most samples were below detection limits. For these chemicals, only a short description of the data is made. Geographic distribution maps and tables are shown only for those chemicals having a significant proportion of samples above detection limits.

ANTIMONY (SB)

The WHO guideline value for antimony is 0.02 mg/L, and all samples measured were well below this level. There is no Bangladesh drinking water standard for antimony.

Antimony was below the detection limit (0.0005 mg/L) in 93% of samples. Of the 210 samples with detectable antimony, only seven (7) measured more than 0.001 mg/L:

District	Antimony, mg/L
Bagerhat	0.0018
Dhaka	0.0011
Dhaka	0.0017
Habiganj	0.0019
Madaripur	0.0012
Pabna	0.003
Rangamati	0.0015

With such a low number of samples with detectable antimony, no further analysis is made.

ARSENIC (AS)

The Bangladesh standard for arsenic in drinking water is 0.05 mg/L. The WHO provisional guideline value is 0.01 mg/L. Visible symptoms are more frequent at concentrations above approximately 0.2 mg/L; this level is indicated with dark blue shading in the following tables.

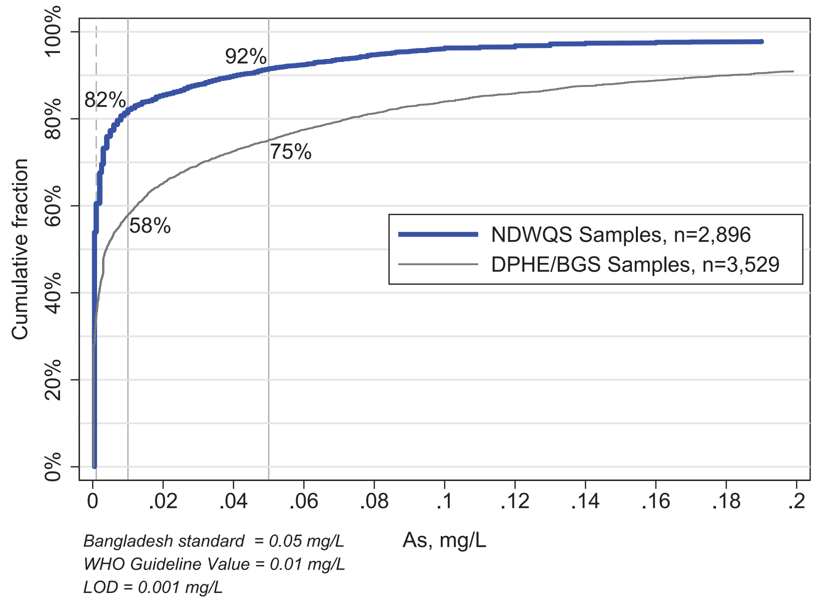
The health effects of chronic exposure to even low concentrations of arsenic can be quite severe, and are both visible and invisible. Exposure to arsenic can result in skin lesions, hardening of the skin, dark spots on hands and feet, swollen limbs and loss of feeling from hands and legs. Lesions are easily infected, pose a threat of gangrene and can be very painful. Lesions can appear quickly if arsenic concentrations are very high. Malnourished people are more likely to develop skin lesions than well-nourished people. The invisible impacts of long-term exposure to arsenic include internal cancers of the lungs, bladder and kidney, which can be fatal. Long-term exposure to arsenic also increases the mortality rate from heart attacks and other cardio-pulmonary diseases. Exposure to arsenic can impair cognitive development in children. In general children are particularly vulnerable to arsenic poisoning and are much more likely to face health impacts than adults.

Nearly 15,000 samples were analyzed for arsenic in Bangladesh, using Digital Arsenators. About 20% of these samples were sent to the reference laboratory for cross-checking. Results from the laboratory and Arsenator datasets are presented separately, and the two datasets are compared afterwards.

ARSENIC (LABORATORY)

According to the laboratory data, 8% of samples exceeded the Bangladesh standard, while 18% exceeded the WHO provisional guideline value.

Figure 18: **Arsenic distribution (laboratory data), with 92% of samples meeting the Bangladesh standard of 0.05 mg/L**

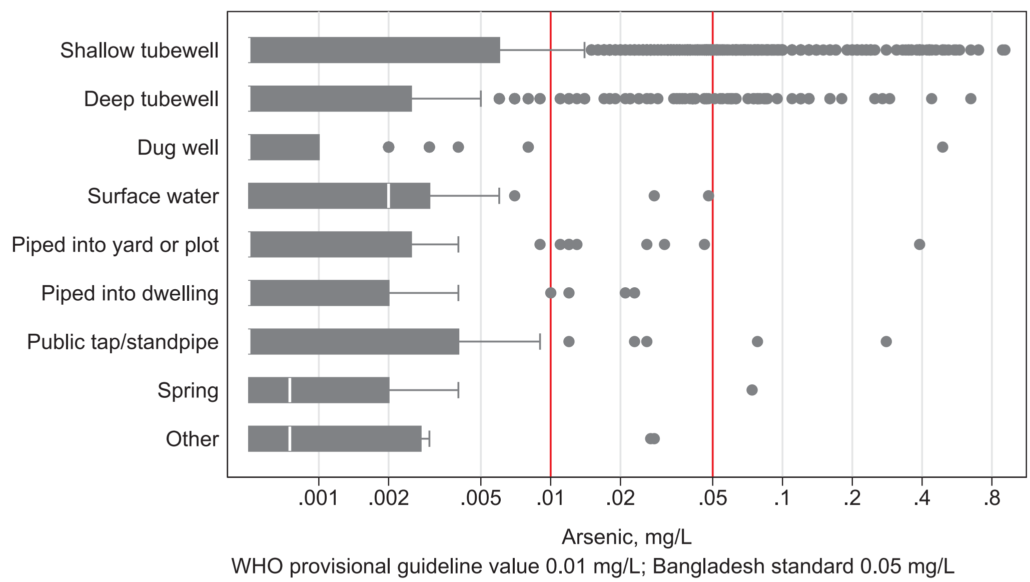


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 64.6% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 18a: Arsenic levels by water source (laboratory data)

District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Shallow tubewell	2060	0.001	0.006	0.050	0.910	0.021	0.556	0.597	0.796	0.901	0.974
Deep tubewell	526	0.001	0.003	0.035	0.650	0.012	0.588	0.627	0.857	0.930	0.991
Dug well	59	0.001	0.001	0.003	0.490	0.010	0.627	0.763	0.983	0.983	0.983
Surface water	67	0.002	0.003	0.004	0.048	0.003	0.299	0.433	0.970	1.000	1.000
Piped into yard or plot	54	0.001	0.003	0.012	0.390	0.011	0.685	0.685	0.852	0.982	0.982
Piped into dwelling	48	0.001	0.002	0.004	0.023	0.002	0.563	0.708	0.938	1.000	1.000
Public tap/standpipe	44	0.001	0.004	0.012	0.280	0.011	0.546	0.546	0.886	0.955	0.977
Spring	22	0.001	0.002	0.003	0.074	0.005	0.500	0.591	0.955	0.955	1.000
Other	16	0.001	0.003	0.027	0.028	0.004	0.563	0.688	0.875	1.000	1.000

Figure 18b: Arsenic levels by water source (laboratory data)



Map 18a: **Arsenic levels by laboratory tests**

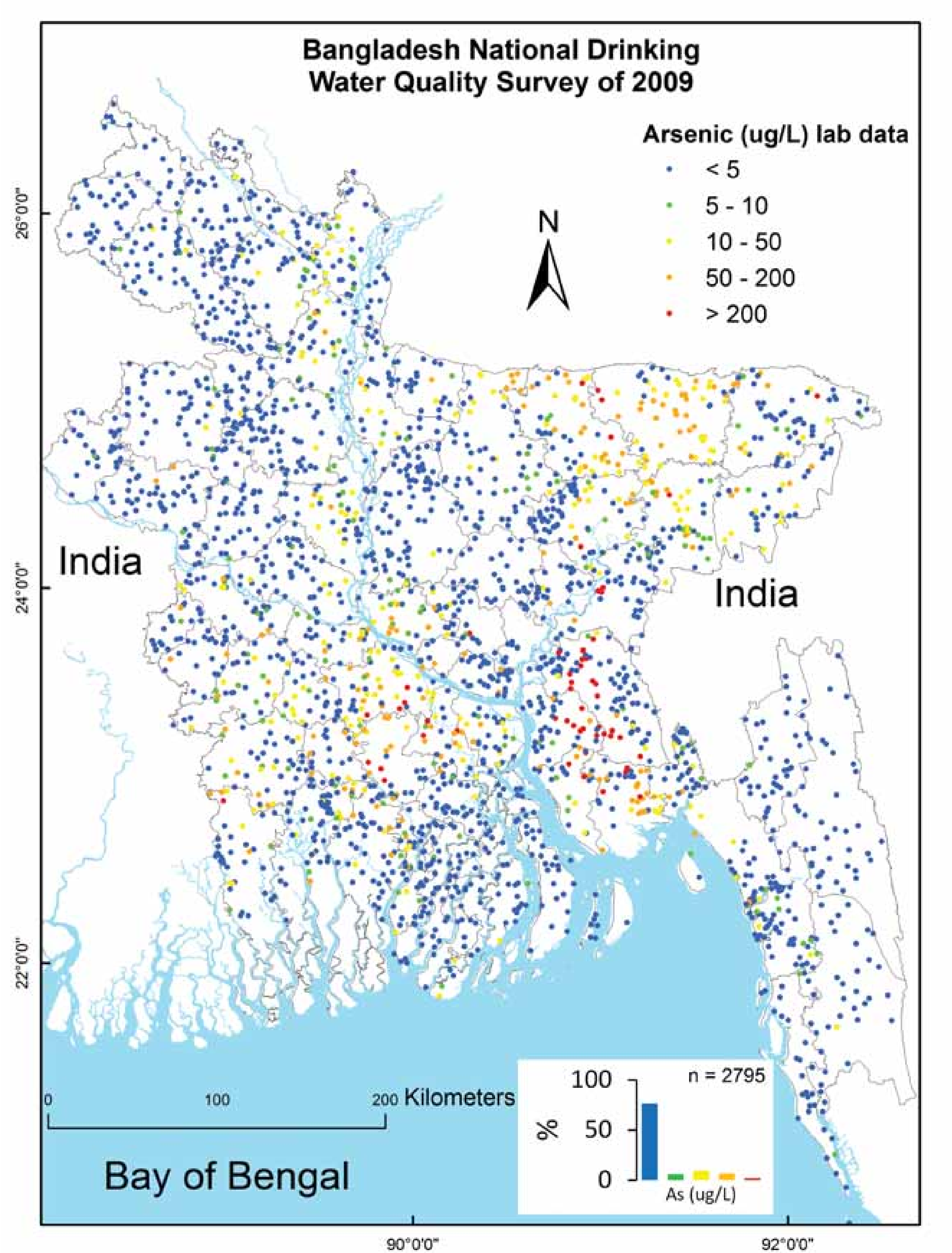


Table 18b: Geographic distribution of arsenic (laboratory tests)

District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Barguna	35	0.001	0.002	0.003	0.004	0.001	0.543	0.657	1.000	1.000	1.000
Barisal	65	0.001	0.002	0.004	0.130	0.004	0.539	0.600	0.954	0.985	1.000
Bhola	36	0.001	0.001	0.001	0.003	0.001	0.778	0.944	1.000	1.000	1.000
Jhalokati	26	0.001	0.003	0.005	0.014	0.002	0.577	0.615	0.962	1.000	1.000
Patuakhali	46	0.001	0.001	0.006	0.012	0.002	0.717	0.783	0.935	1.000	1.000
Pirojpur	40	0.002	0.005	0.043	0.068	0.009	0.375	0.425	0.850	0.950	1.000
Barisal Division	*248*	*0.001*	*0.002*	*0.004*	*0.130*	*0.003*	*0.585*	*0.665*	*0.948*	*0.988*	*1.000*
Bandarban	44	0.001	0.002	0.004	0.012	0.002	0.568	0.682	0.977	1.000	1.000
Brahamanbaria	52	0.001	0.002	0.006	0.560	0.030	0.654	0.731	0.904	0.904	0.923
Chandpur	47	0.002	0.190	0.390	0.910	0.107	0.319	0.383	0.723	0.723	0.766
Chittagong	92	0.001	0.004	0.010	0.073	0.005	0.598	0.609	0.902	0.978	1.000
Comilla	86	0.001	0.010	0.430	0.890	0.090	0.488	0.547	0.756	0.802	0.814
Cox's Bazar	38	0.001	0.001	0.003	0.009	0.001	0.737	0.842	1.000	1.000	1.000
Feni	38	0.002	0.004	0.012	0.075	0.006	0.421	0.447	0.868	0.947	1.000
Khagrachhari	47	0.001	0.001	0.002	0.004	0.001	0.809	0.872	1.000	1.000	1.000
Lakshmipur	32	0.004	0.071	0.130	0.700	0.065	0.344	0.406	0.625	0.719	0.906
Noakhali	51	0.024	0.100	0.310	0.700	0.093	0.353	0.333	0.471	0.569	0.863
Rangamati	56	0.001	0.002	0.002	0.006	0.001	0.589	0.679	1.000	1.000	1.000
Chittagong Division	*583*	*0.001*	*0.004*	*0.079*	*0.910*	*0.038*	*0.540*	*0.595*	*0.841*	*0.880*	*0.930*
Dhaka	74	0.001	0.002	0.007	0.220	0.008	0.662	0.716	0.905	0.946	0.987
Faridpur	48	0.032	0.078	0.210	0.460	0.068	0.125	0.146	0.313	0.667	0.896
Gazipur	33	0.001	0.001	0.001	0.001	0.001	0.939	1.000	1.000	1.000	1.000
Gopalganj	31	0.036	0.120	0.170	0.330	0.071	0.387	0.161	0.452	0.548	0.903
Jamalpur	39	0.001	0.010	0.026	0.170	0.010	0.564	0.590	0.821	0.974	1.000
Kishoreganj	75	0.001	0.010	0.048	0.280	0.014	0.480	0.533	0.760	0.907	0.987
Madaripur	22	0.005	0.051	0.200	0.440	0.064	0.364	0.364	0.546	0.727	0.909
Manikganj	40	0.006	0.034	0.069	0.093	0.019	0.325	0.350	0.675	0.825	1.000
Munshiganj	36	0.001	0.001	0.004	0.084	0.006	0.694	0.778	0.917	0.944	1.000
Mymensingh	71	0.001	0.006	0.027	0.076	0.008	0.578	0.634	0.817	0.944	1.000
Narayanganj	31	0.001	0.003	0.005	0.098	0.009	0.645	0.677	0.903	0.903	1.000
Narsingdi	33	0.001	0.001	0.003	0.097	0.007	0.758	0.849	0.909	0.939	1.000
Netrakona	53	0.015	0.069	0.130	0.280	0.047	0.283	0.302	0.434	0.679	0.962
Rajbari	27	0.002	0.020	0.070	0.160	0.018	0.444	0.482	0.704	0.889	1.000
Shariatpur	36	0.002	0.017	0.048	0.071	0.012	0.500	0.472	0.722	0.917	1.000
Sherpur	31	0.001	0.001	0.006	0.110	0.006	0.645	0.774	0.903	0.968	1.000
Tangail	73	0.001	0.002	0.004	0.036	0.002	0.616	0.726	0.973	1.000	1.000
Dhaka Division	*753*	*0.001*	*0.009*	*0.063*	*0.460*	*0.020*	*0.529*	*0.568*	*0.761*	*0.881*	*0.981*

Table 18b: Geographic distribution of arsenic (laboratory tests), continued

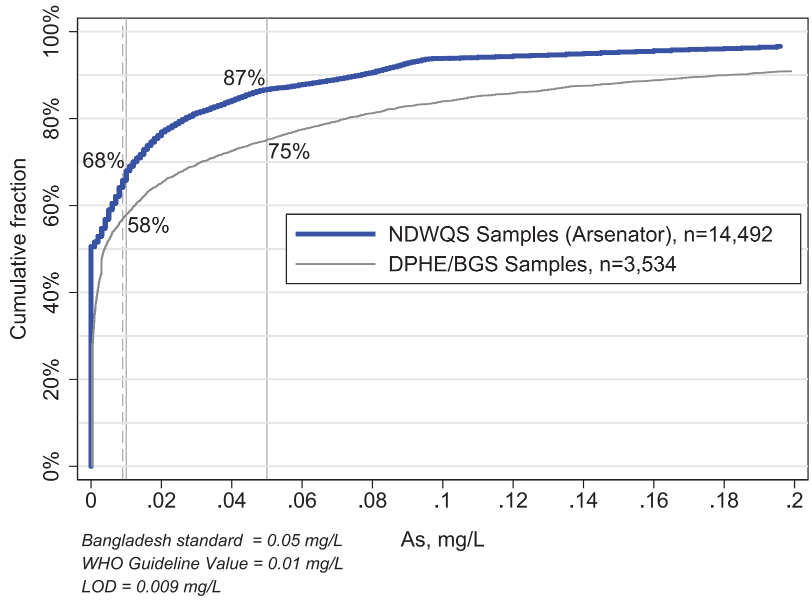
District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Bagerhat	54	0.002	0.003	0.036	0.130	0.010	0.482	0.444	0.870	0.926	1.000
Chuadanga	23	0.001	0.002	0.006	0.069	0.006	0.696	0.739	0.913	0.913	1.000
Jessore	43	0.002	0.038	0.063	0.270	0.024	0.419	0.419	0.674	0.861	0.977
Jhenaidah	36	0.002	0.010	0.025	0.076	0.009	0.417	0.472	0.806	0.944	1.000
Khulna	64	0.002	0.005	0.019	0.160	0.010	0.578	0.484	0.828	0.938	1.000
Kushtia	35	0.002	0.010	0.049	0.130	0.015	0.400	0.457	0.771	0.914	1.000
Magura	27	0.001	0.018	0.028	0.036	0.008	0.444	0.556	0.741	1.000	1.000
Meherpur	22	0.001	0.001	0.004	0.024	0.002	0.636	0.818	0.955	1.000	1.000
Narail	21	0.001	0.005	0.039	0.120	0.015	0.429	0.571	0.762	0.905	1.000
Satkhira	39	0.003	0.023	0.045	0.210	0.019	0.385	0.333	0.692	0.923	0.974
Khulna Division	*364*	*0.002*	*0.007*	*0.039*	*0.270*	*0.013*	*0.484*	*0.497*	*0.797*	*0.929*	*0.995*
Bogra	72	0.001	0.001	0.002	0.013	0.001	0.847	0.875	0.986	1.000	1.000
Dinajpur	82	0.001	0.001	0.003	0.020	0.001	0.805	0.829	0.976	1.000	1.000
Gaibandha	40	0.002	0.011	0.039	0.079	0.010	0.425	0.450	0.750	0.975	1.000
Joypurhat	31	0.001	0.001	0.003	0.028	0.002	0.774	0.839	0.968	1.000	1.000
Kurigram	45	0.001	0.006	0.022	0.047	0.006	0.489	0.556	0.844	1.000	1.000
Lalmonirhat	33	0.001	0.001	0.014	0.042	0.004	0.727	0.758	0.879	1.000	1.000
Naogaon	57	0.001	0.001	0.004	0.035	0.002	0.772	0.842	0.965	1.000	1.000
Natore	37	0.001	0.001	0.001	0.007	0.001	0.865	0.919	1.000	1.000	1.000
Nawabganj	32	0.001	0.001	0.004	0.096	0.006	0.750	0.875	0.938	0.938	1.000
Nilphamari	34	0.001	0.001	0.003	0.007	0.001	0.706	0.794	1.000	1.000	1.000
Pabna	46	0.001	0.001	0.008	0.037	0.003	0.783	0.804	0.913	1.000	1.000
Panchagarh	32	0.001	0.002	0.002	0.004	0.001	0.656	0.688	1.000	1.000	1.000
Rajshahi	66	0.001	0.001	0.003	0.091	0.005	0.849	0.849	0.939	0.939	1.000
Rangpur	49	0.001	0.002	0.016	0.031	0.004	0.653	0.674	0.898	1.000	1.000
Sirajganj	42	0.001	0.014	0.022	0.076	0.009	0.429	0.524	0.691	0.952	1.000
Thakurgaon	33	0.001	0.001	0.002	0.004	0.001	0.788	0.818	1.000	1.000	1.000
Rajshahi Division	*731*	*0.001*	*0.001*	*0.006*	*0.096*	*0.004*	*0.721*	*0.765*	*0.925*	*0.988*	*1.000*
Habiganj	47	0.010	0.042	0.096	0.240	0.033	0.170	0.213	0.532	0.787	0.979
Maulvi Bazar	41	0.004	0.018	0.052	0.100	0.016	0.439	0.463	0.634	0.878	1.000
Sunamganj	65	0.046	0.071	0.095	0.350	0.056	0.062	0.108	0.154	0.569	0.969
Sylhet	64	0.001	0.005	0.041	0.230	0.012	0.453	0.578	0.828	0.922	0.984
Sylhet Division	217	0.009	0.046	0.078	0.350	0.030	0.272	0.336	0.525	0.779	0.982
Grand Total	***2,896***	***0.001***	***0.004***	***0.041***	***0.910***	***0.018***	***0.559***	***0.605***	***0.821***	***0.915***	***0.979***

Note: 25[th] percentiles were below the LOD for all districts except Faridpur (0.005), Gopalganj (0.003), and Habiganj (0.002).

ARSENIC (DIGITAL ARSENATOR)

According to the Digital Arsenator data, 13.4% of samples exceeded the Bangladesh standard, while 32.0% exceeded the WHO provisional guideline value

Figure 19: **Arsenic distribution (Digital Arsenator data)**

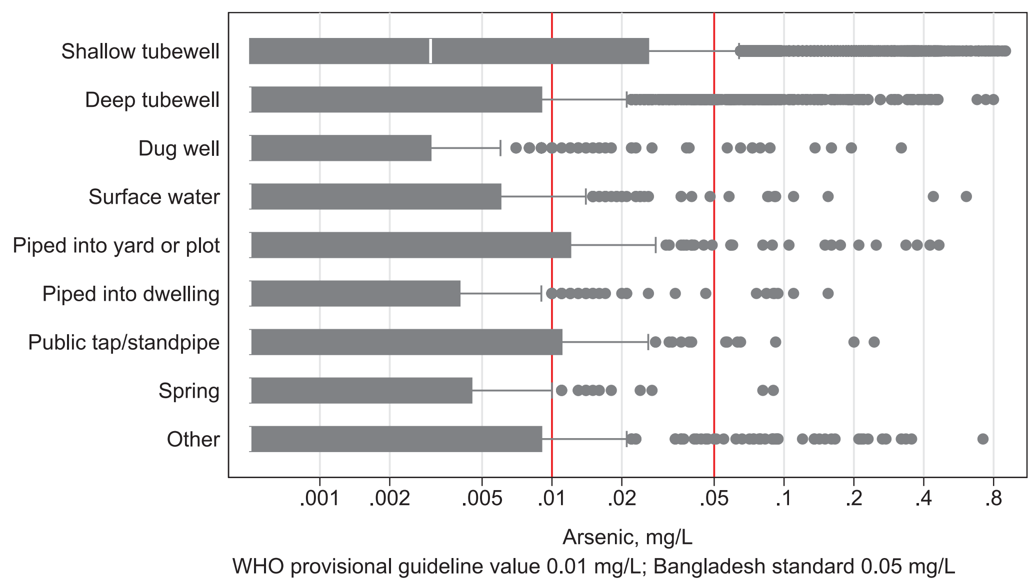


The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 56.2% that the DPHE/BGS distribution is greater than the NDWQS distribution.

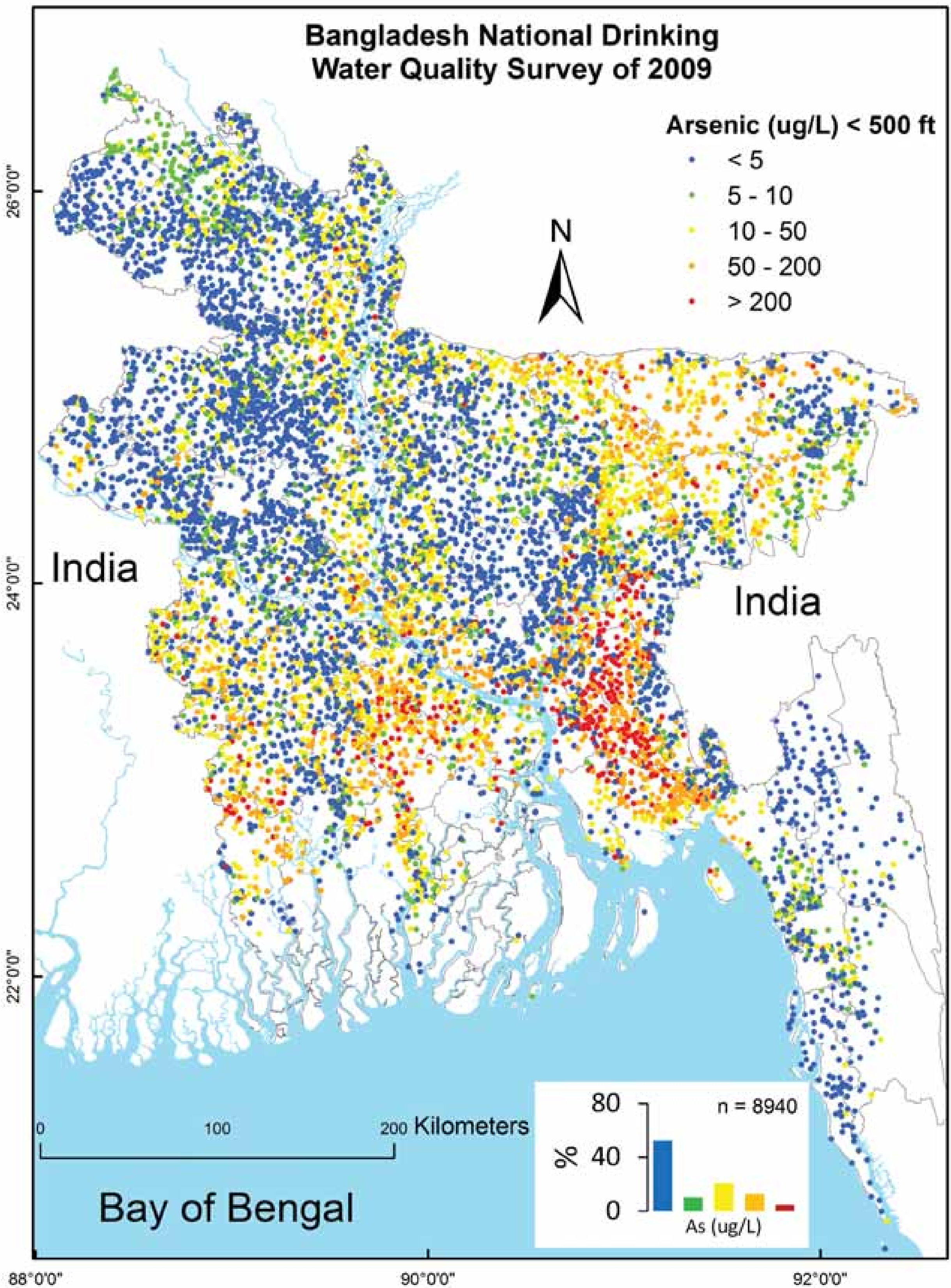
Table 19a: Arsenic levels by water source (Digital Arsenator data)

District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Shallow tubewell	10066	0.003	0.026	0.087	0.900	0.032	0.546	0.611	0.629	0.836	0.957
Deep tubewell	2636	0.000	0.009	0.034	0.800	0.015	0.678	0.751	0.781	0.925	0.986
Dug well	242	0.000	0.003	0.013	0.320	0.008	0.781	0.851	0.880	0.959	0.996
Surface water	346	0.000	0.006	0.015	0.610	0.009	0.725	0.815	0.841	0.974	0.994
Piped into yard or plot	204	0.000	0.012	0.038	0.465	0.020	0.662	0.716	0.740	0.927	0.971
Piped into dwelling	231	0.000	0.004	0.012	0.155	0.006	0.766	0.831	0.866	0.970	1.000
Public tap/standpipe	163	0.000	0.011	0.025	0.245	0.011	0.595	0.736	0.749	0.957	0.988
Spring	116	0.000	0.005	0.011	0.090	0.004	0.767	0.836	0.879	0.983	1.000
Other	438	0.000	0.009	0.036	0.720	0.017	0.669	0.753	0.785	0.918	0.977

Figure 19b: Arsenic levels by water source (Digital Arsenator data)



Map 19a: Arsenic levels (arsenator data) in shallow tubewells (<150 m)



Map 19b: Arsenic levels (Arsenator data) in deep tubewells (>150 m)

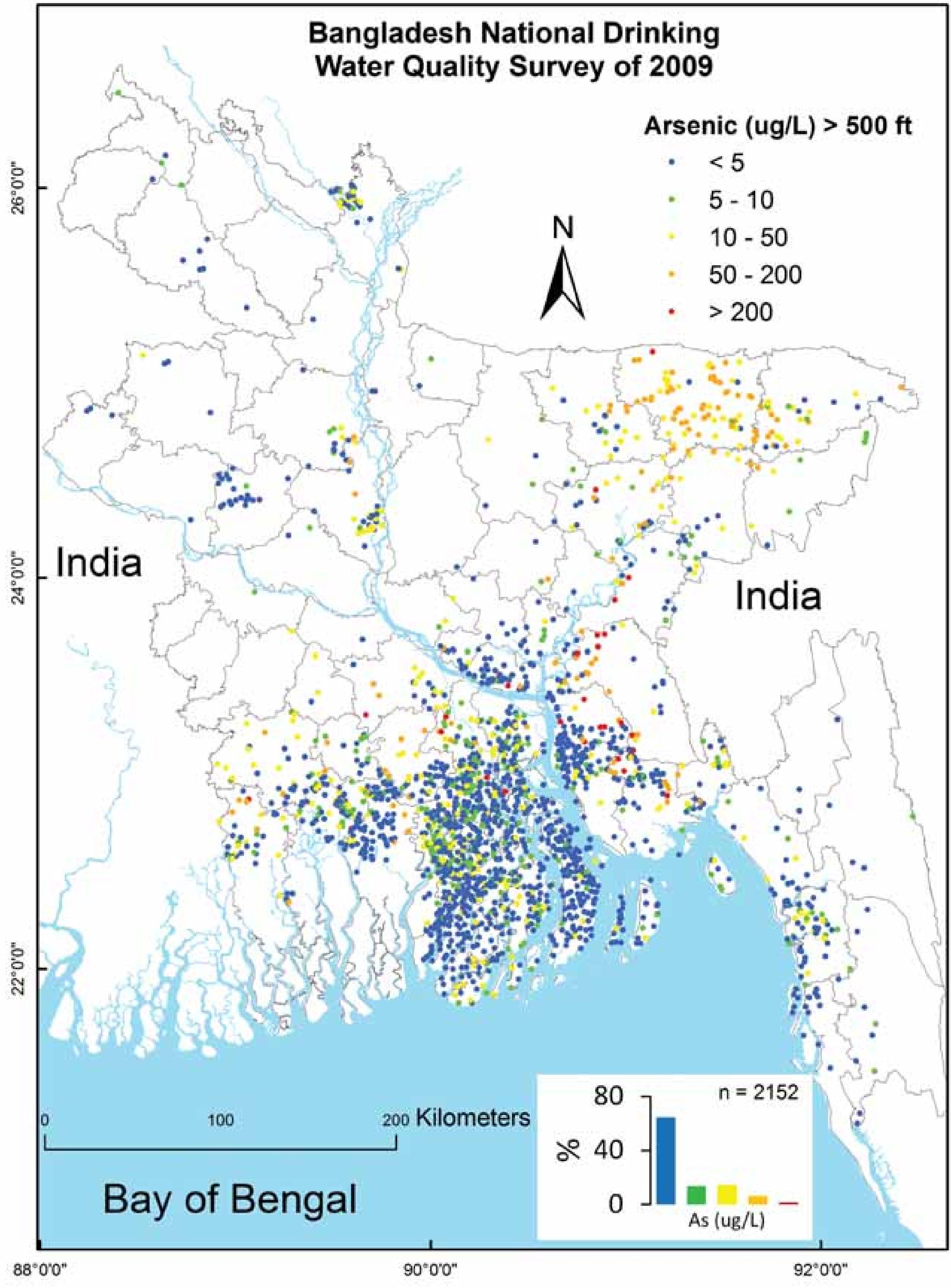


Table 19b: Geographic distribution of arsenic (Digital Arsenator data)

District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Barguna	158	0.000	0.000	0.001	0.020	0.001	0.968	0.981	0.981	1.000	1.000
Barisal	327	0.000	0.004	0.015	0.720	0.011	0.786	0.850	0.881	0.973	0.982
Bhola	205	0.000	0.000	0.004	0.030	0.001	0.917	0.951	0.976	1.000	1.000
Jhalokati	131	0.000	0.008	0.014	0.120	0.006	0.718	0.802	0.840	0.985	1.000
Patuakhali	200	0.000	0.008	0.015	0.026	0.004	0.705	0.790	0.835	1.000	1.000
Pirojpur	211	0.007	0.012	0.021	0.205	0.011	0.450	0.640	0.697	0.976	0.995
Barisal Division	*1232*	*0.000*	*0.005*	*0.014*	*0.720*	*0.006*	*0.753*	*0.833*	*0.866*	*0.987*	*0.994*
Bandarban	208	0.000	0.005	0.010	0.026	0.003	0.774	0.880	0.904	1.000	1.000
Brahamanbaria	237	0.004	0.083	0.350	0.800	0.083	0.549	0.574	0.578	0.692	0.827
Chandpur	232	0.006	0.215	0.380	0.890	0.127	0.496	0.513	0.513	0.556	0.733
Chittagong	440	0.004	0.011	0.025	0.440	0.014	0.550	0.689	0.736	0.939	0.989
Comilla	436	0.044	0.195	0.345	0.900	0.117	0.397	0.417	0.424	0.514	0.755
Cox's Bazar	199	0.000	0.000	0.002	0.050	0.001	0.950	0.975	0.975	0.995	1.000
Feni	187	0.008	0.073	0.089	0.710	0.041	0.455	0.529	0.535	0.701	0.968
Khagrachhari	234	0.000	0.000	0.000	0.057	0.000	0.987	0.987	0.987	0.996	1.000
Lakshmipur	161	0.010	0.046	0.130	0.830	0.060	0.435	0.478	0.503	0.770	0.919
Noakhali	261	0.019	0.091	0.255	0.870	0.083	0.364	0.406	0.422	0.602	0.870
Rangamati	285	0.000	0.000	0.010	0.042	0.003	0.804	0.863	0.902	1.000	1.000
Chittagong Division	*2880*	*0.000*	*0.027*	*0.185*	*0.900*	*0.051*	*0.597*	*0.651*	*0.669*	*0.787*	*0.907*
Dhaka	337	0.000	0.000	0.016	0.240	0.008	0.852	0.875	0.887	0.950	0.994
Faridpur	258	0.032	0.088	0.205	0.455	0.067	0.233	0.271	0.275	0.640	0.892
Gazipur	160	0.000	0.000	0.000	0.185	0.002	0.956	0.956	0.963	0.988	1.000
Gopalganj	155	0.046	0.130	0.220	0.430	0.084	0.226	0.252	0.271	0.529	0.852
Jamalpur	206	0.001	0.011	0.033	0.205	0.010	0.583	0.714	0.733	0.956	0.995
Kishoreganj	367	0.011	0.037	0.078	0.450	0.032	0.392	0.480	0.499	0.807	0.973
Madaripur	133	0.019	0.089	0.220	0.475	0.068	0.241	0.353	0.376	0.662	0.872
Manikganj	197	0.013	0.039	0.082	0.760	0.033	0.325	0.406	0.442	0.792	0.980
Munshiganj	188	0.000	0.037	0.150	0.790	0.044	0.660	0.670	0.681	0.761	0.942
Mymensingh	331	0.004	0.013	0.037	0.460	0.013	0.541	0.653	0.683	0.952	0.997
Narayanganj	109	0.000	0.009	0.093	0.235	0.023	0.651	0.762	0.771	0.844	0.982
Narsingdi	182	0.000	0.016	0.084	0.640	0.029	0.670	0.698	0.714	0.857	0.967
Netrakona	288	0.024	0.067	0.105	0.390	0.046	0.278	0.323	0.347	0.691	0.962
Rajbari	130	0.000	0.018	0.064	0.315	0.020	0.654	0.677	0.700	0.892	0.985
Shariatpur	180	0.006	0.015	0.054	0.445	0.023	0.500	0.628	0.667	0.894	0.978
Sherpur	160	0.000	0.011	0.030	0.280	0.011	0.650	0.719	0.744	0.963	0.994
Tangail	341	0.000	0.015	0.030	0.210	0.011	0.663	0.716	0.733	0.965	0.997
Dhaka Division	*3722*	*0.004*	*0.027*	*0.084*	*0.790*	*0.029*	*0.531*	*0.594*	*0.614*	*0.840*	*0.967*

Table 19b: Geographic distribution of arsenic (Digital Arsenator data), continued

District	Samples	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
Bagerhat	256	0.000	0.006	0.040	0.810	0.017	0.750	0.789	0.793	0.914	0.981
Chuadanga	131	0.013	0.037	0.070	0.365	0.029	0.374	0.466	0.473	0.824	0.985
Jessore	235	0.013	0.053	0.145	0.610	0.045	0.404	0.451	0.472	0.740	0.945
Jhenaidah	176	0.009	0.033	0.075	0.260	0.023	0.443	0.506	0.517	0.858	0.989
Khulna	337	0.005	0.016	0.061	0.610	0.020	0.502	0.614	0.656	0.896	0.982
Kushtia	164	0.005	0.017	0.033	0.105	0.013	0.549	0.659	0.665	0.945	1.000
Magura	131	0.010	0.039	0.082	0.445	0.032	0.473	0.496	0.512	0.809	0.970
Meherpur	106	0.019	0.037	0.071	0.365	0.038	0.311	0.377	0.406	0.830	0.943
Narail	106	0.010	0.064	0.165	0.310	0.043	0.462	0.481	0.509	0.726	0.943
Satkhira	210	0.017	0.070	0.170	0.690	0.056	0.314	0.391	0.400	0.714	0.929
Khulna Division	*1852*	*0.007*	*0.030*	*0.083*	*0.810*	*0.030*	*0.477*	*0.546*	*0.564*	*0.834*	*0.968*
Bogra	337	0.000	0.001	0.018	0.190	0.006	0.819	0.843	0.855	0.970	1.000
Dinajpur	349	0.000	0.000	0.005	0.029	0.002	0.903	0.937	0.948	1.000	1.000
Gaibandha	209	0.010	0.024	0.049	0.350	0.021	0.450	0.498	0.546	0.904	0.986
Joypurhat	161	0.000	0.005	0.012	0.043	0.004	0.758	0.845	0.888	1.000	1.000
Kurigram	259	0.000	0.016	0.033	0.275	0.012	0.595	0.637	0.672	0.961	0.996
Lalmonirhat	157	0.000	0.004	0.012	0.045	0.003	0.777	0.860	0.879	1.000	1.000
Naogaon	294	0.000	0.000	0.016	0.051	0.004	0.796	0.816	0.830	0.997	1.000
Natore	179	0.000	0.000	0.003	0.068	0.001	0.939	0.967	0.972	0.994	1.000
Nawabganj	160	0.000	0.014	0.060	0.250	0.017	0.700	0.731	0.744	0.881	0.988
Nilphamari	185	0.004	0.010	0.015	0.044	0.006	0.568	0.741	0.789	1.000	1.000
Pabna	254	0.000	0.010	0.037	0.290	0.016	0.661	0.728	0.756	0.913	0.980
Panchagarh	151	0.008	0.009	0.012	0.020	0.008	0.272	0.815	0.874	1.000	1.000
Rajshahi	322	0.000	0.001	0.020	0.370	0.008	0.801	0.857	0.870	0.960	0.994
Rangpur	213	0.000	0.006	0.015	0.072	0.005	0.732	0.826	0.836	0.991	1.000
Sirajganj	244	0.005	0.018	0.040	0.190	0.014	0.525	0.598	0.631	0.943	1.000
Thakurgaon	160	0.000	0.000	0.002	0.038	0.001	0.956	0.975	0.975	1.000	1.000
Rajshahi Division	*3634*	*0.000*	*0.008*	*0.020*	*0.370*	*0.008*	*0.717*	*0.793*	*0.815*	*0.969*	*0.996*
Habiganj	234	0.013	0.038	0.088	0.270	0.030	0.368	0.432	0.462	0.812	0.979
Maulvi Bazar	202	0.010	0.041	0.083	0.230	0.029	0.183	0.436	0.525	0.807	0.995
Sunamganj	306	0.048	0.082	0.110	0.355	0.059	0.131	0.157	0.160	0.520	0.977
Sylhet	380	0.001	0.021	0.075	0.440	0.022	0.634	0.684	0.697	0.842	0.987
Sylhet Division	1122	0.015	0.052	0.089	0.440	0.035	0.360	0.443	0.471	0.742	0.984
Grand Total	***14442***	***0.000***	***0.018***	***0.077***	***0.900***	***0.027***	***0.590***	***0.658***	***0.680***	***0.866***	***0.966***

Note: 25th percentiles were below the LOD for all districts except Faridpur (0.008), Gopalganj (0.008), Madaripur (0.006), Satkhira (0.002), Panchagarh (0.005), Maulvi Bazar (0.007) and Sunamganj (0.024).

LABORATORY AND DIGITAL ARSENATOR COMPARISON

The distributions of arsenic found in the laboratory and digital arsenator datasets are substantially different. In the laboratory data, only 8.5% and 17.9% of samples exceed the Bangladesh standard and WHO guideline value, respectively. The larger Digital Arsenator set finds higher levels of contamination: 13.4% and 32.1% above these limits. One possible explanation for this difference would be a systematic bias among one of the analytical methods – for instance, if the Digital Arsenator consistently gave higher results than the laboratory tests. However, analysis of replicates indicates that this is not the case. Of the 1,925 samples for which both Digital Arsenator and laboratory data are available, the correlation is very good, with an r^2 of 0.906. The slope of 1.03, while greater than unity, is not large enough to account for the difference in distributions. See the Appendix for further discussion of the differences between these datasets. Correlation plots and distribution frequencies serve to validate the Digital Arsenator results above 0.01 mg/L. Since the Digital Arsenator dataset is much larger than the laboratory dataset, this dataset is much more powerful especially for disaggregated analysis. Therefore, greater weight should be given to the Arsenator dataset for risk assessment.

ARSENIC IN DEEP TUBEWELLS

Both the laboratory data and the Arsenator data find substantial proportions of deep tubewells with elevated arsenic levels (approximately 7% above 0.05 mg/L in both datasets). This contrasts with hydrogeological studies which find samples collected directly from deep tubewells to be largely free from arsenic contamination. The DPHE/BGS survey, for example, tested 327 deep tubewells and found arsenic above 0.05 mg/L in only 3 cases (< 1%).

One explanation may be that people report using a deep tubewell, but actually the water sampled is shallow groundwater. This could happen if:

- Respondents report using a deep tubewell while actually using a shallow tubewell
- The reported 'deep tubewell' is actually screened at < 150 m and should have been classified as 'shallow'
- The deep tubewell has leaking joints in shallow strata, which allow infiltration of arsenic-contaminated shallow groundwater into the borehole

There are confirmed reports of arsenic in deep groundwater in the Khulna region (i.e. parts of Jessore and Satkhira) as well as in the Sylhet basin (i.e. parts of Sunamganj). Map 19b suggests that low-level contamination of deep wells in Sunamganj and surrounding districts is widespread; this is consistent with the geology of the Sylhet basin. Indeed, 5 of the 8 deep wells tested in the DPHE/BGS survey in Sylhet division contained more than 0.01 mg/L arsenic, and 5 of the top 6 were in Sunamganj district.

Although the first step is to confirm the depth of the self reported deep tube wells, sporadic occurrence of high arsenic in deep groundwater underlying shallow groundwater with high arsenic is worrisome. With deep tube wells being increasingly used for arsenic mitigation, the quality of construction to prevent arsenic infiltration from shallow depth is an item worthy of attention –leaking joints have caused apparent contamination in some deep tubewells. Better mapping and understanding of the hydrogeology of deep aquifers is essential. Furthermore, a monitoring network for deep groundwater needs to be established for sustainable development and management of this precious resource for drinking water supply. For example, it may be advisable to put regulatory limits on the pumping rate of deep tube wells to avoid excessive draw down and pollution of the deep groundwater.

SELF-REPORTED TESTING STATUS

In the MICS surveys, respondents were asked if the source of their drinking water had been tested for arsenic, and whether or not they knew the results. Tables 19c and 19d show that respondents who self-reported using red tubewells as a drinking water source had the highest arsenic levels, with 27% above 0.2 mg/L. However, 13% of these samples were below 0.01 mg/L. Nearly 90% of those who self-reported taking drinking water from green tubewells had drinking water meeting the national standard of 0.05 mg/L. In terms of arsenic distribution, sources which were not tested, or which were tested but results were unknown, were similar to sources which were reportedly tested and found safe (green).

Table 19c: Distribution of arsenic levels in mg/L (Digital Arsenator data) by self-reported testing status

Reported testing status of drinking water source	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Red	0.037	0.087	0.210	0.365	0.900	0.142	0.111	0.130	0.133	0.326
Green	0.000	0.001	0.018	0.057	0.790	0.021	0.582	0.648	0.671	0.891
Tested, don't know results	0.000	0.003	0.026	0.085	0.890	0.033	0.543	0.609	0.630	0.838
Not tested	0.000	0.000	0.011	0.047	0.840	0.020	0.642	0.718	0.739	0.903
Don't know / missing	0.000	0.000	0.013	0.064	0.640	0.019	0.638	0.701	0.720	0.885

Table 19d: Proportion of samples with different arsenic levels (Digital Arsenator data) by self-reported testing status

Reported testing status of drinking water source	Samples	< 0.01 mg/L	0.010 – 0.049 mg/L	0.050 – 0.199 mg/L	>= 0.200 mg/L
Red	679	0.133	0.193	0.404	**0.271**
Green	4,803	0.671	0.220	0.092	0.017
Tested, don't know results	1,072	0.630	0.208	0.122	0.040
Not tested	6,529	0.739	0.164	0.073	0.024
Don't know / missing	1,359	0.734	0.158	0.091	0.016
Total	14,442	0.680	0.187	0.100	0.034

DIFFERENCES WITH SUMMARY MICS REPORT OF 2010

The distribution of arsenic in drinking water reported in this detailed report differs slightly from that in the Summary MICS report of 2010[9], even though both reports use the underlying dataset.

Table 19c: Comparison of arsenic distribution (Digital Arsenatordata) in the MICS Summary Report and the NDWQS Report

	Arsenic Test Value (mg/L)						Number of samples tested
	< 0.01	0.010 – 0.049	0.050 – 0.199	> 0.200	< 0.05	>= 0.05	
Summary Report 2010	76.9	10.5	9.5	3.1	87.4	12.6	13,423
NDWQS Report 2011	68.0	18.7	10.0	3.4	86.6	13.4	14,442

The differences are negligible for samples above 0.05 mg/L, and both reports agree that about 13% of households samples nationwide exceeded the 0.05 mg/L national standard. At lower concentrations, this detailed report indicates a higher proportion of samples in the 0.01 – 0.049 mg/L range, and a lower proportion of samples in the < 0.01 mg/L range. This may be due to the fact that raw data were processed by separate teams for the two reports. With more time in hand, less data were discarded in this report because more time is available to carefully match their origins.

[9] BBS/UNICEF. (2010). "Multiple Indicator Cluster Survey 2009: Volume 1, Technical Report." Bangladesh Bureau of Statistics/UNICEF, Dhaka. Table 19, page 113.

BERYLLIUM (BE)

There is no WHO guideline value for beryllium (Be), nor is there any Bangladesh drinking water standard.

Beryllium was below the method detection limit (0.0005 mg/L) in 99.4% of samples. Of the 18 samples with detectable beryllium, only seven (7) measured more than 0.001 mg/L:

District	Beryllium, mg/L
Chittagong	0.0011
Maulvi Bazar	0.0025
Maulvi Bazar	0.0011
Maulvi Bazar	0.0012
Mymensingh	0.0013
Mymensingh	0.0065
Narsingdi	0.0012

With such a low number of samples with detectable beryllium, no further analysis is made.

BISMUTH (BI)

There is no WHO guideline value for bismuth (Bi), nor is there any Bangladesh drinking water standard.

Bismuth was detected in only 4 samples (0.1%):

District	Bismuth, mg/L
Dhaka	0.001
Gopalganj	0.003
Satkhira	0.001
Habiganj	0.001

With such a low number of samples with detectable bismuth, no further analysis is made.

CADMIUM(CD)

Cadmium (Cd) is used in metal plating, plastics, pigments and batteries. It is carcinogenic when inhaled, but there is no evidence that ingestion through drinking water can cause cancer. The WHO guideline value of 0.003 mg/L is set to protect against kidney damage. The Bangladesh standard is 0.005 mg/L.

Although cadmium was measured in the laboratory, and precision among laboratory replicates was high, analysis of field quality control samples revealed significant contamination of blanks and poor reproducibility among field replicates. Cadmium levels were in fact very similar in blanks and field samples. For these reasons, cadmium data from this survey are not considered reliable and are not analyzed further.

CHROMIUM (CR)

Both the WHO guideline value and the Bangladesh standard for chromium are set at 0.05 mg/L. The guideline value is designated as provisional because of uncertainties in the toxicological database.

Chromium was below the detection limit (0.005 mg/L) in 97.7% of samples. Of the 67 samples with detectable chromium, only eighteen measured more than 0.01 mg/L:

District	Chromium, mg/L
Dhaka	0.015
Dhaka	0.017
Dinajpur	0.011
Gazipur	0.011
Gazipur	0.014
Kishoreganj	0.011
Kishoreganj	0.015
Kishoreganj	0.016
Magura	0.059
Mymensingh	0.012
Narsingdi	0.011
Narsingdi	0.011
Pabna	0.015
Tangail	0.011
Tangail	0.011
Tangail	0.013
Tangail	0.017
Tangail	0.020

With such a low number of samples with detectable chromium, no further analysis is made.

COBALT (CO)

There is no WHO guideline value for cobalt, nor is there any Bangladesh drinking water standard.

Figure 20: **Cobalt distribution**

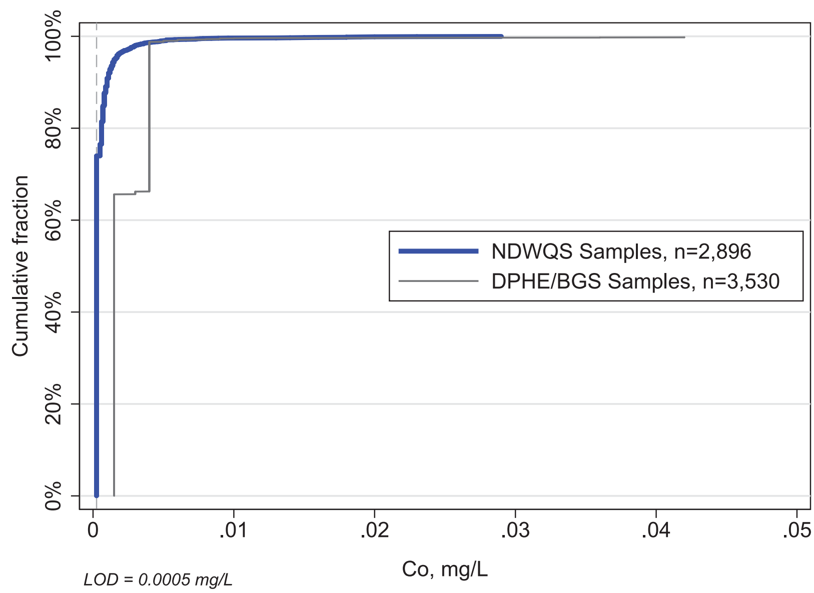


Table 20: Geographic distribution of cobalt

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.0003	0.0003	0.0003	0.0003	0.0006	0.0003	0.943	0.943	n.a.	n.a.
Barisal	65	0.0003	0.0003	0.0003	0.0003	0.0012	0.0003	0.954	0.954	n.a.	n.a.
Bhola	36	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	1.000	1.000	n.a.	n.a.
Jhalokati	26	0.0003	0.0003	0.0003	0.0010	0.0025	0.0005	0.885	0.846	n.a.	n.a.
Patuakhali	46	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.913	0.913	n.a.	n.a.
Pirojpur	40	0.0003	0.0003	0.0003	0.0008	0.0025	0.0004	0.800	0.775	n.a.	n.a.
Barisal Division	*248*	*0.0003*	*0.0003*	*0.0003*	*0.0003*	*0.0025*	*0.0003*	*0.919*	*0.911*	*n.a.*	*n.a.*
Bandarban	44	0.0003	0.0003	0.0003	0.0012	0.0031	0.0005	0.864	0.864	n.a.	n.a.
Brahamanbaria	52	0.0003	0.0006	0.0010	0.0016	0.0061	0.0008	0.462	0.462	n.a.	n.a.
Chandpur	47	0.0003	0.0003	0.0006	0.0008	0.0040	0.0005	0.681	0.681	n.a.	n.a.
Chittagong	92	0.0003	0.0003	0.0003	0.0011	0.0200	0.0008	0.793	0.793	n.a.	n.a.
Comilla	86	0.0003	0.0004	0.0008	0.0019	0.0073	0.0008	0.500	0.500	n.a.	n.a.
Cox's Bazar	38	0.0003	0.0003	0.0003	0.0017	0.0180	0.0010	0.763	0.763	n.a.	n.a.
Feni	38	0.0003	0.0003	0.0006	0.0014	0.0066	0.0008	0.658	0.658	n.a.	n.a.
Khagrachhari	47	0.0003	0.0003	0.0006	0.0017	0.0089	0.0008	0.723	0.723	n.a.	n.a.
Lakshmipur	32	0.0003	0.0003	0.0003	0.0007	0.0015	0.0004	0.813	0.813	n.a.	n.a.
Noakhali	51	0.0003	0.0003	0.0005	0.0008	0.0014	0.0004	0.686	0.686	n.a.	n.a.
Rangamati	56	0.0003	0.0003	0.0007	0.0027	0.0074	0.0008	0.732	0.732	n.a.	n.a.
Chittagong Division	*583*	*0.0003*	*0.0003*	*0.0006*	*0.0014*	*0.0200*	*0.0007*	*0.686*	*0.686*	*n.a.*	*n.a.*
Dhaka	74	0.0003	0.0003	0.0003	0.0008	0.0036	0.0004	0.797	0.797	n.a.	n.a.
Faridpur	48	0.0003	0.0003	0.0003	0.0006	0.0017	0.0004	0.833	0.833	n.a.	n.a.
Gazipur	33	0.0003	0.0003	0.0006	0.0008	0.0052	0.0005	0.727	0.727	n.a.	n.a.
Gopalganj	31	0.0003	0.0003	0.0003	0.0007	0.0014	0.0004	0.839	0.839	n.a.	n.a.
Jamalpur	39	0.0003	0.0003	0.0006	0.0009	0.0015	0.0005	0.667	0.641	n.a.	n.a.
Kishoreganj	75	0.0003	0.0003	0.0008	0.0014	0.0027	0.0006	0.573	0.573	n.a.	n.a.
Madaripur	22	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.955	0.955	n.a.	n.a.
Manikganj	40	0.0003	0.0003	0.0003	0.0006	0.0010	0.0003	0.875	0.875	n.a.	n.a.
Munshiganj	36	0.0003	0.0010	0.0024	0.0036	0.0052	0.0015	0.417	0.417	n.a.	n.a.
Mymensingh	71	0.0003	0.0003	0.0005	0.0014	0.0076	0.0006	0.718	0.718	n.a.	n.a.
Narayanganj	31	0.0003	0.0003	0.0012	0.0018	0.0073	0.0009	0.548	0.548	n.a.	n.a.
Narsingdi	33	0.0003	0.0003	0.0008	0.0013	0.0025	0.0006	0.545	0.545	n.a.	n.a.
Netrakona	53	0.0003	0.0003	0.0003	0.0008	0.0024	0.0004	0.792	0.792	n.a.	n.a.
Rajbari	27	0.0003	0.0003	0.0006	0.0011	0.0018	0.0005	0.667	0.667	n.a.	n.a.
Shariatpur	36	0.0003	0.0003	0.0003	0.0003	0.0006	0.0003	0.944	0.944	n.a.	n.a.
Sherpur	31	0.0003	0.0003	0.0008	0.0013	0.0027	0.0007	0.548	0.548	n.a.	n.a.
Tangail	73	0.0003	0.0003	0.0006	0.0010	0.0034	0.0005	0.726	0.726	n.a.	n.a.
Dhaka Division	*753*	*0.0003*	*0.0003*	*0.0006*	*0.0011*	*0.0076*	*0.0005*	*0.716*	*0.714*	*n.a.*	*n.a.*

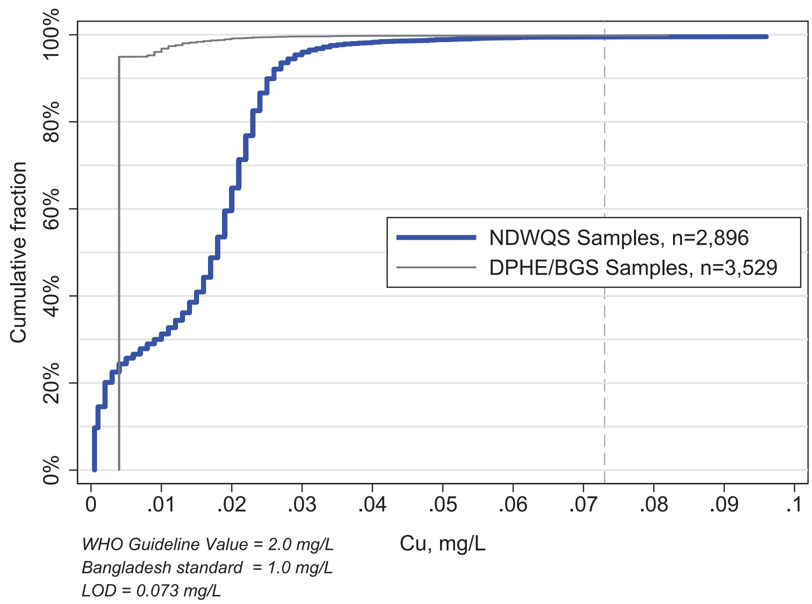
Table 20: Geographic distribution of cobalt, continued

District	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.0003	0.0003	0.0003	0.0003	0.0007	0.0003	0.963	0.963	n.a.	n.a.
Chuadanga	23	0.0003	0.0003	0.0003	0.0006	0.0007	0.0003	0.826	0.826	n.a.	n.a.
Jessore	43	0.0003	0.0003	0.0005	0.0008	0.0012	0.0004	0.744	0.744	n.a.	n.a.
Jhenaidah	36	0.0003	0.0003	0.0006	0.0010	0.0013	0.0005	0.667	0.667	n.a.	n.a.
Khulna	64	0.0003	0.0003	0.0003	0.0007	0.0030	0.0004	0.781	0.781	n.a.	n.a.
Kushtia	35	0.0003	0.0003	0.0003	0.0008	0.0010	0.0003	0.857	0.857	n.a.	n.a.
Magura	27	0.0003	0.0003	0.0008	0.0009	0.0014	0.0005	0.630	0.630	n.a.	n.a.
Meherpur	22	0.0003	0.0003	0.0003	0.0005	0.0008	0.0003	0.864	0.864	n.a.	n.a.
Narail	21	0.0003	0.0003	0.0007	0.0011	0.0012	0.0005	0.524	0.524	n.a.	n.a.
Satkhira	39	0.0003	0.0003	0.0003	0.0006	0.0009	0.0003	0.846	0.846	n.a.	n.a.
Khulna Division	*364*	*0.0003*	*0.0003*	*0.0003*	*0.0007*	*0.0030*	*0.0004*	*0.788*	*0.788*	*n.a.*	*n.a.*
Bogra	72	0.0003	0.0003	0.0006	0.0012	0.0020	0.0005	0.722	0.722	n.a.	n.a.
Dinajpur	82	0.0003	0.0003	0.0005	0.0007	0.0018	0.0004	0.732	0.732	n.a.	n.a.
Gaibandha	40	0.0003	0.0003	0.0006	0.0015	0.0021	0.0005	0.725	0.725	n.a.	n.a.
Joypurhat	31	0.0003	0.0003	0.0008	0.0010	0.0017	0.0005	0.581	0.581	n.a.	n.a.
Kurigram	45	0.0003	0.0003	0.0003	0.0007	0.0014	0.0004	0.778	0.756	n.a.	n.a.
Lalmonirhat	33	0.0003	0.0003	0.0003	0.0003	0.0011	0.0003	0.909	0.909	n.a.	n.a.
Naogaon	57	0.0003	0.0003	0.0006	0.0012	0.0037	0.0006	0.702	0.702	n.a.	n.a.
Natore	37	0.0003	0.0003	0.0003	0.0007	0.0011	0.0004	0.811	0.811	n.a.	n.a.
Nawabganj	32	0.0003	0.0003	0.0003	0.0003	0.0011	0.0003	0.906	0.906	n.a.	n.a.
Nilphamari	34	0.0003	0.0003	0.0005	0.0012	0.0027	0.0005	0.735	0.735	n.a.	n.a.
Pabna	46	0.0003	0.0003	0.0007	0.0011	0.0046	0.0006	0.630	0.630	n.a.	n.a.
Panchagarh	32	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003	0.969	0.969	n.a.	n.a.
Rajshahi	66	0.0003	0.0003	0.0003	0.0008	0.0016	0.0004	0.803	0.803	n.a.	n.a.
Rangpur	49	0.0003	0.0003	0.0006	0.0009	0.0018	0.0005	0.653	0.653	n.a.	n.a.
Sirajganj	42	0.0003	0.0003	0.0003	0.0010	0.0036	0.0005	0.762	0.762	n.a.	n.a.
Thakurgaon	33	0.0003	0.0003	0.0003	0.0007	0.0017	0.0004	0.848	0.848	n.a.	n.a.
Rajshahi Division	*731*	*0.0003*	*0.0003*	*0.0003*	*0.0009*	*0.0046*	*0.0004*	*0.757*	*0.755*	*n.a.*	*n.a.*
Habiganj	47	0.0003	0.0003	0.0003	0.0009	0.0014	0.0004	0.787	0.787	n.a.	n.a.
Maulvi Bazar	41	0.0003	0.0003	0.0022	0.0140	0.1300	0.0058	0.561	0.561	n.a.	n.a.
Sunamganj	65	0.0003	0.0003	0.0006	0.0009	0.0017	0.0004	0.692	0.692	n.a.	n.a.
Sylhet	64	0.0003	0.0003	0.0013	0.0052	0.0290	0.0022	0.531	0.531	n.a.	n.a.
Sylhet Division	*217*	*0.0003*	*0.0003*	*0.0007*	*0.0023*	*0.1300*	*0.0020*	*0.641*	*0.641*	*n.a.*	*n.a.*
Grand Total	***2896***	***0.0003***	***0.0003***	***0.0005***	***0.0010***	***0.1300***	***0.0006***	***0.741***	***0.740***	***n.a.***	***n.a.***

COPPER (CU)

The Bangladesh standard is 1.0 mg/L. The WHO guideline value is set at 2.0 mg/L, to be protective against acute gastrointestinal effects of copper and provide an adequate margin of safety in populations with normal copper homeostasis.

Figure 21: **Copper distribution, with 100% of samples meeting the Bangladesh standard of 1.0 mg/L**



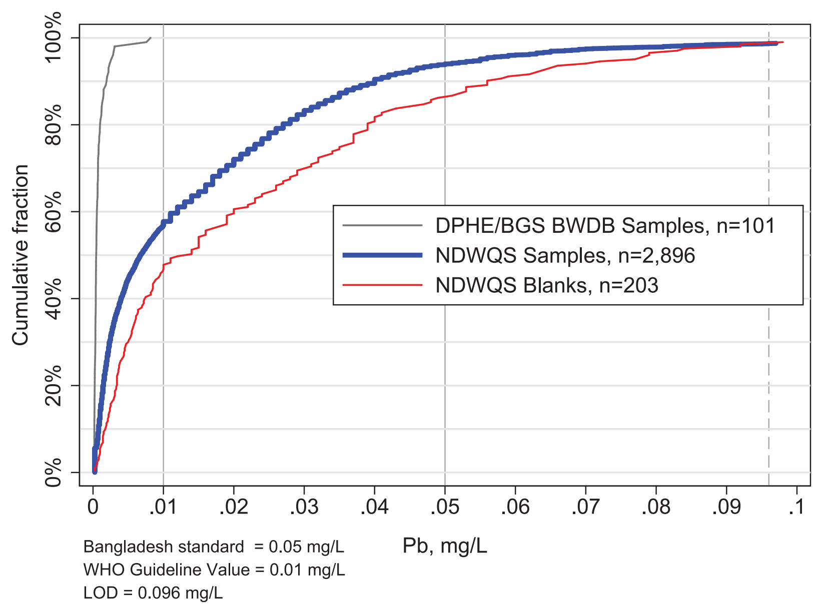
The high LOD indicates contamination of the samples. Less than 1% of samples were above the LOD, so disaggregated results are not presented. The cumulative frequency graph suggests that copper levels were higher in the MICS survey than in the DPHE/BGS survey, but with the main differences found well below the LOD, no conclusions can be drawn. However, in spite of the high LOD, measured concentrations were all well below the Bangladesh standard and the WHO guideline value.

LEAD (PB)

The Bangladesh standard for lead (Pb) is 0.05 mg/L, while the WHO guideline value is 0.01 mg/L.

Although lead was measured in the laboratory, and precision among laboratory replicates was high, analysis of field quality control samples revealed significant contamination of blanks and poor reproducibility among field replicates. Lead levels were actually higher in blanks than in field samples. For these reasons, lead data from this survey are not considered reliable and are not analyzed further.

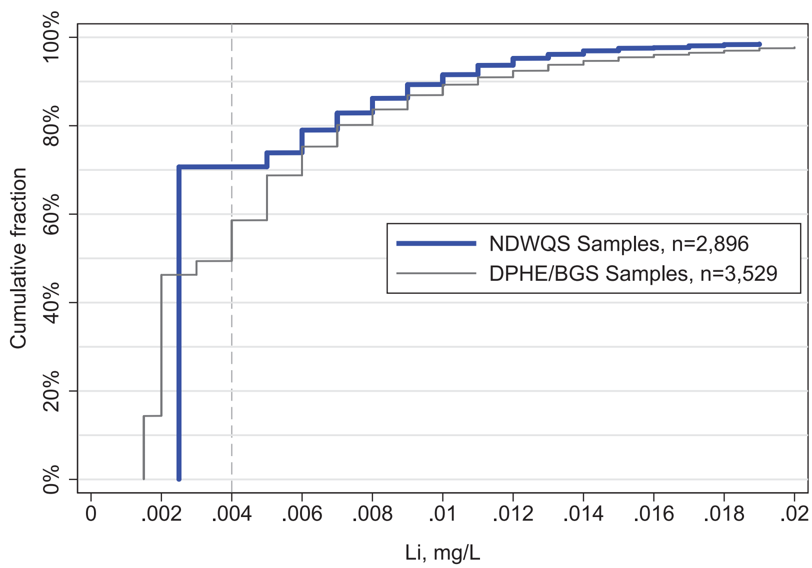
Figure 22: Lead distribution



LITHIUM (LI)

There is no Bangladesh standard or WHO guideline value for lithium.

Figure 23: **Lithium distribution**



LOD = 0.004 mg/L

The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 55.2% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 23: Geographic distribution of lithium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.003	0.003	0.006	0.008	0.011	0.004	0.571	0.571	n.a.	n.a.
Barisal	65	0.003	0.003	0.006	0.009	0.085	0.006	0.646	0.646	n.a.	n.a.
Bhola	36	0.003	0.003	0.003	0.003	0.005	0.003	0.917	0.917	n.a.	n.a.
Jhalokati	26	0.003	0.003	0.006	0.010	0.025	0.005	0.731	0.692	n.a.	n.a.
Patuakhali	46	0.003	0.003	0.003	0.005	0.007	0.003	0.870	0.870	n.a.	n.a.
Pirojpur	40	0.003	0.003	0.006	0.010	0.025	0.005	0.675	0.650	n.a.	n.a.
Barisal Division	*248*	*0.003*	*0.003*	*0.005*	*0.007*	*0.085*	*0.004*	*0.730*	*0.722*	*n.a.*	*n.a.*
Bandarban	44	0.003	0.003	0.003	0.005	0.010	0.003	0.886	0.886	n.a.	n.a.
Brahamanbaria	52	0.003	0.003	0.005	0.008	0.010	0.004	0.731	0.731	n.a.	n.a.
Chandpur	47	0.003	0.003	0.008	0.017	0.025	0.006	0.574	0.574	n.a.	n.a.
Chittagong	92	0.003	0.003	0.009	0.012	0.033	0.006	0.511	0.511	n.a.	n.a.
Comilla	86	0.003	0.003	0.007	0.009	0.031	0.005	0.640	0.640	n.a.	n.a.
Cox's Bazar	38	0.003	0.007	0.010	0.026	0.045	0.010	0.316	0.316	n.a.	n.a.
Feni	38	0.003	0.003	0.006	0.009	0.013	0.004	0.684	0.684	n.a.	n.a.
Khagrachhari	47	0.003	0.003	0.003	0.007	0.013	0.004	0.787	0.787	n.a.	n.a.
Lakshmipur	32	0.003	0.003	0.005	0.010	0.012	0.004	0.719	0.719	n.a.	n.a.
Noakhali	51	0.003	0.003	0.006	0.007	0.015	0.004	0.647	0.647	n.a.	n.a.
Rangamati	56	0.003	0.003	0.003	0.009	0.028	0.004	0.821	0.821	n.a.	n.a.
Chittagong Division	*583*	*0.003*	*0.003*	*0.007*	*0.010*	*0.045*	*0.005*	*0.657*	*0.657*	*n.a.*	*n.a.*
Dhaka	74	0.003	0.007	0.010	0.012	0.021	0.007	0.405	0.405	n.a.	n.a.
Faridpur	48	0.003	0.003	0.003	0.011	0.014	0.004	0.854	0.854	n.a.	n.a.
Gazipur	33	0.003	0.003	0.003	0.005	0.008	0.003	0.879	0.879	n.a.	n.a.
Gopalganj	31	0.003	0.003	0.011	0.015	0.088	0.010	0.516	0.516	n.a.	n.a.
Jamalpur	39	0.003	0.003	0.003	0.003	0.011	0.003	0.949	0.923	n.a.	n.a.
Kishoreganj	75	0.003	0.003	0.003	0.007	0.017	0.004	0.813	0.813	n.a.	n.a.
Madaripur	22	0.003	0.003	0.012	0.015	0.015	0.007	0.591	0.591	n.a.	n.a.
Manikganj	40	0.003	0.003	0.003	0.012	0.018	0.004	0.800	0.800	n.a.	n.a.
Munshiganj	36	0.003	0.007	0.011	0.014	0.021	0.008	0.278	0.278	n.a.	n.a.
Mymensingh	71	0.003	0.003	0.003	0.005	0.023	0.003	0.873	0.873	n.a.	n.a.
Narayanganj	31	0.003	0.005	0.008	0.010	0.012	0.005	0.452	0.452	n.a.	n.a.
Narsingdi	33	0.003	0.003	0.003	0.005	0.009	0.003	0.879	0.879	n.a.	n.a.
Netrakona	53	0.003	0.003	0.003	0.003	0.022	0.003	0.962	0.962	n.a.	n.a.
Rajbari	27	0.003	0.003	0.003	0.007	0.013	0.004	0.815	0.815	n.a.	n.a.
Shariatpur	36	0.003	0.006	0.012	0.016	0.031	0.008	0.444	0.444	n.a.	n.a.
Sherpur	31	0.003	0.003	0.003	0.003	0.006	0.003	0.935	0.935	n.a.	n.a.
Tangail	73	0.003	0.003	0.003	0.006	0.011	0.003	0.836	0.836	n.a.	n.a.
Dhaka Division	*753*	*0.003*	*0.003*	*0.005*	*0.010*	*0.088*	*0.005*	*0.734*	*0.733*	*n.a.*	*n.a.*

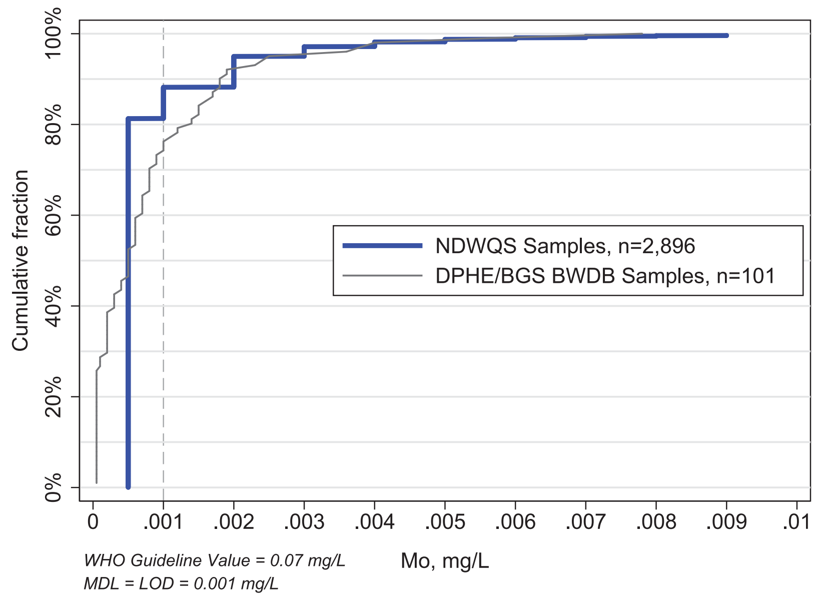
Table 23: **Geographic distribution of lithium, continued**

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.003	0.006	0.012	0.017	0.040	0.008	0.481	0.481	n.a.	n.a.
Chuadanga	23	0.003	0.003	0.006	0.007	0.013	0.004	0.739	0.739	n.a.	n.a.
Jessore	43	0.003	0.003	0.003	0.009	0.020	0.004	0.791	0.791	n.a.	n.a.
Jhenaidah	36	0.003	0.003	0.003	0.007	0.011	0.004	0.778	0.778	n.a.	n.a.
Khulna	64	0.003	0.007	0.010	0.017	0.040	0.008	0.422	0.422	n.a.	n.a.
Kushtia	35	0.003	0.005	0.009	0.015	0.032	0.007	0.486	0.486	n.a.	n.a.
Magura	27	0.003	0.003	0.009	0.012	0.014	0.006	0.519	0.519	n.a.	n.a.
Meherpur	22	0.003	0.005	0.008	0.009	0.009	0.005	0.455	0.455	n.a.	n.a.
Narail	21	0.005	0.007	0.012	0.014	0.025	0.009	0.190	0.190	n.a.	n.a.
Satkhira	39	0.003	0.006	0.011	0.014	0.046	0.008	0.410	0.410	n.a.	n.a.
Khulna Division	*364*	*0.003*	*0.003*	*0.009*	*0.014*	*0.046*	*0.007*	*0.530*	*0.530*	*n.a.*	*n.a.*
Bogra	72	0.003	0.004	0.007	0.010	0.015	0.005	0.500	0.500	n.a.	n.a.
Dinajpur	82	0.003	0.003	0.003	0.003	0.012	0.003	0.939	0.939	n.a.	n.a.
Gaibandha	40	0.003	0.003	0.003	0.003	0.006	0.003	0.950	0.950	n.a.	n.a.
Joypurhat	31	0.003	0.003	0.007	0.008	0.012	0.005	0.581	0.581	n.a.	n.a.
Kurigram	45	0.003	0.003	0.003	0.003	0.006	0.003	0.978	0.956	n.a.	n.a.
Lalmonirhat	33	0.003	0.003	0.003	0.003	0.003	0.003	1.000	1.000	n.a.	n.a.
Naogaon	57	0.003	0.003	0.007	0.009	0.018	0.005	0.614	0.614	n.a.	n.a.
Natore	37	0.006	0.008	0.011	0.012	0.021	0.008	0.162	0.162	n.a.	n.a.
Nawabganj	32	0.003	0.003	0.007	0.011	0.020	0.005	0.563	0.563	n.a.	n.a.
Nilphamari	34	0.003	0.003	0.003	0.003	0.003	0.003	1.000	1.000	n.a.	n.a.
Pabna	46	0.003	0.005	0.010	0.012	0.015	0.006	0.478	0.478	n.a.	n.a.
Panchagarh	32	0.003	0.003	0.003	0.003	0.003	0.003	1.000	1.000	n.a.	n.a.
Rajshahi	66	0.003	0.006	0.008	0.010	0.011	0.006	0.379	0.379	n.a.	n.a.
Rangpur	49	0.003	0.003	0.003	0.003	0.003	0.003	1.000	1.000	n.a.	n.a.
Sirajganj	42	0.003	0.003	0.003	0.003	0.014	0.003	0.905	0.905	n.a.	n.a.
Thakurgaon	33	0.003	0.003	0.003	0.003	0.003	0.003	1.000	1.000	n.a.	n.a.
Rajshahi Division	*731*	*0.003*	*0.003*	*0.005*	*0.009*	*0.021*	*0.004*	*0.736*	*0.735*	*n.a.*	*n.a.*
Habiganj	47	0.003	0.003	0.003	0.005	0.012	0.003	0.894	0.894	n.a.	n.a.
Maulvi Bazar	41	0.003	0.003	0.003	0.003	0.010	0.003	0.902	0.902	n.a.	n.a.
Sunamganj	65	0.003	0.003	0.003	0.003	0.008	0.003	0.985	0.985	n.a.	n.a.
Sylhet	64	0.003	0.003	0.003	0.003	0.008	0.003	0.938	0.938	n.a.	n.a.
Sylhet Division	*217*	*0.003*	*0.003*	*0.003*	*0.003*	*0.012*	*0.003*	*0.935*	*0.935*	*n.a.*	*n.a.*
Grand Total	***2896***	***0.003***	***0.003***	***0.006***	***0.010***	***0.088***	***0.005***	***0.708***	***0.707***	***n.a.***	***n.a.***

MOLYBDENUM (MO)

WHO guideline value is 0.07 mg/L. There is no Bangladesh standard.

Figure 24: **Molybdenum distribution**



The NDWQS and DPHE/BGS distributions are not significantly different.

Table 24: Geographic distribution of molybdenum

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.001	0.001	0.001	0.001	0.002	0.001	0.857	0.857	1.000	n.a.
Barisal	65	0.001	0.001	0.001	0.001	0.002	0.001	0.985	0.985	1.000	n.a.
Bhola	36	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	1.000	n.a.
Jhalokati	26	0.001	0.001	0.001	0.001	0.005	0.001	0.962	0.923	1.000	n.a.
Patuakhali	46	0.001	0.001	0.001	0.001	0.002	0.001	0.870	0.870	1.000	n.a.
Pirojpur	40	0.001	0.001	0.001	0.001	0.005	0.001	0.800	0.775	1.000	n.a.
Barisal Division	*248*	*0.001*	*0.001*	*0.001*	*0.001*	*0.005*	*0.001*	*0.915*	*0.907*	*1.000*	*n.a.*
Bandarban	44	0.001	0.001	0.001	0.001	0.003	0.001	0.955	0.955	1.000	n.a.
Brahamanbaria	52	0.001	0.001	0.001	0.001	0.003	0.001	0.923	0.923	1.000	n.a.
Chandpur	47	0.001	0.001	0.001	0.002	0.009	0.001	0.872	0.872	1.000	n.a.
Chittagong	92	0.001	0.001	0.001	0.001	0.011	0.001	0.902	0.902	1.000	n.a.
Comilla	86	0.001	0.001	0.001	0.002	0.008	0.001	0.826	0.826	1.000	n.a.
Cox's Bazar	38	0.001	0.001	0.001	0.001	0.002	0.001	0.895	0.895	1.000	n.a.
Feni	38	0.001	0.001	0.001	0.002	0.007	0.001	0.816	0.816	1.000	n.a.
Khagrachhari	47	0.001	0.001	0.001	0.001	0.005	0.001	0.979	0.979	1.000	n.a.
Lakshmipur	32	0.001	0.001	0.002	0.004	0.022	0.002	0.656	0.656	1.000	n.a.
Noakhali	51	0.001	0.002	0.004	0.006	0.023	0.003	0.471	0.471	1.000	n.a.
Rangamati	56	0.001	0.001	0.001	0.001	0.002	0.001	0.982	0.982	1.000	n.a.
Chittagong Division	*583*	*0.001*	*0.001*	*0.001*	*0.002*	*0.023*	*0.001*	*0.851*	*0.851*	*1.000*	*n.a.*
Dhaka	74	0.001	0.001	0.001	0.001	0.005	0.001	0.932	0.932	1.000	n.a.
Faridpur	48	0.001	0.001	0.001	0.002	0.006	0.001	0.458	0.458	1.000	n.a.
Gazipur	33	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	1.000	n.a.
Gopalganj	31	0.001	0.001	0.002	0.002	0.002	0.001	0.387	0.387	1.000	n.a.
Jamalpur	39	0.001	0.001	0.001	0.001	0.006	0.001	0.923	0.897	1.000	n.a.
Kishoreganj	75	0.001	0.001	0.001	0.002	0.004	0.001	0.680	0.680	1.000	n.a.
Madaripur	22	0.001	0.001	0.002	0.003	0.011	0.002	0.636	0.636	1.000	n.a.
Manikganj	40	0.001	0.001	0.001	0.002	0.010	0.001	0.600	0.600	1.000	n.a.
Munshiganj	36	0.001	0.001	0.002	0.003	0.007	0.001	0.639	0.639	1.000	n.a.
Mymensingh	71	0.001	0.001	0.001	0.003	0.008	0.001	0.789	0.789	1.000	n.a.
Narayanganj	31	0.001	0.001	0.001	0.002	0.004	0.001	0.806	0.806	1.000	n.a.
Narsingdi	33	0.001	0.001	0.001	0.001	0.002	0.001	0.970	0.970	1.000	n.a.
Netrakona	53	0.001	0.001	0.003	0.005	0.015	0.002	0.528	0.528	1.000	n.a.
Rajbari	27	0.001	0.001	0.001	0.002	0.004	0.001	0.741	0.741	1.000	n.a.
Shariatpur	36	0.001	0.001	0.001	0.001	0.002	0.001	0.889	0.889	1.000	n.a.
Sherpur	31	0.001	0.001	0.001	0.001	0.002	0.001	0.968	0.968	1.000	n.a.
Tangail	73	0.001	0.001	0.001	0.001	0.002	0.001	0.918	0.918	1.000	n.a.
Dhaka Division	*753*	*0.001*	*0.001*	*0.001*	*0.002*	*0.015*	*0.001*	*0.762*	*0.761*	*1.000*	*n.a.*

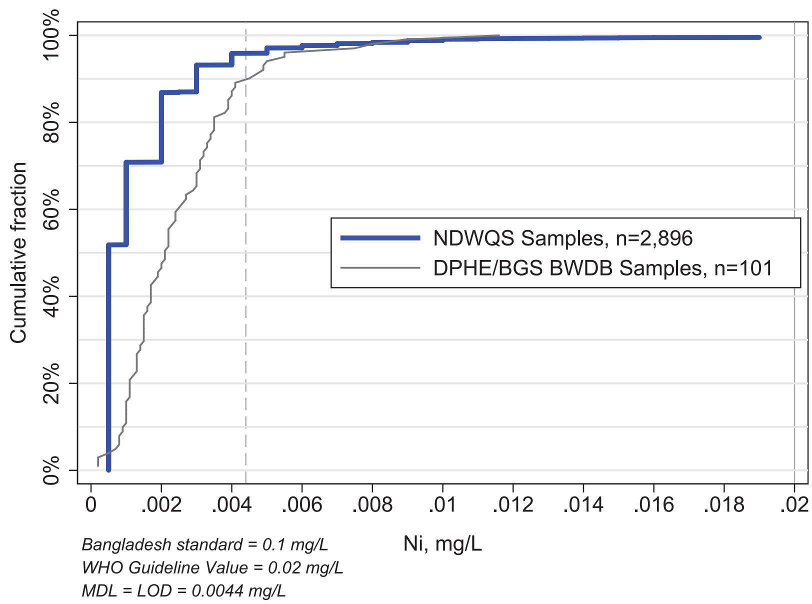
Table 24: Geographic distribution of molybdenum, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.001	0.001	0.001	0.002	0.003	0.001	0.759	0.759	1.000	n.a.
Chuadanga	23	0.001	0.001	0.001	0.002	0.003	0.001	0.609	0.609	1.000	n.a.
Jessore	43	0.001	0.001	0.001	0.002	0.007	0.001	0.628	0.628	1.000	n.a.
Jhenaidah	36	0.001	0.001	0.001	0.002	0.003	0.001	0.611	0.611	1.000	n.a.
Khulna	64	0.001	0.001	0.001	0.002	0.004	0.001	0.781	0.781	1.000	n.a.
Kushtia	35	0.001	0.001	0.001	0.002	0.003	0.001	0.600	0.600	1.000	n.a.
Magura	27	0.001	0.001	0.001	0.002	0.002	0.001	0.741	0.741	1.000	n.a.
Meherpur	22	0.001	0.001	0.001	0.002	0.008	0.001	0.727	0.727	1.000	n.a.
Narail	21	0.001	0.001	0.001	0.002	0.002	0.001	0.619	0.619	1.000	n.a.
Satkhira	39	0.001	0.001	0.001	0.002	0.003	0.001	0.590	0.590	1.000	n.a.
Khulna Division	*364*	*0.001*	*0.001*	*0.001*	*0.002*	*0.008*	*0.001*	*0.679*	*0.679*	*1.000*	*n.a.*
Bogra	72	0.001	0.001	0.001	0.001	0.002	0.001	0.944	0.944	1.000	n.a.
Dinajpur	82	0.001	0.001	0.001	0.001	0.003	0.001	0.988	0.988	1.000	n.a.
Gaibandha	40	0.001	0.001	0.001	0.001	0.004	0.001	0.900	0.900	1.000	n.a.
Joypurhat	31	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	1.000	n.a.
Kurigram	45	0.001	0.001	0.001	0.001	0.002	0.001	0.867	0.844	1.000	n.a.
Lalmonirhat	33	0.001	0.001	0.001	0.001	0.003	0.001	0.848	0.848	1.000	n.a.
Naogaon	57	0.001	0.001	0.001	0.001	0.001	0.001	0.982	0.982	1.000	n.a.
Natore	37	0.001	0.001	0.001	0.002	0.002	0.001	0.811	0.811	1.000	n.a.
Nawabganj	32	0.001	0.001	0.001	0.001	0.004	0.001	0.938	0.938	1.000	n.a.
Nilphamari	34	0.001	0.001	0.001	0.003	0.005	0.001	0.853	0.853	1.000	n.a.
Pabna	46	0.001	0.001	0.001	0.002	0.006	0.001	0.804	0.804	1.000	n.a.
Panchagarh	32	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	1.000	n.a.
Rajshahi	66	0.001	0.001	0.001	0.002	0.003	0.001	0.576	0.576	1.000	n.a.
Rangpur	49	0.001	0.001	0.001	0.001	0.004	0.001	0.857	0.857	1.000	n.a.
Sirajganj	42	0.001	0.001	0.001	0.002	0.003	0.001	0.762	0.762	1.000	n.a.
Thakurgaon	33	0.001	0.001	0.001	0.001	0.002	0.001	0.970	0.970	1.000	n.a.
Rajshahi Division	*731*	*0.001*	*0.001*	*0.001*	*0.001*	*0.006*	*0.001*	*0.877*	*0.876*	*1.000*	*n.a.*
Habiganj	47	0.001	0.001	0.001	0.001	0.005	0.001	0.894	0.894	1.000	n.a.
Maulvi Bazar	41	0.001	0.001	0.001	0.002	0.004	0.001	0.854	0.854	1.000	n.a.
Sunamganj	65	0.001	0.001	0.002	0.004	0.014	0.002	0.554	0.554	1.000	n.a.
Sylhet	64	0.001	0.001	0.001	0.001	0.008	0.001	0.938	0.938	1.000	n.a.
Sylhet Division	*217*	*0.001*	*0.001*	*0.001*	*0.002*	*0.014*	*0.001*	*0.797*	*0.797*	*1.000*	*n.a.*
Grand Total	***2896***	***0.001***	***0.001***	***0.001***	***0.002***	***0.023***	***0.001***	***0.814***	***0.813***	***1.000***	***n.a.***

NICKEL (NI)

The Bangladesh standard is 0.1 mg/L. The WHO provisional guideline value is 0.02 mg/L. The guideline value is considered provisional owing to uncertainties about the effect level for perinatal mortality.

Figure 25: **Nickel distribution, with 100% samples meeting the Bangladesh standard of 0.1 mg/L.**



The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 53.3% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 25: Geographic distribution of nickel

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.0005	0.0005	0.0005	0.0005	0.0020	0.0006	0.914	1.000	1.000	1.000
Barisal	65	0.0005	0.0005	0.0005	0.0020	0.0090	0.0009	0.815	0.985	1.000	1.000
Bhola	36	0.0005	0.0005	0.0010	0.0030	0.0200	0.0014	0.694	0.972	1.000	1.000
Jhalokati	26	0.0005	0.0005	0.0005	0.0020	0.0600	0.0030	0.769	0.962	0.962	1.000
Patuakhali	46	0.0005	0.0005	0.0010	0.0010	0.0030	0.0008	0.717	1.000	1.000	1.000
Pirojpur	40	0.0005	0.0005	0.0005	0.0010	0.0050	0.0007	0.850	0.975	1.000	1.000
Barisal Division	*248*	*0.0005*	*0.0005*	*0.0005*	*0.0010*	*0.0600*	*0.0011*	*0.794*	*0.984*	*0.996*	*1.000*
Bandarban	44	0.0008	0.0010	0.0020	0.0040	0.0080	0.0019	0.250	0.909	1.000	1.000
Brahamanbaria	52	0.0008	0.0020	0.0030	0.0040	0.0090	0.0022	0.250	0.904	1.000	1.000
Chandpur	47	0.0005	0.0005	0.0010	0.0010	0.0020	0.0007	0.723	1.000	1.000	1.000
Chittagong	92	0.0005	0.0005	0.0010	0.0030	0.0410	0.0017	0.652	0.935	0.989	1.000
Comilla	86	0.0005	0.0010	0.0020	0.0040	0.0090	0.0017	0.337	0.942	1.000	1.000
Cox's Bazar	38	0.0005	0.0005	0.0020	0.0030	0.0280	0.0021	0.579	0.921	0.974	1.000
Feni	38	0.0005	0.0005	0.0020	0.0030	0.0060	0.0014	0.526	0.947	1.000	1.000
Khagrachhari	47	0.0020	0.0020	0.0030	0.0050	0.0140	0.0028	0.064	0.894	1.000	1.000
Lakshmipur	32	0.0005	0.0005	0.0010	0.0020	0.0030	0.0009	0.719	1.000	1.000	1.000
Noakhali	51	0.0005	0.0005	0.0010	0.0020	0.0020	0.0009	0.588	1.000	1.000	1.000
Rangamati	56	0.0005	0.0010	0.0020	0.0040	0.0060	0.0016	0.321	0.964	1.000	1.000
Chittagong Division	*583*	*0.0005*	*0.0010*	*0.0020*	*0.0030*	*0.0410*	*0.0016*	*0.451*	*0.945*	*0.997*	*1.000*
Dhaka	74	0.0010	0.0020	0.0030	0.0040	0.0070	0.0020	0.203	0.946	1.000	1.000
Faridpur	48	0.0005	0.0005	0.0010	0.0020	0.0030	0.0008	0.729	1.000	1.000	1.000
Gazipur	33	0.0020	0.0020	0.0030	0.0040	0.0080	0.0026	0.091	0.909	1.000	1.000
Gopalganj	31	0.0005	0.0005	0.0005	0.0010	0.0020	0.0007	0.806	1.000	1.000	1.000
Jamalpur	39	0.0005	0.0020	0.0020	0.0030	0.0050	0.0016	0.308	0.974	1.000	1.000
Kishoreganj	75	0.0010	0.0010	0.0020	0.0040	0.0100	0.0019	0.200	0.920	1.000	1.000
Madaripur	22	0.0005	0.0005	0.0005	0.0040	0.1900	0.0096	0.773	0.909	0.955	0.955
Manikganj	40	0.0005	0.0005	0.0008	0.0020	0.0030	0.0008	0.750	1.000	1.000	1.000
Munshiganj	36	0.0005	0.0015	0.0030	0.0030	0.0060	0.0018	0.306	0.944	1.000	1.000
Mymensingh	71	0.0005	0.0010	0.0020	0.0030	0.0130	0.0015	0.408	0.944	1.000	1.000
Narayanganj	31	0.0005	0.0005	0.0020	0.0030	0.0090	0.0015	0.516	0.968	1.000	1.000
Narsingdi	33	0.0010	0.0020	0.0030	0.0040	0.0100	0.0022	0.182	0.939	1.000	1.000
Netrakona	53	0.0005	0.0005	0.0020	0.0020	0.0040	0.0011	0.547	1.000	1.000	1.000
Rajbari	27	0.0005	0.0005	0.0010	0.0010	0.0010	0.0007	0.704	1.000	1.000	1.000
Shariatpur	36	0.0005	0.0005	0.0005	0.0010	0.0030	0.0007	0.806	1.000	1.000	1.000
Sherpur	31	0.0010	0.0020	0.0020	0.0030	0.0060	0.0019	0.129	0.968	1.000	1.000
Tangail	73	0.0005	0.0020	0.0030	0.0040	0.0190	0.0021	0.288	0.945	1.000	1.000
Dhaka Division	*753*	*0.0005*	*0.0010*	*0.0020*	*0.0030*	*0.1900*	*0.0018*	*0.420*	*0.960*	*0.999*	*0.999*

Table 25: Geographic distribution of nickel, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.0005	0.0005	0.0010	0.0020	0.0030	0.0009	0.667	1.000	1.000	1.000
Chuadanga	23	0.0005	0.0005	0.0005	0.0010	0.0020	0.0007	0.826	1.000	1.000	1.000
Jessore	43	0.0005	0.0005	0.0010	0.0030	0.0080	0.0013	0.628	0.930	1.000	1.000
Jhenaidah	36	0.0005	0.0005	0.0010	0.0020	0.0040	0.0010	0.556	1.000	1.000	1.000
Khulna	64	0.0005	0.0005	0.0010	0.0020	0.0270	0.0012	0.703	0.984	0.984	1.000
Kushtia	35	0.0005	0.0005	0.0005	0.0010	0.0050	0.0008	0.829	0.971	1.000	1.000
Magura	27	0.0005	0.0005	0.0010	0.0020	0.0050	0.0009	0.741	0.963	1.000	1.000
Meherpur	22	0.0005	0.0005	0.0005	0.0010	0.0010	0.0006	0.818	1.000	1.000	1.000
Narail	21	0.0005	0.0005	0.0010	0.0020	0.0050	0.0010	0.667	0.952	1.000	1.000
Satkhira	39	0.0005	0.0005	0.0010	0.0020	0.0040	0.0009	0.718	1.000	1.000	1.000
Khulna Division	*364*	*0.0005*	*0.0005*	*0.0010*	*0.0020*	*0.0270*	*0.0010*	*0.703*	*0.981*	*0.997*	*1.000*
Bogra	72	0.0005	0.0010	0.0020	0.0040	0.0110	0.0016	0.431	0.972	1.000	1.000
Dinajpur	82	0.0005	0.0010	0.0010	0.0030	0.0070	0.0013	0.463	0.963	1.000	1.000
Gaibandha	40	0.0005	0.0010	0.0020	0.0030	0.0110	0.0015	0.475	0.950	1.000	1.000
Joypurhat	31	0.0005	0.0010	0.0020	0.0030	0.0040	0.0015	0.452	1.000	1.000	1.000
Kurigram	45	0.0005	0.0005	0.0010	0.0020	0.0030	0.0009	0.511	1.000	1.000	1.000
Lalmonirhat	33	0.0005	0.0005	0.0010	0.0020	0.0050	0.0010	0.667	0.970	1.000	1.000
Naogaon	57	0.0005	0.0005	0.0010	0.0020	0.0050	0.0011	0.596	0.982	1.000	1.000
Natore	37	0.0005	0.0005	0.0010	0.0020	0.0030	0.0009	0.568	1.000	1.000	1.000
Nawabganj	32	0.0005	0.0010	0.0020	0.0020	0.0060	0.0013	0.438	0.938	1.000	1.000
Nilphamari	34	0.0005	0.0008	0.0020	0.0020	0.0210	0.0016	0.500	0.971	0.971	1.000
Pabna	46	0.0005	0.0005	0.0010	0.0020	0.0150	0.0014	0.652	0.957	1.000	1.000
Panchagarh	32	0.0005	0.0005	0.0010	0.0020	0.0020	0.0009	0.563	1.000	1.000	1.000
Rajshahi	66	0.0005	0.0005	0.0010	0.0020	0.0090	0.0009	0.727	0.985	1.000	1.000
Rangpur	49	0.0005	0.0010	0.0020	0.0030	0.0040	0.0013	0.429	1.000	1.000	1.000
Sirajganj	42	0.0005	0.0010	0.0020	0.0030	0.0100	0.0016	0.405	0.952	1.000	1.000
Thakurgaon	33	0.0005	0.0010	0.0020	0.0030	0.0050	0.0014	0.394	0.970	1.000	1.000
Rajshahi Division	*731*	*0.0005*	*0.0005*	*0.0020*	*0.0020*	*0.0210*	*0.0013*	*0.520*	*0.975*	*0.999*	*1.000*
Habiganj	47	0.0005	0.0005	0.0010	0.0020	0.0200	0.0014	0.596	0.979	1.000	1.000
Maulvi Bazar	41	0.0010	0.0020	0.0040	0.0090	0.1600	0.0075	0.220	0.780	0.951	0.976
Sunamganj	65	0.0005	0.0005	0.0010	0.0020	0.0100	0.0011	0.569	0.985	1.000	1.000
Sylhet	64	0.0005	0.0020	0.0060	0.0110	0.0520	0.0046	0.313	0.719	0.969	1.000
Sylhet Division	*217*	*0.0005*	*0.0010*	*0.0020*	*0.0080*	*0.1600*	*0.0034*	*0.433*	*0.866*	*0.982*	*0.995*
Grand Total	***2896***	***0.0005***	***0.0005***	***0.0020***	***0.0030***	***0.1900***	***0.0016***	***0.520***	***0.959***	***0.997***	***0.999***

SELENIUM (SE)

The Bangladesh standard is 0.01 mg/L. The WHO Guideline Value is set at 0.01 mg/L, but this value is currently under revision and is likely to be increased in the future.

Selenium is an essential trace element. There is a fairly narrow range between doses essential to humans and those associated with adverse effects, mainly affected nails, hair, and liver. However, there are studies indicating anticarcinogenic effects from consumption in the 0.100 – 0.300+ mg/day range. The health-based guideline value of 0.010 mg/L would give an intake (based on 2 litres consumption) lower than the recommended daily intakes for men and women (0.070 and 0.055 mg/day, respectively).

Selenium was below the method detection limit (0.002 mg/L) in 97.8% of samples. Of the 62 samples with detectable selenium, only thirteen (13) measured 0.005 mg/L or more:

District	Selenium, mg/L
Gopalganj	0.005
Gopalganj	0.005
Jamalpur	0.006
Jhalokati	0.010
Khulna	0.005
Lakshmipur	0.005
Lakshmipur	0.005
Mymensingh	0.013
Noakhali	0.005
Pirojpur	0.005
Pirojpur	0.005
Pirojpur	0.010
Rajshahi	0.015

With such a low number of samples with detectable selenium, no further analysis is made.

SILVER (AG)

The Bangladesh standard for silver (Ag) is 0.02 mg/L. There is no WHO guideline value.

Silver was below the method detection limit (0.001 mg/L) in 99.6% of samples. Of the 24 samples with detectable silver, only six (6) measured 0.005 mg/L or more:

District	Silver, mg/L
Chittagong	0.0009
Faridpur	0.0005
Habiganj	0.0006
Jhalokati	0.0005
Kurigram	0.0041
Pirojpur	0.0005

With such a low number of samples with detectable silver, no further analysis is made.

TELLURIUM (TE)

There is no Bangladesh standard or WHO guideline value for tellurium (Te).

Tellurium was below the detection limit (0.005 mg/L) in 99.9% of samples. Only four (4) samples showed slight levels above the detection limit:

District	Tellurium, mg/L
Dhaka	0.002
Habiganj	0.002
Jhalokati	0.005
Pirojpur	0.005

With such a low number of samples with detectable tellurium, no further analysis is made.

THALLIUM (TL)

There is no Bangladesh standard or WHO guideline value for thallium (Tl).

Thallum was below the detection limit (0.00005 mg/L) in 97.9% of samples. Only one sample, in Mymensingh, showed more than than 0.0005 mg/L, at 0.0007 mg/L.

With such a low number of samples with detectable thallium, no further analysis is made.

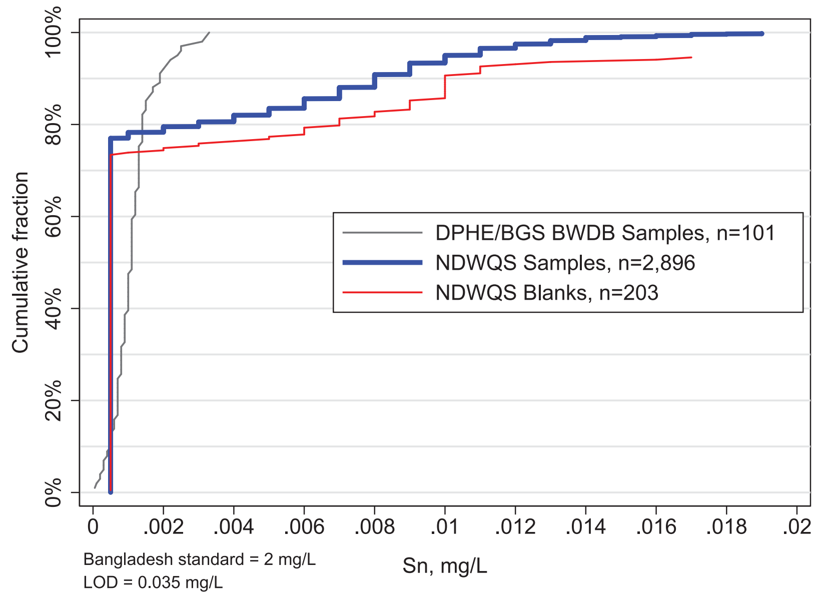
THORIUM (TH)

There is no Bangladesh standard or WHO guideline value for thorium (Th).
Thorium was below the detection limit (0.001 mg/L) in all samples.

TIN (SN)

The Bangladesh standard for tin (Sn) is 2 mg/L. There is no WHO guideline value for tin.

Figure 26: **Tin distribution**

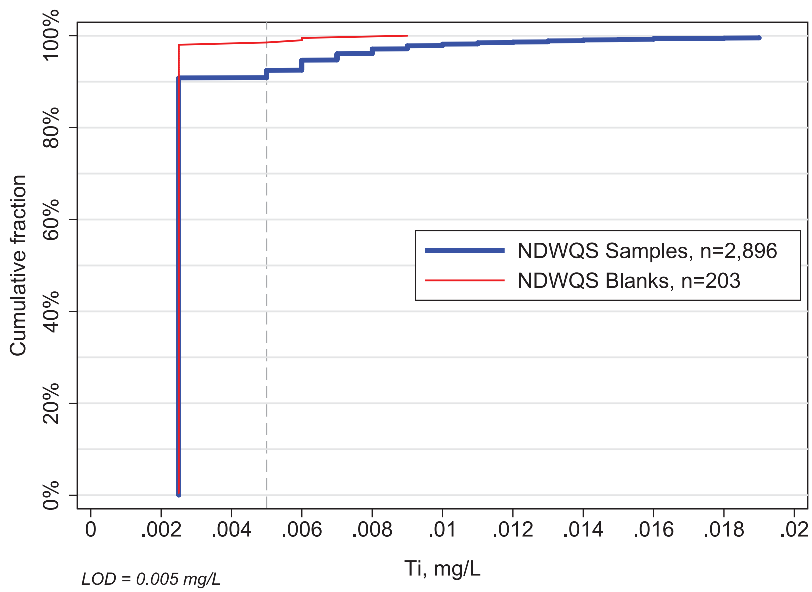


Although tin was measured in the laboratory, and precision among laboratory replicates was high, analysis of field quality control samples revealed significant contamination of blanks and poor reproducibility among field replicates. Tin levels were very similar in blanks and field samples, and all samples were below the limit of detection. For these reasons, tin data from this survey are not considered reliable and are not analyzed further. However, it can be noted that the measured tin levels were all well below the Bangladesh standard.

TITANIUM (TI)

There is no Bangladesh standard or WHO guideline value for titanium.

Figure 27: **Titanium distribution**

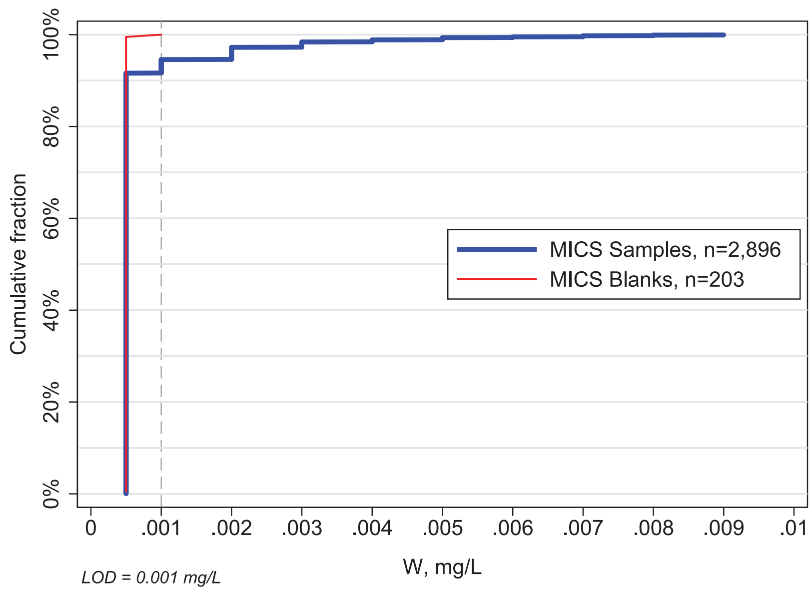


Only 7.5% of samples were above the limit of detection. However, there were clear differences between field samples and field blanks.

TUNGSTEN (W)

There is no Bangladesh standard or WHO guideline value for tungsten.

Figure 28: **Tungsten distribution**



Only 5.4% of samples were above the limit of detection. However, there were clear differences between field samples and field blanks, and this is the first survey to report tungsten in Bangladesh, so the remaining data are presented in disaggregated tables.

The geographic distribution of tungsten hints at a marine source – highest levels are found in Barisal Division, followed by Khulna Division.

Table 28: Geographic distribution of tungsten

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.001	0.001	0.002	0.003	0.005	0.001	0.486	0.714	n.a.	n.a.
Barisal	65	0.001	0.001	0.002	0.003	0.007	0.001	0.523	0.677	n.a.	n.a.
Bhola	36	0.001	0.001	0.001	0.001	0.004	0.001	0.944	0.972	n.a.	n.a.
Jhalokati	26	0.001	0.003	0.005	0.007	0.008	0.004	0.192	0.269	n.a.	n.a.
Patuakhali	46	0.001	0.001	0.002	0.004	0.006	0.002	0.326	0.522	n.a.	n.a.
Pirojpur	40	0.001	0.001	0.002	0.003	0.008	0.001	0.550	0.650	n.a.	n.a.
Barisal Division	*248*	*0.001*	*0.001*	*0.002*	*0.004*	*0.008*	*0.002*	*0.512*	*0.649*	*n.a.*	*n.a.*
Bandarban	44	0.001	0.001	0.001	0.001	0.011	0.001	0.955	0.955	n.a.	n.a.
Brahamanbaria	52	0.001	0.001	0.001	0.001	0.004	0.001	0.942	0.962	n.a.	n.a.
Chandpur	47	0.001	0.001	0.001	0.002	0.006	0.001	0.766	0.872	n.a.	n.a.
Chittagong	92	0.001	0.001	0.001	0.001	0.003	0.001	0.978	0.989	n.a.	n.a.
Comilla	86	0.001	0.001	0.001	0.001	0.005	0.001	0.907	0.953	n.a.	n.a.
Cox's Bazar	38	0.001	0.001	0.001	0.001	0.022	0.001	0.947	0.947	n.a.	n.a.
Feni	38	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Khagrachhari	47	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Lakshmipur	32	0.001	0.001	0.001	0.001	0.003	0.001	0.875	0.938	n.a.	n.a.
Noakhali	51	0.001	0.001	0.001	0.001	0.003	0.001	0.882	0.941	n.a.	n.a.
Rangamati	56	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Chittagong Division	*583*	*0.001*	*0.001*	*0.001*	*0.001*	*0.022*	*0.001*	*0.935*	*0.962*	*n.a.*	*n.a.*
Dhaka	74	0.001	0.001	0.001	0.001	0.001	0.001	0.986	1.000	n.a.	n.a.
Faridpur	48	0.001	0.001	0.001	0.001	0.002	0.001	0.938	0.979	n.a.	n.a.
Gazipur	33	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Gopalganj	31	0.001	0.001	0.001	0.002	0.002	0.001	0.677	0.806	n.a.	n.a.
Jamalpur	39	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Kishoreganj	75	0.001	0.001	0.001	0.001	0.006	0.001	0.907	0.947	n.a.	n.a.
Madaripur	22	0.001	0.001	0.001	0.001	0.004	0.001	0.955	0.955	n.a.	n.a.
Manikganj	40	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Munshiganj	36	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Mymensingh	71	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Narayanganj	31	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Narsingdi	33	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Netrakona	53	0.001	0.001	0.001	0.001	0.003	0.001	0.906	0.981	n.a.	n.a.
Rajbari	27	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Shariatpur	36	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Sherpur	31	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Tangail	73	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Dhaka Division	*753*	*0.001*	*0.001*	*0.001*	*0.001*	*0.006*	*0.001*	*0.964*	*0.983*	*n.a.*	*n.a.*

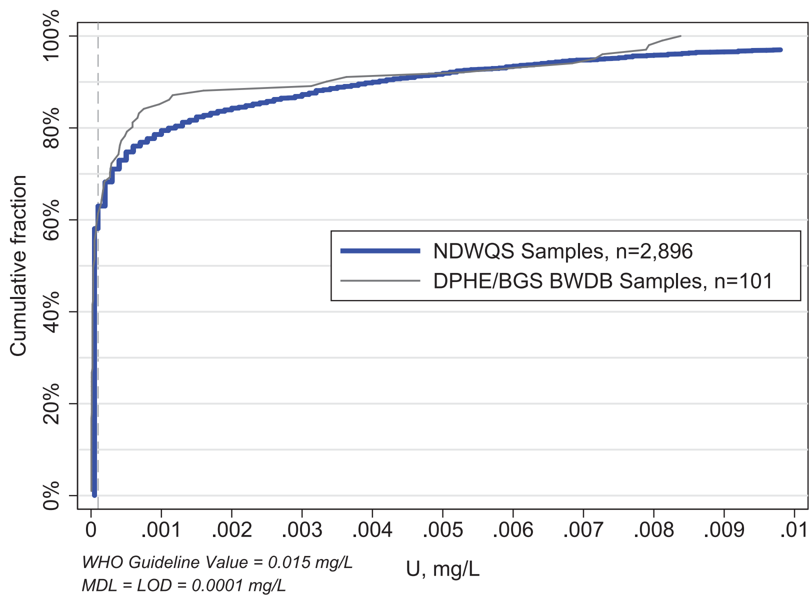
Table 28: Geographic distribution of tungsten, continued

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.001	0.001	0.001	0.001	0.005	0.001	0.889	0.926	n.a.	n.a.
Chuadanga	23	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Jessore	43	0.001	0.001	0.001	0.001	0.009	0.001	0.930	0.953	n.a.	n.a.
Jhenaidah	36	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Khulna	64	0.001	0.001	0.002	0.003	0.007	0.001	0.609	0.688	n.a.	n.a.
Kushtia	35	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Magura	27	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Meherpur	22	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Narail	21	0.001	0.001	0.001	0.001	0.003	0.001	0.857	0.905	n.a.	n.a.
Satkhira	39	0.001	0.001	0.001	0.002	0.008	0.001	0.692	0.846	n.a.	n.a.
Khulna Division	*364*	*0.001*	*0.001*	*0.001*	*0.001*	*0.009*	*0.001*	*0.865*	*0.907*	*n.a.*	*n.a.*
Bogra	72	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Dinajpur	82	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Gaibandha	40	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Joypurhat	31	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Kurigram	45	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Lalmonirhat	33	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Naogaon	57	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Natore	37	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Nawabganj	32	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Nilphamari	34	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Pabna	46	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Panchagarh	32	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Rajshahi	66	0.001	0.001	0.001	0.001	0.001	0.001	0.985	1.000	n.a.	n.a.
Rangpur	49	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Sirajganj	42	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Thakurgaon	33	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Rajshahi Division	*731*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.999*	*1.000*	*n.a.*	*n.a.*
Habiganj	47	0.001	0.001	0.001	0.001	0.001	0.001	0.979	1.000	n.a.	n.a.
Maulvi Bazar	41	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Sunamganj	65	0.001	0.001	0.001	0.001	0.003	0.001	0.969	0.985	n.a.	n.a.
Sylhet	64	0.001	0.001	0.001	0.001	0.001	0.001	1.000	1.000	n.a.	n.a.
Sylhet Division	217	0.001	0.001	0.001	0.001	0.003	0.001	0.986	0.995	n.a.	n.a.
Grand Total	***2896***	***0.001***	***0.001***	***0.001***	***0.001***	***0.022***	***0.001***	***0.917***	***0.946***	***n.a.***	***n.a.***

URANIUM (U)

There is no Bangladesh standard for uranium. The WHO provisional guideline value was raised in 2004 from 0.002 mg/L to 0.015 mg/L. The guideline value is designated as provisional because of outstanding uncertainties regarding the toxicology and epidemiology of uranium as well as difficulties concerning its technical achievability in smaller supplies. The Guideline Value is currently under review and is likely to be raised again in the near future.

Figure 29: **Uranium distribution, with 99% of samples meeting the WHO guideline value of 0.015 mg/L.**

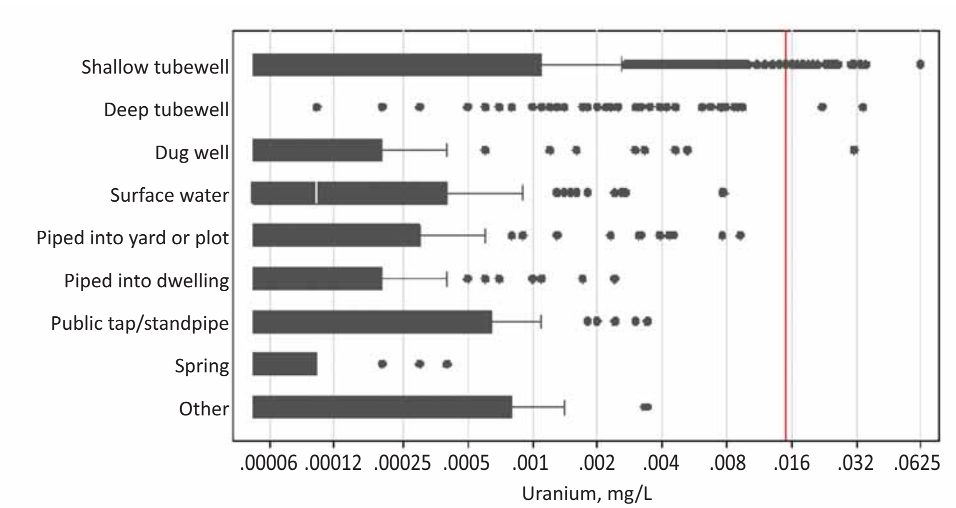


The NDWQS and DPHE/BGS distributions are not significantly different.

Table 29a: Uranium levels by water source

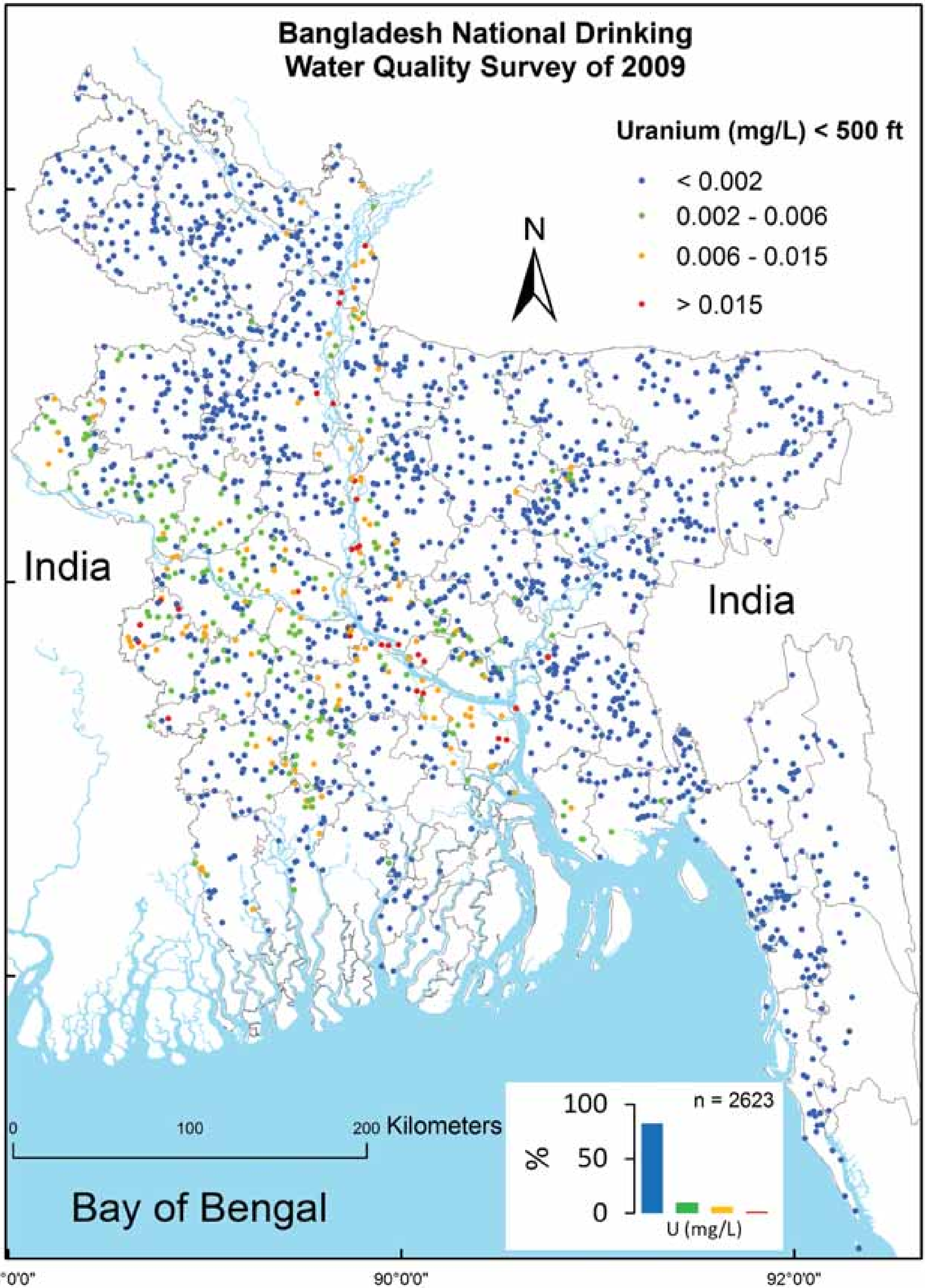
District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Shallow tubewell	2060	0.0001	0.0001	0.0011	0.0052	0.0630	0.0016	0.523	0.572	0.986	n.a.
Deep tubewell	526	0.0001	0.0001	0.0001	0.0005	0.0340	0.0004	0.821	0.850	0.996	n.a.
Dug well	59	0.0001	0.0001	0.0002	0.0016	0.0310	0.0010	0.610	0.661	0.983	n.a.
Surface water	67	0.0001	0.0001	0.0004	0.0018	0.0077	0.0007	0.463	0.522	1.000	n.a.
Piped into yard or plot	54	0.0001	0.0001	0.0003	0.0032	0.0092	0.0008	0.593	0.630	1.000	n.a.
Piped into dwelling	48	0.0001	0.0001	0.0002	0.0010	0.0024	0.0003	0.604	0.708	1.000	n.a.
Public tap/standpipe	44	0.0001	0.0001	0.0006	0.0020	0.0034	0.0005	0.614	0.659	1.000	n.a.
Spring	22	0.0001	0.0001	0.0001	0.0002	0.0004	0.0001	0.591	0.773	1.000	n.a.
Other	16	0.0001	0.0001	0.0008	0.0034	0.0034	0.0008	0.563	0.688	1.000	n.a.

Figure 29b: Uranium levels by water source



WHO guideline value 0.015 mg/L

Map 29a: **Uranium levels in shallow tubewells (< 150 m)**



Map 29b: **Uranium levels in deep tubewells (> 150 m)**

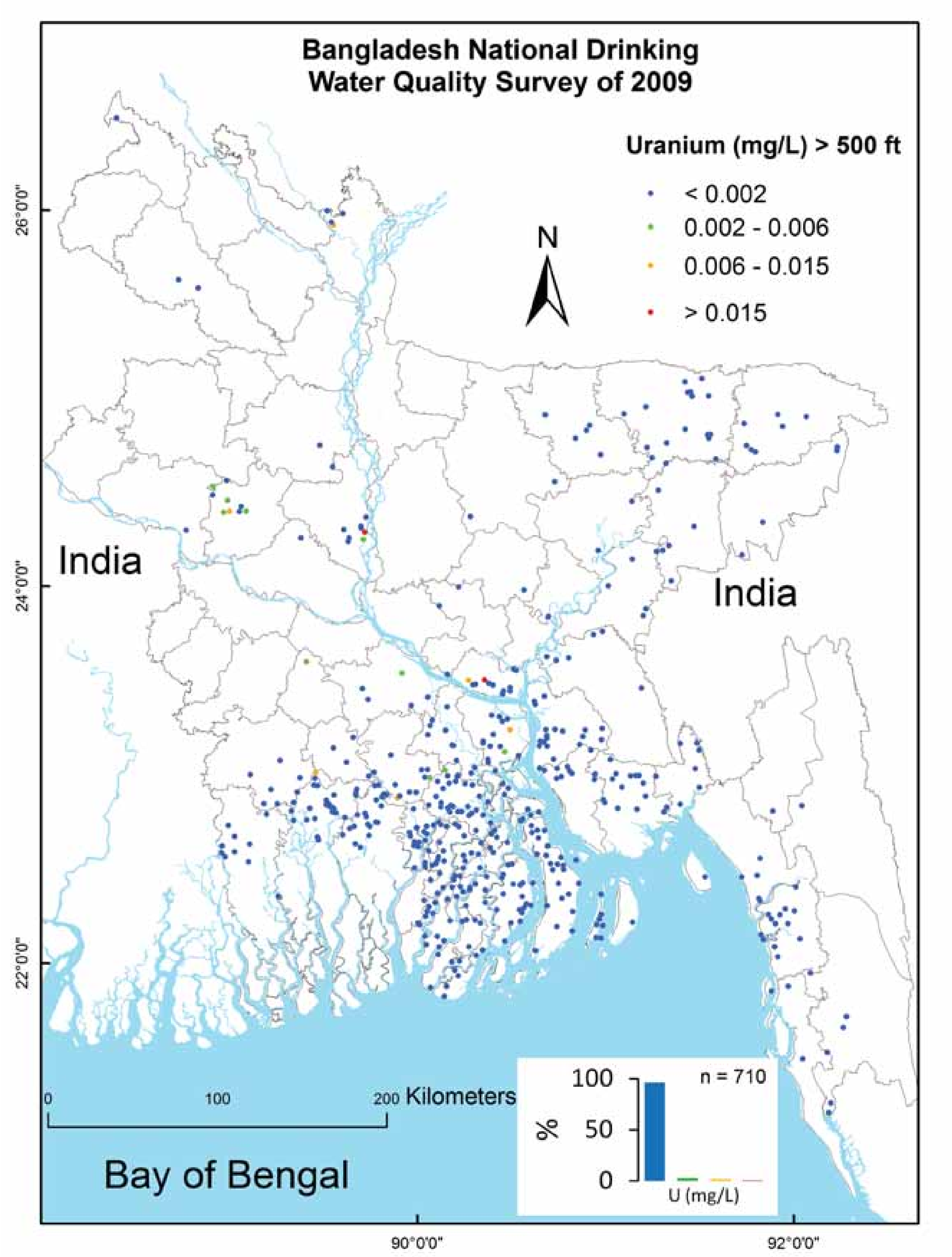


Table 29: Geographic distribution of uranium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.971	0.971	1.000	n.a.
Barisal	65	0.0001	0.0001	0.0001	0.0002	0.0140	0.0004	0.877	0.892	1.000	n.a.
Bhola	36	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.889	0.917	1.000	n.a.
Jhalokati	26	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.885	0.923	1.000	n.a.
Patuakhali	46	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.935	0.957	1.000	n.a.
Pirojpur	40	0.0001	0.0001	0.0002	0.0015	0.0076	0.0004	0.725	0.750	1.000	n.a.
Barisal Division	*248*	*0.0001*	*0.0001*	*0.0001*	*0.0002*	*0.0140*	*0.0002*	*0.879*	*0.899*	*1.000*	*n.a.*
Bandarban	44	0.0001	0.0001	0.0002	0.0004	0.0006	0.0001	0.659	0.750	1.000	n.a.
Brahamanbaria	52	0.0001	0.0001	0.0001	0.0004	0.0046	0.0003	0.731	0.808	1.000	n.a.
Chandpur	47	0.0001	0.0001	0.0001	0.0005	0.0170	0.0006	0.702	0.766	0.979	n.a.
Chittagong	92	0.0001	0.0001	0.0001	0.0001	0.0033	0.0001	0.946	0.967	1.000	n.a.
Comilla	86	0.0001	0.0001	0.0003	0.0012	0.0180	0.0005	0.640	0.709	0.988	n.a.
Cox's Bazar	38	0.0001	0.0001	0.0001	0.0010	0.0023	0.0003	0.737	0.789	1.000	n.a.
Feni	38	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.947	0.974	1.000	n.a.
Khagrachhari	47	0.0001	0.0001	0.0001	0.0001	0.0007	0.0001	0.915	0.957	1.000	n.a.
Lakshmipur	32	0.0001	0.0001	0.0015	0.0082	0.0140	0.0019	0.625	0.656	1.000	n.a.
Noakhali	51	0.0001	0.0001	0.0003	0.0026	0.0092	0.0008	0.569	0.588	1.000	n.a.
Rangamati	56	0.0001	0.0001	0.0001	0.0002	0.0004	0.0001	0.750	0.857	1.000	n.a.
Chittagong Division	*583*	*0.0001*	*0.0001*	*0.0001*	*0.0005*	*0.0180*	*0.0004*	*0.755*	*0.810*	*0.997*	*n.a.*
Dhaka	74	0.0001	0.0002	0.0013	0.0031	0.0260	0.0015	0.297	0.419	0.973	n.a.
Faridpur	48	0.0001	0.0008	0.0055	0.0097	0.0170	0.0031	0.417	0.417	0.979	n.a.
Gazipur	33	0.0001	0.0001	0.0002	0.0004	0.0022	0.0002	0.636	0.727	1.000	n.a.
Gopalganj	31	0.0001	0.0001	0.0022	0.0039	0.0076	0.0011	0.710	0.742	1.000	n.a.
Jamalpur	39	0.0001	0.0001	0.0003	0.0058	0.0130	0.0015	0.513	0.641	1.000	n.a.
Kishoreganj	75	0.0001	0.0002	0.0006	0.0034	0.0110	0.0010	0.427	0.480	1.000	n.a.
Madaripur	22	0.0001	0.0001	0.0064	0.0150	0.0230	0.0039	0.500	0.545	0.955	n.a.
Manikganj	40	0.0001	0.0009	0.0057	0.0145	0.0310	0.0044	0.400	0.425	0.950	n.a.
Munshiganj	36	0.0001	0.0011	0.0030	0.0086	0.0220	0.0029	0.250	0.333	0.972	n.a.
Mymensingh	71	0.0001	0.0001	0.0004	0.0008	0.0025	0.0003	0.535	0.592	1.000	n.a.
Narayanganj	31	0.0002	0.0008	0.0031	0.0041	0.0090	0.0017	0.194	0.194	1.000	n.a.
Narsingdi	33	0.0001	0.0001	0.0003	0.0006	0.0062	0.0004	0.515	0.606	1.000	n.a.
Netrakona	53	0.0001	0.0001	0.0003	0.0010	0.0052	0.0003	0.642	0.679	1.000	n.a.
Rajbari	27	0.0010	0.0030	0.0069	0.0098	0.0200	0.0043	0.074	0.074	0.963	n.a.
Shariatpur	36	0.0001	0.0001	0.0072	0.0110	0.0240	0.0037	0.500	0.556	0.972	n.a.
Sherpur	31	0.0001	0.0001	0.0001	0.0003	0.0009	0.0001	0.710	0.806	1.000	n.a.
Tangail	73	0.0001	0.0001	0.0009	0.0069	0.0330	0.0022	0.493	0.548	0.973	n.a.
Dhaka Division	*753*	*0.0001*	*0.0001*	*0.0011*	*0.0060*	*0.0330*	*0.0018*	*0.460*	*0.519*	*0.985*	*n.a.*

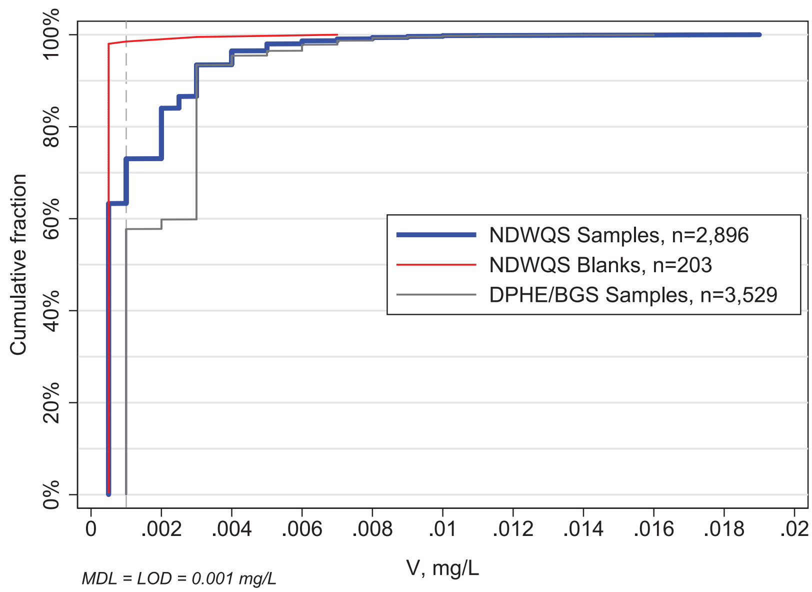
Table 29: Geographic distribution of uranium, continued

District	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.0001	0.0001	0.0001	0.0014	0.0042	0.0004	0.759	0.759	1.000	n.a.
Chuadanga	23	0.0003	0.0042	0.0073	0.0120	0.0310	0.0055	0.174	0.174	0.957	n.a.
Jessore	43	0.0001	0.0003	0.0035	0.0066	0.0096	0.0021	0.465	0.488	1.000	n.a.
Jhenaidah	36	0.0002	0.0015	0.0045	0.0064	0.0250	0.0030	0.222	0.222	0.972	n.a.
Khulna	64	0.0001	0.0001	0.0007	0.0046	0.0100	0.0012	0.703	0.719	1.000	n.a.
Kushtia	35	0.0003	0.0016	0.0037	0.0060	0.0140	0.0026	0.171	0.171	1.000	n.a.
Magura	27	0.0002	0.0006	0.0025	0.0038	0.0057	0.0015	0.185	0.185	1.000	n.a.
Meherpur	22	0.0035	0.0097	0.0160	0.0170	0.0630	0.0116	0.000	0.000	0.727	n.a.
Narail	21	0.0001	0.0032	0.0049	0.0073	0.0200	0.0039	0.238	0.333	0.952	n.a.
Satkhira	39	0.0001	0.0001	0.0003	0.0077	0.0140	0.0017	0.641	0.692	1.000	n.a.
Khulna Division	*364*	*0.0001*	*0.0003*	*0.0036*	*0.0073*	*0.0630*	*0.0026*	*0.437*	*0.453*	*0.975*	*n.a.*
Bogra	72	0.0001	0.0002	0.0005	0.0014	0.0300	0.0011	0.361	0.458	0.972	n.a.
Dinajpur	82	0.0001	0.0001	0.0001	0.0004	0.0059	0.0002	0.683	0.756	1.000	n.a.
Gaibandha	40	0.0001	0.0001	0.0005	0.0053	0.0350	0.0019	0.550	0.625	0.975	n.a.
Joypurhat	31	0.0001	0.0001	0.0001	0.0002	0.0005	0.0001	0.774	0.839	1.000	n.a.
Kurigram	45	0.0001	0.0001	0.0015	0.0089	0.0310	0.0029	0.444	0.511	0.956	n.a.
Lalmonirhat	33	0.0001	0.0001	0.0001	0.0002	0.0081	0.0003	0.727	0.848	1.000	n.a.
Naogaon	57	0.0001	0.0001	0.0004	0.0018	0.0052	0.0006	0.474	0.509	1.000	n.a.
Natore	37	0.0014	0.0025	0.0038	0.0059	0.0092	0.0030	0.000	0.000	1.000	n.a.
Nawabganj	32	0.0015	0.0029	0.0052	0.0079	0.0140	0.0037	0.063	0.063	1.000	n.a.
Nilphamari	34	0.0001	0.0001	0.0003	0.0012	0.0210	0.0010	0.471	0.559	0.971	n.a.
Pabna	46	0.0011	0.0032	0.0058	0.0085	0.0190	0.0040	0.043	0.065	0.978	n.a.
Panchagarh	32	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.844	0.938	1.000	n.a.
Rajshahi	66	0.0009	0.0023	0.0038	0.0061	0.0110	0.0028	0.076	0.091	1.000	n.a.
Rangpur	49	0.0001	0.0001	0.0002	0.0006	0.0110	0.0006	0.612	0.735	1.000	n.a.
Sirajganj	42	0.0001	0.0004	0.0033	0.0130	0.0340	0.0038	0.357	0.405	0.929	n.a.
Thakurgaon	33	0.0001	0.0001	0.0001	0.0002	0.0004	0.0001	0.758	0.879	1.000	n.a.
Rajshahi Division	*731*	*0.0001*	*0.0001*	*0.0014*	*0.0050*	*0.0350*	*0.0016*	*0.439*	*0.503*	*0.986*	*n.a.*
Habiganj	47	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.979	1.000	1.000	n.a.
Maulvi Bazar	41	0.0001	0.0001	0.0001	0.0001	0.0004	0.0001	0.878	0.927	1.000	n.a.
Sunamganj	65	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.954	0.954	1.000	n.a.
Sylhet	64	0.0001	0.0001	0.0001	0.0001	0.0006	0.0001	0.906	0.906	1.000	n.a.
Sylhet Division	217	0.0001	0.0001	0.0001	0.0001	0.0006	0.0001	0.931	0.945	1.000	n.a.
Grand Total	***2896***	***0.0001***	***0.0001***	***0.0006***	***0.0041***	***0.0630***	***0.0013***	***0.582***	***0.630***	***0.989***	***n.a.***

VANADIUM (V)

There is no Bangladesh standard or WHO guideline value for vanadium.

Figure 30: **Vanadium distribution**



The NDWQS and DPHE/BGS distributions are significantly different, with a probability of 58.3% that the DPHE/BGS distribution is greater than the NDWQS distribution.

Table 30: Geographic distribution of vanadium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Barguna	35	0.001	0.002	0.003	0.003	0.005	0.002	0.429	0.400	n.a.	n.a.
Barisal	65	0.001	0.001	0.001	0.001	0.005	0.001	0.785	0.923	n.a.	n.a.
Bhola	36	0.001	0.001	0.001	0.001	0.001	0.001	0.972	1.000	n.a.	n.a.
Jhalokati	26	0.001	0.001	0.003	0.004	0.010	0.002	0.577	0.577	n.a.	n.a.
Patuakhali	46	0.001	0.001	0.001	0.005	0.006	0.001	0.609	0.783	n.a.	n.a.
Pirojpur	40	0.001	0.002	0.003	0.004	0.017	0.002	0.425	0.450	n.a.	n.a.
Barisal Division	*248*	*0.001*	*0.001*	*0.002*	*0.003*	*0.017*	*0.001*	*0.649*	*0.722*	*n.a.*	*n.a.*
Bandarban	44	0.001	0.001	0.001	0.003	0.006	0.001	0.659	0.773	n.a.	n.a.
Brahamanbaria	52	0.001	0.001	0.001	0.003	0.004	0.001	0.731	0.808	n.a.	n.a.
Chandpur	47	0.001	0.001	0.001	0.002	0.003	0.001	0.851	0.872	n.a.	n.a.
Chittagong	92	0.001	0.001	0.002	0.003	0.019	0.001	0.826	0.750	n.a.	n.a.
Comilla	86	0.001	0.001	0.001	0.003	0.004	0.001	0.616	0.767	n.a.	n.a.
Cox's Bazar	38	0.001	0.001	0.001	0.002	0.005	0.001	0.763	0.842	n.a.	n.a.
Feni	38	0.001	0.001	0.001	0.001	0.002	0.001	0.974	0.974	n.a.	n.a.
Khagrachhari	47	0.001	0.001	0.001	0.002	0.004	0.001	0.638	0.872	n.a.	n.a.
Lakshmipur	32	0.001	0.001	0.001	0.001	0.003	0.001	0.906	0.906	n.a.	n.a.
Noakhali	51	0.001	0.001	0.001	0.003	0.003	0.001	0.804	0.824	n.a.	n.a.
Rangamati	56	0.001	0.001	0.002	0.003	0.008	0.001	0.643	0.732	n.a.	n.a.
Chittagong Division	*583*	*0.001*	*0.001*	*0.001*	*0.003*	*0.019*	*0.001*	*0.751*	*0.813*	*n.a.*	*n.a.*
Dhaka	74	0.001	0.002	0.002	0.005	0.010	0.002	0.324	0.473	n.a.	n.a.
Faridpur	48	0.001	0.001	0.001	0.003	0.004	0.001	0.750	0.792	n.a.	n.a.
Gazipur	33	0.001	0.003	0.004	0.006	0.010	0.003	0.212	0.273	n.a.	n.a.
Gopalganj	31	0.001	0.001	0.003	0.003	0.009	0.001	0.806	0.742	n.a.	n.a.
Jamalpur	39	0.001	0.001	0.001	0.001	0.002	0.001	0.872	0.949	n.a.	n.a.
Kishoreganj	75	0.001	0.001	0.003	0.005	0.014	0.002	0.560	0.640	n.a.	n.a.
Madaripur	22	0.001	0.001	0.001	0.003	0.004	0.001	0.909	0.864	n.a.	n.a.
Manikganj	40	0.001	0.001	0.001	0.002	0.003	0.001	0.875	0.900	n.a.	n.a.
Munshiganj	36	0.001	0.002	0.003	0.006	0.008	0.002	0.389	0.444	n.a.	n.a.
Mymensingh	71	0.001	0.001	0.003	0.004	0.009	0.002	0.521	0.592	n.a.	n.a.
Narayanganj	31	0.001	0.002	0.003	0.004	0.008	0.002	0.226	0.419	n.a.	n.a.
Narsingdi	33	0.001	0.001	0.002	0.004	0.008	0.001	0.576	0.697	n.a.	n.a.
Netrakona	53	0.001	0.001	0.002	0.003	0.007	0.001	0.642	0.717	n.a.	n.a.
Rajbari	27	0.001	0.001	0.003	0.004	0.005	0.002	0.593	0.593	n.a.	n.a.
Shariatpur	36	0.001	0.001	0.001	0.001	0.003	0.001	0.889	0.944	n.a.	n.a.
Sherpur	31	0.001	0.001	0.001	0.001	0.001	0.001	0.935	1.000	n.a.	n.a.
Tangail	73	0.001	0.001	0.001	0.003	0.005	0.001	0.616	0.767	n.a.	n.a.
Dhaka Division	*753*	*0.001*	*0.001*	*0.002*	*0.004*	*0.014*	*0.002*	*0.606*	*0.683*	*n.a.*	*n.a.*

Table 30: Geographic distribution of vanadium

District	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below MDL	Below LOD	Below WHO GV	Below BD Standard
Bagerhat	54	0.001	0.002	0.003	0.003	0.007	0.002	0.333	0.370	n.a.	n.a.
Chuadanga	23	0.001	0.002	0.003	0.003	0.004	0.002	0.304	0.435	n.a.	n.a.
Jessore	43	0.001	0.001	0.003	0.004	0.010	0.002	0.581	0.558	n.a.	n.a.
Jhenaidah	36	0.001	0.001	0.003	0.004	0.006	0.002	0.500	0.556	n.a.	n.a.
Khulna	64	0.001	0.002	0.003	0.004	0.013	0.002	0.625	0.500	n.a.	n.a.
Kushtia	35	0.001	0.001	0.003	0.005	0.016	0.002	0.514	0.543	n.a.	n.a.
Magura	27	0.001	0.002	0.003	0.005	0.006	0.002	0.444	0.444	n.a.	n.a.
Meherpur	22	0.001	0.001	0.002	0.003	0.005	0.001	0.227	0.636	n.a.	n.a.
Narail	21	0.001	0.002	0.003	0.004	0.005	0.002	0.286	0.381	n.a.	n.a.
Satkhira	39	0.001	0.001	0.002	0.003	0.011	0.002	0.641	0.641	n.a.	n.a.
Khulna Division	*364*	*0.001*	*0.001*	*0.003*	*0.004*	*0.016*	*0.002*	*0.478*	*0.505*	*n.a.*	*n.a.*
Bogra	72	0.001	0.001	0.002	0.002	0.004	0.001	0.611	0.722	n.a.	n.a.
Dinajpur	82	0.001	0.001	0.001	0.002	0.004	0.001	0.793	0.878	n.a.	n.a.
Gaibandha	40	0.001	0.001	0.001	0.001	0.007	0.001	0.850	0.950	n.a.	n.a.
Joypurhat	31	0.001	0.001	0.002	0.003	0.003	0.001	0.677	0.742	n.a.	n.a.
Kurigram	45	0.001	0.001	0.001	0.001	0.001	0.001	0.889	1.000	n.a.	n.a.
Lalmonirhat	33	0.001	0.001	0.001	0.002	0.002	0.001	0.727	0.879	n.a.	n.a.
Naogaon	57	0.001	0.001	0.001	0.002	0.005	0.001	0.807	0.895	n.a.	n.a.
Natore	37	0.001	0.002	0.002	0.003	0.007	0.002	0.324	0.432	n.a.	n.a.
Nawabganj	32	0.001	0.001	0.002	0.003	0.008	0.001	0.438	0.594	n.a.	n.a.
Nilphamari	34	0.001	0.001	0.001	0.002	0.008	0.001	0.735	0.853	n.a.	n.a.
Pabna	46	0.001	0.002	0.003	0.003	0.009	0.002	0.326	0.478	n.a.	n.a.
Panchagarh	32	0.001	0.001	0.001	0.001	0.002	0.001	0.875	0.906	n.a.	n.a.
Rajshahi	66	0.001	0.002	0.003	0.004	0.006	0.002	0.303	0.348	n.a.	n.a.
Rangpur	49	0.001	0.001	0.001	0.002	0.004	0.001	0.755	0.857	n.a.	n.a.
Sirajganj	42	0.001	0.001	0.001	0.002	0.003	0.001	0.738	0.833	n.a.	n.a.
Thakurgaon	33	0.001	0.001	0.001	0.001	0.003	0.001	0.879	0.909	n.a.	n.a.
Rajshahi Division	*731*	*0.001*	*0.001*	*0.001*	*0.002*	*0.009*	*0.001*	*0.663*	*0.759*	*n.a.*	*n.a.*
Habiganj	47	0.001	0.001	0.001	0.001	0.001	0.001	0.936	1.000	n.a.	n.a.
Maulvi Bazar	41	0.001	0.001	0.001	0.001	0.001	0.001	0.951	1.000	n.a.	n.a.
Sunamganj	65	0.001	0.001	0.001	0.001	0.001	0.001	0.969	1.000	n.a.	n.a.
Sylhet	64	0.001	0.001	0.001	0.002	0.009	0.001	0.813	0.875	n.a.	n.a.
Sylhet Division	217	0.001	0.001	0.001	0.001	0.009	0.001	0.912	0.963	n.a.	n.a.
Grand Total	***2896***	***0.001***	***0.001***	***0.002***	***0.003***	***0.019***	***0.001***	***0.660***	***0.730***	***n.a.***	***n.a.***

ZIRCONIUM (ZR)

There is no Bangladesh standard or WHO guideline value for zirconium (Zr).

Zirconium was below the detection limit (0.001 mg/L) in 99.8% of samples. Only seven (7) samples showed levels slightly above the detection limit:

District	Zirconium, mg/L
Barguna	0.003
Jhalokati	0.005
Jhenaidah	0.004
Khagrachhari	0.006
Pirojpur	0.005
Rangamati	0.003
Sylhet	0.002

With such a low number of samples with detectable zirconium, no further analysis is made.

CHEMICAL QUALITY OF WATER

With a large number of parameters tested, it is possible to make observations regarding inter-parameter correlations. This is only done with NDWQS laboratory samples, and since fluoride and chloride were collected in a separate survey they are not included in this analysis.

WHO GUIDELINE VALUES

Of the parameters measured in the NDWQS, nine have health-based guideline values established by the WHO. These are summarized in Table 31.

Table 31: **Elements measured in NDWQS survey having health-based WHO Guideline Values. All values in mg/L.**

Analyte	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	WHO GV	Below WHO GV
Arsenic (As)	0.001	0.001	0.004	0.041	0.910	0.018	0.01 (P)	0.821
Barium (Ba)	0.05	0.09	0.15	0.26	1.50	0.13	0.7	0.992
Boron (B)	0.012	0.027	0.094	0.330	3.0	0.110	0.5	0.939
Copper (Cu)	0.0003	0.0003	0.0005	0.0010	0.130	0.0006	2.0	1.000
Manganese (Mn)	0.04	0.20	0.63	1.30	9.2	0.49	0.4	0.647
Molybdenum (Mo)	0.001	0.001	0.001	0.002	0.023	0.001	0.07	1.000
Nickel (Ni)	0.001	0.001	0.002	0.003	0.190	0.002	0.02 (P)	0.997
Selenium (Se)	0.001	0.001	0.001	0.001	0.015	0.001	0.01	0.999
Uranium (U)	0.0001	0.0001	0.0006	0.0041	0.063	0.0013	0.015	0.989

(P) indicates provisional guideline values

The WHO guidelines most frequently exceeded are for Mn and As. A substantial number of samples also exceed the Bangladesh guideline value, while other guidelines are met in the great majority of samples. Table 32 indicates the cumulative compliance of samples drawn from different sources. Less than half (48.4%) of household drinking water samples met all nine WHO guideline values. Shallow tubewells were the source providing the worst quality drinking water in terms of chemical quality, with deep tubewells the second worst, although other sources likely had higher microbial contamination.

Table 32: **Proportion of samples meeting multiple WHO guideline values**

Water Source	Samples	Meets WHO guideline value for			
		As	As,Mn	As, Mn, B	All 9
Shallow tubewell	2060	0.796	0.441	0.428	0.422
Deep tubewell	526	0.857	0.774	0.568	0.559
Dug well	59	0.983	0.763	0.763	0.746
Surface water	67	0.970	0.866	0.836	0.836
Piped into yard or plot	54	0.852	0.741	0.685	0.685
Piped into dwelling	48	0.938	0.854	0.813	0.813
Public tap/standpipe	44	0.886	0.773	0.750	0.750
Spring	22	0.955	0.909	0.818	0.818
Other	16	0.875	0.688	0.688	0.688
TOTAL	2896	0.821	0.540	0.490	0.484

A pairwise correlation analysis shows that some analytes correlate strongly with one another. In the following correlation matrix (Table 33), the top number in each cell indicates the bivariate correlation coefficient (r), while the bottom number shows the statistical significance (p-value). A negative correlation coefficient indicates that two analytes are inversely correlated. Correlation coefficients significant at the 95% level are indicated with an asterisk. Because of their frequent occurrence and importance in arsenic removal, iron and phosphate (for which no WHO guideline values are set) are included in this analysis.

Table 33: **Correlation matrix, analytes having health-based WHO Guideline Values**

Analyte	As	Ba	B	Cu	Fe	Mn	Mo	Ni	P	Se	U
As	1										
Ba	0.035 0.064	1									
B	0.065* 0.001	-0.051* 0.006	1								
Cu	-0.060* 0.001	0.062* 0.001	-0.103* < 0.001	1							
Fe	0.199* < 0.001	0.093* < 0.001	-0.120* < 0.001	-0.006 0.733	1						
Mn	-0.022 0.230	0.108* < 0.001	-0.166* < 0.001	0.029 0.124	0.105* < 0.001	1					
Mo	0.308* < 0.001	0.001 0.949	0.124* < 0.001	-0.026 0.165	0.021 0.257	0.012 0.516	1				
Ni	-0.031 0.101	0.149* < 0.001	-0.043* 0.021	0.088* < 0.001	0.016 0.382	0.019 0.299	-0.001 0.951	1			
P	0.463* < 0.001	0.038* 0.043	0.248* < 0.001	-0.067* < 0.001	0.258* < 0.001	-0.110* < 0.001	0.155* < 0.001	-0.043* 0.020	1		
Se	0.013 0.488	0.046* 0.014	0.085* < 0.001	-0.009 0.626	-0.020 0.284	0.024 0.191	0.035 0.060	0.069* < 0.001	0.007 0.717	1	
U	-0.068* < 0.001	0.164* < 0.001	-0.055* 0.003	0.035 0.064	-0.131* < 0.001	0.264* < 0.001	0.021 0.252	-0.026 0.163	-0.129* < 0.001	0.036 0.056	1

It is clear that As, B, Mo, and P (which all form oxyanions) are strongly and positively linked with each other. Fe also correlates well with this set of parameters, suggesting a common mobilization mechanism related to iron oxide dissolution. U is negatively associated with these elements (except for Mo), suggesting that sources or mobilization mechanisms are different for this element but is consistent with its known redox behavior. Se also forms oxyanions but does not correlate strongly with the other oxyanions, perhaps because concentrations were low.

BANGLADESH DRINKING WATER STANDARDS

Fifteen of the parameters measured in the reference laboratory from the NDWQS could be compared against Bangladesh drinking water standards (see Table 34). Seven parameters were exceeded in at least 10% of samples. Note that fluoride is excluded since analyses were made on different samples. However, only 1% of samples exceeded the Bangladesh limit for fluoride.

Table 34: Elements from NDWQS having Bangladesh drinking water standards. All values in mg/L.

Analyte	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Bangladesh Standard (Maximum)	Below BD Standard
Aluminium (Al)	0.035	0.051	0.087	0.160	16.0	0.098	0.2	0.938
Arsenic (As)	0.001	0.001	0.004	0.041	0.910	0.018	0.05	0.915
Boron (B)	0.012	0.027	0.094	0.330	3.0	0.110	1.0	0.993
Calcium (Ca)	14	30	70	110	520	47	75	0.773
Copper (Cu)	0.0003	0.0003	0.0005	0.0010	0.130	0.0006	1.0	1.000
Hardness (as CaCO3)	65	138	289	434	1409	196	500	0.936
Iron (Fe)	0.24	0.71	2.30	6.10	43.0	2.22	1.0	0.598
Magnesium (Mg)	6	13	24	36	210	18	35	0.894
Manganese (Mn)	0.04	0.20	0.63	1.30	9.2	0.49	0.10	0.389
Nickel (Ni)	0.001	0.001	0.002	0.003	0.190	0.002	0.10	0.999
Phosphorus (P)	0.15	0.24	0.44	1.40	13.0	0.54	1.96*	0.935
Potassium (K)	2	3	5	9	520	5	12	0.927
Selenium (Se)	0.001	0.001	0.001	0.001	0.015	0.001	0.01	1.000
Sodium (Na)	14	27	77	250	1700	87	200	0.867
Zinc (Zn)	0.009	0.015	0.034	0.077	5.5	0.046	5	1.000

* Adjusted from 6 mg/L as phosphate

The Bangladesh standards most frequently exceeded are for Mn and Fe, followed by Ca. Table 35 indicates the cumulative compliance of samples drawn from different sources. Fewer than one in five (18.5%) of household drinking water samples met all fifteen Bangladesh drinking water standards.

Table 35: **Proportion of samples meeting multiple Bangladeshdrinking water standards**

Water Source	Meets Bangladesh drinking water standards for					
	As	As, Mn	As, Mn, Fe	As, Mn, Fe, Ca, Mg, hardness	As, Mn, Fe, Ca, Mg, hard-ness, Na	All 15
Shallow tubewell	0.901	0.238	0.175	0.155	0.146	0.131
Deep tubewell	0.930	0.679	0.601	0.559	0.297	0.281
Dug well	0.983	0.458	0.407	0.373	0.373	0.288
Surface water	1.000	0.687	0.657	0.627	0.597	0.299
Piped into yard or plot	0.981	0.667	0.648	0.574	0.444	0.444
Piped into dwelling	1.000	0.688	0.688	0.646	0.583	0.479
Public tap/standpipe	0.955	0.614	0.591	0.455	0.455	0.386
Spring	0.955	0.818	0.727	0.727	0.727	0.591
Other	1.000	0.500	0.500	0.500	0.500	0.375
TOTAL	0.915	0.360	0.298	0.271	0.212	0.185

Table 36 shows that many of the analytes exceeding Bangladesh drinking water standards are correlated. Arsenic correlates strongly with Fe and P, as noted earlier, but also with hardness,Ca, and especially Mg. These last three are all strongly inter-correlated, as expected since Ca and Mg are the principal components of hardness (which was calculated in this study). Na is strongly positively correlated with Mg, suggesting sea water influences, and negatively correlated with Fe and Mn.

Table 36: **Correlation matrix, analytes most commonly exceeding Bangladesh drinking water standards**

Analyte	As	Mn	Fe	Ca	Mg	Hardness	Na	P
As	1							
Mn	-0.022 0.230	1						
Fe	0.199* < 0.001	0.105* < 0.001	1					
Ca	0.054* 0.004	0.320* < 0.001	-0.037* 0.046	1				
Mg	0.170* < 0.001	0.204* < 0.001	-0.033 0.076	0.607* < 0.001	1			
Hardness	0.118* < 0.001	0.316* < 0.001	0.003 0.888	0.939* < 0.001	0.842* < 0.001	1		
Na	0.067* < 0.001	-0.102* < 0.001	-0.101* < 0.001	0.060* 0.001	0.520* < 0.001	0.260* < 0.001	1	
P	0.463* < 0.001	-0.110* < 0.001	0.258* < 0.001	-0.094* < 0.001	0.120* < 0.001	-0.002 0.903	0.264* < 0.001	1

DIFFERENCES BETWEEN NDWQS AND DPHE/BGS SURVEYS

For certain analytes, marked differences were noted in the NDWQS and DPHE/BGS surveys. In many instances, concentrations were significantly higher in the DPHE/BGS survey, these are italicized in the following table.

Table 37: **Summary table of differences between NDWQS and DPHE/BGS survey**

Analyte	Median (NDWQS)	Median (DPHE/BGS)	Significantly dffer-ent?*	Probability that DPHE/BGS>NDWQS
Major elements (median > 1 mg/L)				
Calcium (Ca)	*30*	*33*	*< 0.0001*	*0.532*
Chloride (Cl)	*12*	*22.2*	*0.006*	*0.581*
Magnesium (Mg)	*13*	*15*	*< 0.0001*	*0.551*
Potassium (K)	*2.7*	*2.9*	*< 0.0001*	*0.532*
Silicon (Si)	*17*	*20*	*< 0.0001*	*0.579*
Sodium (Na)	27	26	0.180	0.490
Minor elements (median 0.01 - 1.0 mg/L)				
Aluminium (Al)	0.051	.020	< 0.0001	0.455
Barium (Ba)	0.087	.057	< 0.0001	0.446
Boron (B)	0.027	.050	0.058	0.489
Fluoride (F)	*0.15*	*0.21*	*0.020*	*0.554*
Iron (Fe)	*0.71*	*1.10*	*< 0.0001*	*0.545*
Manganese (Mn)	*0.20*	*0.29*	*< 0.0001*	*0.565*
Phosphorus (P)	*0.24*	*0.30*	*< 0.0001*	*0.565*
Strontium (Sr)	*0.16*	*0.18*	*0.001*	*0.524*
Zinc (Zn)	0.015	0.017	0.002	0.486
Trace elements (median < 0.01 mg/L)				
Arsenic (As, laboratory)	*0.001*	*0.004*	*< 0.0001*	*0.646*
Arsenic (As, Arsenator)	*0.001*	*0.004*	*< 0.0001*	*0.562*
*Cobalt (Co)***	*0.0005*	*0.003*	*< 0.0001*	*0.958*
Copper (Cu)**	0.018	0.008	0.0006	0.498
*Lithium (Li)***	*0.005*	*0.004*	*< 0.0001*	*0.552*
*Nickel (Ni)***	*0.001*	*0.002*	*0.0015*	*0.533*
*Molybdenum (Mo)***	*0.001*	*0.001*	*< 0.0001*	*0.624*
Uranium (U)	0.0001	0.00004	0.82	0.494
*Vanadium (V)***	*0.001*	*0.001*	*< 0.0001*	*0.583*

* Statistical significance (p-values), and the probability of the DPHE/BGS data distribution being greater than the NDWQS data distribution, were both calculated using the Mann-Whitney-Wilcoxon rank-sum test. A p-value of < 0.05 indicates a significant difference at the 95% level. This rank-sum test calculates the likelihood that one distribution is greater than the other, but this is a non-parametric test, which says nothing about the magnitude of the difference. Note that a probability less than 0.50 indicates that the NDWQS distribution was likely to be greater than the DPHE/BGS distribution.

** Most samples were below the detection limit, any significant differences are caused by a small number of samples with detectable levels of the analyte.

There are at least two plausible mechanisms which could explain higher concentrations of elements in the DPHE/BGS survey compared to the NDWQS.

First, the DPHE/BGS survey aimed for a statistically representative sample of groundwaters, while the NDWQS survey targettted household water for drinking. Much groundwater in Bangladesh contains elevated levels of iron. When exposed to air and stored in the household, iron can react with oxygen and form insoluble precipitates, which slowly settle to the bottom of the container. This is the reason that water pumped from such wells is initially clear, but becomes brownish-red and turbid over time. When iron precipitates from solution, other elements may co-precipitate or adsorb onto the new surface. Many metals (Fe, Mn, Cu) can be removed in this way, as can some anions (arsenic, phosphate, silicate, uranium). Some elements are not very well adsorbed by iron solids (B, Cl, F), and would not be expected to be impacted by this mechanism.

An alternate explanation is that people systematically prefer to collect drinking water from sources which taste better, and that groundwater with lower levels of dissolved minerals (e.g. salinity, hardness, iron) is preferred by users.

Concentrations of all the major elements, excepting sodium, are significantly lower in the NDWQS dataset. Iron precipitation is unlikely to explain the differences in chloride and hardness, but could explain the difference in silicon, which does not have significant taste impacts at the concentrations seen in the survey but does adsorb to ferric iron surfaces. Taste preference could account for much of the difference in major ion levels between the two surveys, as people can readily taste high levels of chloride or hardness in drinking water.

Among the minor elements, iron, manganese, strontium and phosphorus are lower in the NDWQS, which could be explained either by taste preference or by oxidation and removal of iron and manganese. Phosphate does not impact water taste, but does adsorb well to iron surfaces and could be removed to some extent during iron precipitation. Manganese also adsorbs to iron surface, furthermore it has a bitter taste which could lead users to preferentially seek low-Mn water sources.

Three minor elements (Al, Ba, and Zn) were higher in the NDWQS compared to DPHE/BGS. The slightly higher levels of Al and possibly Zn in the NDWQS dataset could be due to storage of household water in aluminium vessels. The reason for the difference in Ba levels is not clear, but could be an artefact, as many samples were below the LOD.

Of the trace elements, most were below limits of detection for the majority of samples, so differences in distributions are hard to interpret. The major exception is arsenic, which is substantially lower in the NDWQS survey compared to the DPHE/BGS data. The same two mechanisms (iron precipitation and selective use of better-quality sources) could explain these differences. Since awareness of the hazards of arsenic in groundwater has increased tremendously in Bangladesh between 1999 and 2009, it is plausible that substantial numbers of people have changed their drinking water sources to avoid high arsenic levels. Indeed, this has been reported in focused research areas[10], as well as in the 19 districts where DPHE and UNICEF are implementing the Sanitation, Hygiene Education and Water Supply (SHEWAB) project, and where a baseline survey found that 15% of respondents reported having changed their main drinking water source because of arsenic.

Given the methodological differences between the two surveys, it is impossible to say how much of the difference in arsenic levels observed is due to behavior change resulting from arsenic awareness raising and mitigation activities; how much is simply due to people preferentially choosing water which tastes better; and how much is due to arsenic loss to iron precipitates during storage.

[10] Madajewicz, M., A. Pfaff, et al. (2007). «Can information alone change behavior? Response to arsenic contamination of groundwater in Bangladesh.» Journal of Development Economics 84(2): 731-754

SUMMARY AND CONCLUSIONS

The NDWQS shows that the population exposed to high levels of arsenic in Bangladesh is considerably lower than some estimates, but remains massive. Assuming a population of 164 million in 2010[11], the figures in Table 19c show that 22 million people are exposed to more than 0.05 mg/L through drinking water; 52 million are exposed to more than 0.01 mg/L, the provisional WHO guideline value. A staggering 5.6 million are exposed to more than 0.2 mg/L, and face a high risk of developing arsenicosis and suffer from the most severe health consequences.

Survey respondents who reported taking drinking water from wells which had been tested and marked safe (green) had drinking water in the home meeting the Bangladesh standard of 0.05 mg/L in 89% of cases. Similarly, 87% of those who reported taking water from a source which had been tested and marked unsafe (red) had drinking water exceeding the WHO Guideline Value of 0.01 mg/L (though only 67% of these samples exceeded the Bangladesh standard).

High levels of iron are widespread, with approximately 40% of the population exposed to more than the Bangladesh limit of 1.0 mg/L. The situation is even worse for manganese, which has health impacts: more than 60% of the population consumes drinking water above the Bangladesh limit of 0.1 mg/L, and approximately one third of the population drinks water exceeding the less stringent WHO Guideline Value of 0.4 mg/L.

No significant problems were seen with other elements which have health impacts, including Ba, B, F, Ni, Se, U, and Zn. This survey is the largest fluoride survey to date in Bangladesh, and shows that geogenic fluoride is not a major issue. There have been no previous national surveys of selenium in drinking water, though small scale studies have found low levels in groundwater and in soils. This survey confirms that selenium levels in water are low throughout the country. In Bangladesh selenium deficiency is more likely than selenium toxicity.

Moderately hard to very hard water is common, especially in the coastal regions.

The NDWQS survey found lower concentrations of several elements, including arsenic, than were found in the 1999 DPHE/BGS survey. One important difference between the surveys is that the DPHE/BGS survey collected samples at the tube well, while in the NDWQS survey household water was collected. In the ten years since the DPHE/BGS survey, awareness of arsenic has increased tremendously. More than 100,000 new arsenic-free water points have been installed in arsenic-affected areas by government and NGO programs. People who learned that their shallow tube well was contaminated may have taken corrective actions on their own to reduce their arsenic exposure, either by sharing water from a safe well or by redrilling their well to a deeper, presumably less arsenic-affected, part of the aquifer. While the differences in source water could account for part of the difference between the two data sets, another potential reason is that chemical reaction during drinking water storage tends to lower arsenic if the source water also contains high iron. The NDWQS, by sampling the drinking water instead of just groundwater, represents a more accurate measurement of exposure to arsenic and other chemicals in 2009.

LIMITATIONS

The survey did not include microbiological testing, and it is likely that microbiological contamination of household water is much more widespread than chemical contamination. Household water surveys conducted in the DPHE/UNICEF SHEWA-B project area encompassing 19 of the 64 districts of Bangladesh show that more than half of samples contain *E. coli*, an indicator of faecal contamination, and 10% of samples contain very high levels (> 100 cfu/100 mL). These surveys are not nationally representative, but cover large portions of rural Bangladesh and give some idea of the microbial quality of household drinking water.

[11] Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2008 Revision, http://esa.un.org/unpp,

Quality control measures were not always carried out correctly, and total ion analysis revealed that some samples coded as ‘blanks’ were clearly drinking water samples. True blanks contained high levels of some metals (notably lead and cadmium), indicating contamination of either the locally produced plastic bottle or the acid preservative. Accordingly no assessment could be made of the distribution of these elements.

RECOMMENDATIONS

By collecting water samples at the household rather than at the source, the 2009 NDWQS gives a detailed snapshot of exposure to a wide range of inorganic parameters in drinking water of Bangladesh. Thus, future surveys are recommended to be made with similar methodologies to allow comparison. This is crucial to allow progress towards the MDG Target 7c to be assessed properly. The present Government of Bangladesh committed in its election manifesto that “the arsenic problem will be tackled and measures will be taken to supply drinking water for all by 2011.” Future surveys could provide much-needed evidence on the extent to which arsenic exposure is decreasing in Bangladesh.

The next two MICS surveys planned for 2012 and 2015 will provide critical data for measuring whether Bangladesh is on track to reach MDG targets by 2015. If cost is not a limiting factor, microbiological water quality such as *E. Coli* is recommended to be included in MICS 2012. Although it would somewhat complicate the survey design, it would be extremely valuable to conduct microbiological tests of household water in future surveys. Advances are being made in development of simple robust methods for field use in rugged settings which could render this task less challenging. Enzyme substrate methods, in particular, greatly facilitate the measurement of *E. coli*, compared to standard membrane filtration methods. The 2011 DHS survey in Peru will pilot one such assay, and others will surely follow in coming years. The recent reaffirmation of the human right to safe drinking water and sanitation will provide new impetus for governments around the world to measure fulfillment of this right. Future MICS surveys should also include questions about household assets so that results could be disaggregated by wealth quintiles.

The methodology followed in the 2009 NDWQS was simple enough to be carried out without unduly burdening the field workers. A key element was engaging a local research firm to prepare and distribute sample bottles and labels, so that the only task required of MICS field workers was to fill and label one bottle per cluster visited. Even then, quality control measures were not always followed correctly, thus future surveys could spend more time on training, especially labeling and possibly adopting a bar code system to track samples. The 2009 NDWQS suffered from trace contamination of bottles or preservatives; either stricter evaluation of locally procured materials should be made in future surveys, or laboratory-quality materials could be imported to avoid this problem.

The cost of making more than 17,000 arsenic measurements with Digital Arsenators was considerable, both in terms of supplies and analyst time. This large sample size was necessary to have reasonable precision at district levels. If only nationally-representative data were needed in future surveys, a smaller sample size could be used. In this case it might be best to eliminate the Digital Arsenator testing in favor of laboratory tests (e.g. ICP/MS) which give arsenic levels rapidly, along with iron, manganese, and many other elements of interest. However, to have reasonable precision at upazila (sub-district) level, a much larger sample size is then necessary. Future surveys do not need include fluoride, since the current survey has found that fluoride levels in drinking water do not pose a significant health threat in Bangladesh.

Nationally representative water quality surveys are rare globally, and the current survey represents an important step forward. By building on and improving the experience from the 2009 NDWQS, Bangladesh can continue to provide global leadership in water quality surveillance and management.

APPENDIX: METHODS AND QUALITY CONTROL

This report includes data from two related surveys:

1) A survey of nearly 15,000 households, in which MICS enumerators collected samples and delivered them to DPHE and UNICEF. Samples were then analyzed for arsenic in Bangladesh, using Digital Arsenators. An external laboratory analysis was made of 20% of samples collected through the MICS survey. These samples were acidified and analyzed for a series of 36 metals and metalloids.
2) Shortly after the MICS survey, a separate survey was made by DPHE in 20% of the mouzas visited by the MICS enumerators. These were analyzed for fluoride in Bangladesh using field kits, and 20% of samples were sent to the same external laboratory. These samples were not acidified, and were analyzed for the anions chloride and fluoride.

Sample coding and quality control measures were similar in the two surveys, and are discussed in detail in the following sections.

MICS SURVEY

The water quality module in the MICS survey was designed so that BBS enumerators would collect one sample from each of the 15,000 clusters visited. Data were identified by Cluster ID, Household ID, and Sample ID.

Cluster ID numbers were five-digit ID numbers set by the Bangladesh Bureau of Statistics (BBS), ranging from 1 to 15,000. Each cluster consisted of 20 households, numbered sequentially (i.e. 01-20). Enumerators were instructed to collect a water sample from the first household in each cluster, and as such the two-digit **Household ID number** should in principle always be 01 for water quality samples. Enumerators were provided with locally produced 125 mL plastic bottles, each containing 1.5 ml of 1.1 diluted nitric acid. Enumerators were also provided with pre-printed stickers with which to label the bottles. These stickers contained a pre-printed five-digit **Sample ID number**, consisting of the two-digit district geocode, followed by a three-digit sequential counter (001-999).

Figure A1 shows the sticker with Sample ID 41-440, representing the 440th sample to be collected in district 41 (Jessore).After filling the sample bottle, BBS enumerators wrote the Cluster ID number, Household ID number, and collection date on the sticker and affixed it to the bottle.

41-440 Cluster ID _ _ _ _ _ _	Household ID _ _ _	Date: _______________	*NITRIC ACID Preservative*

Figure A1: Sample bottle labels for MICS survey.

BBS enumerators also collected field quality control samples from 10% of clusters. At clusters with Cluster ID numbers ending in 00, 20, 40, 60, and 80, a field blank was to be collected. DPHE and UNICEF supplied distilled water to the district BBS officers for this purpose. At clusters with ID numbers ending in 10, 30, 50, 70, and 90, a duplicate water sample was to be collected. In this way a total of 1,500 field quality control samples (750 blanks and 750 duplicates) were to be collected. All quality control samples were identified with stickers having Sample ID numbers of 700 or higher. In this way, both the Cluster ID and the Sample ID indicate quality control samples.

DIGITAL ARSENATOR DATA

A local consulting firm, Participatory Management Initiative for Development (PMID), was contracted and trained to use portable quantitative instruments (Wagtech Arsenator, model WE-10500) to measure arsenic in the samples delivered to DPHE and UNICEF. In brief, a 50 mL sample was placed in a reaction vessel, to which was added a premeasured dose of sulfamic acid and a tablet containing sodium borohydride. The ensuing reaction produces hydrogen gas and transforms any arsenate or arsenite into volatile arsine. Gas passes through a hydrogen sulfide trap (cotton impregnated with lead sulfate) before reacting with mercuric bromide impregnated on a paper strip. The bromide strip changes color proportional to the amount of arsenic present, and the color change is measured using a photodiode reader. The instrument can read values from 5-100 μg/L; if higher levels were found the analyst made a second test using a 10:1 dilution with distilled water.

PMID tested a total of 17,205 samples. Of these, 1,255 were not coded with valid sample IDs, and 186 were coded as quality control samples on the basis of the sample ID number but could not be identified as blanks or duplicates on the basis of the cluster ID number. These miscoded records were excluded from further analysis. Of the remaining samples, 14,442 field samples, 665 field blanks and 657 field replicates were identified and form the dataset used for analysis. See Figure A2 for details.

Of the 665 field blanks, arsenic levels were clearly elevated in a number of samples (six samples exceeded 50 μg/L). These were interpreted as errors in sample coding rather than analytical errors. Similarly, analysis of the laboratory dataset for multiple parameters revealed elevated levels of multiple ions in some field blanks (but never in laboratory blanks). In the multiparameter laboratory dataset (see below), 10.3% of coded field blanks were excluded on the basis of elevated concentrations of multiple ions. For the Arsenator dataset, only arsenic tests were available. Rather than exclude 10.3% of field blanks from this dataset, the 5% showing the highest arsenic values were arbitrarily excluded. Of the 632 accepted blanks, the mean and standard deviation were 1.0 and 2.6 μg/L, respectively, giving a Limit of Detection of 8.7 μg/L.

Of the 657 field replicates, 590 could be matched with field samples. Correlation between field duplicates and field samples was reasonable (Figure A3), with an r^2 of 0.74.

It should be noted that in the main MICS report, only 13,301 samples were found to be correctly coded for data analysis, whereas this report uses a dataset of 14,442 samples. The difference is most likely due to the fact that different analysts cleaned the raw dataset independently for the two reports. This leads to minor differences in summary statistics: the main MICS report finds 23.1% of households exceeding the WHO guideline value of 10 μg/L, while 12.6% exceed the Bangladesh standard of 50 μg/L and 3.1% exceed 200 μg/L. The corresponding figures in this report are 32.0%, 13.4%, and 3.4%.

Figure A2: **Data management, Digital Arsenator dataset**

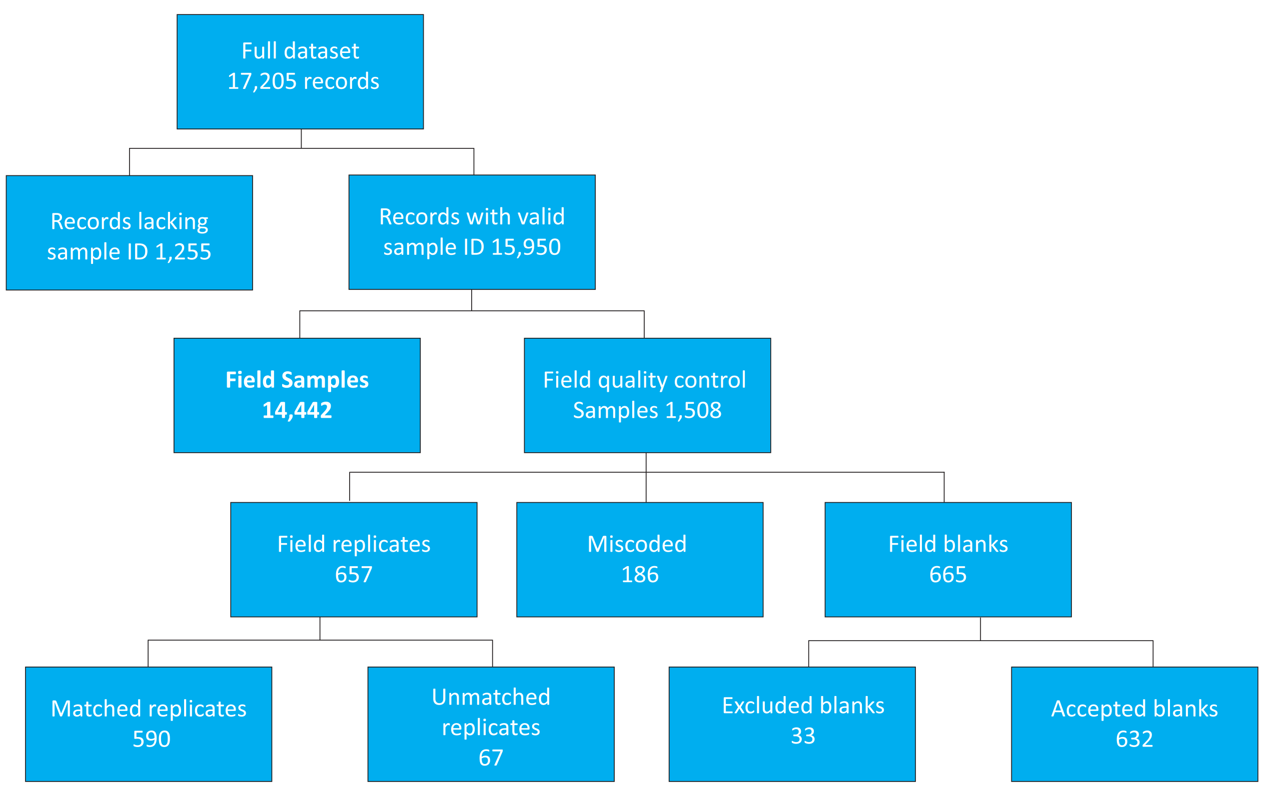
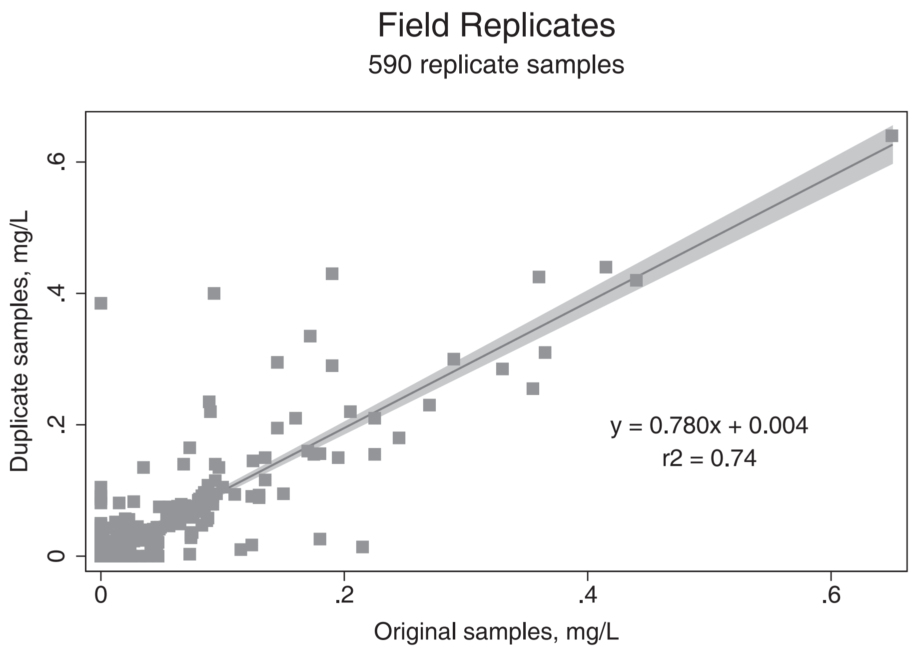


Figure A3: **Comparison of field replicates, Digital Arsenator data**



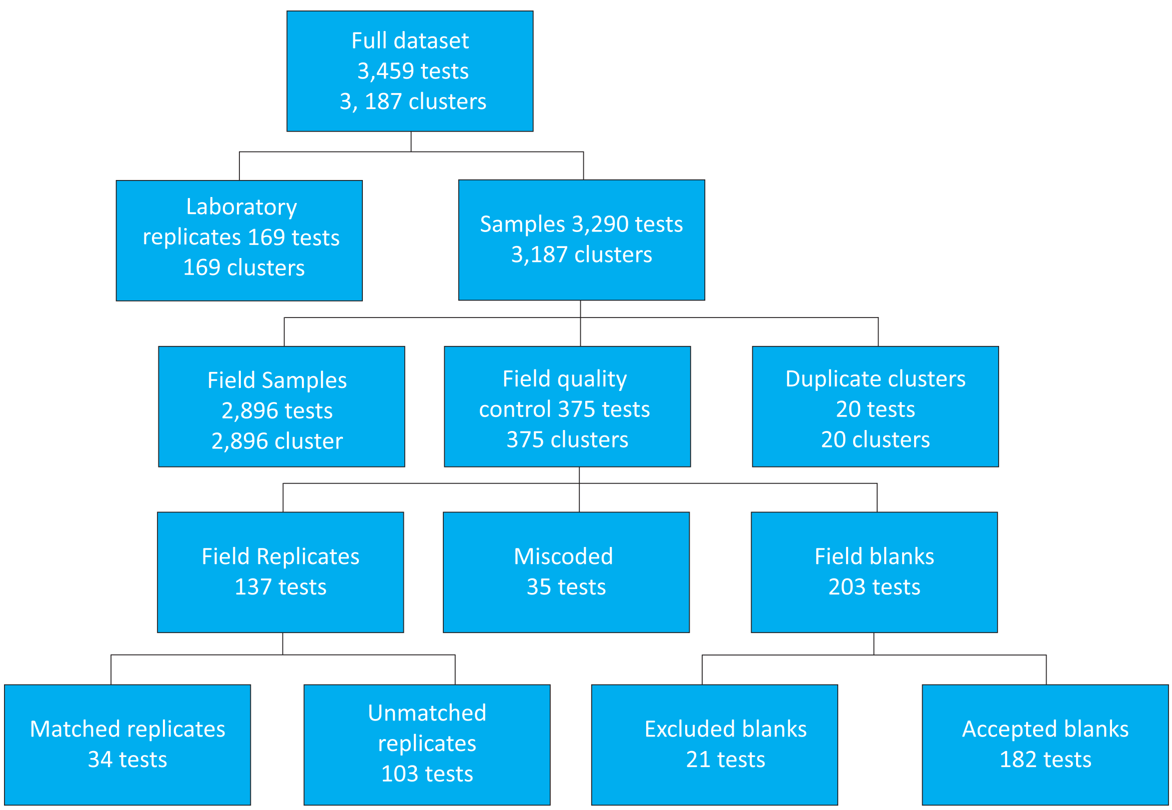
LABORATORY DATA

After PMID had made arsenic analyses using Digital Arsenators, a subset of samples were sent to an external laboratory (Maxxam Analytics, Canada) for analysis of 36 parameters using ICP/MS (EPA Method 6020). 20% of samples from each district, including field blanks and replicates, were selected for laboratory analysis.

Maxxam provided a set of 3,459 records, of which 169 (4.9%) were internal laboratory duplicates. Of the remaining 3,290 records, 2,896 were field samples, each from a unique cluster. 20 samples were excluded because of duplicate Cluster ID numbers.

375 samples (11.4% of the total field samples) were coded as field quality control samples, on the basis of the Sample ID number. Of these samples the Cluster ID indicated the sample was a field blankin 203 cases (54.1%), and a field duplicate in 137 cases (36.5%). 35 quality control samples (9.3%) had Cluster IDs which did not correspond to blanks or duplicates, and were excluded from further analysis. See Figure A4 for details.

Figure A4: **Data management, laboratory data of MICS survey**



Some field blanks were excluded from this analysis because concentrations of multiple analytes were significantly higher than the other blanks. It is to be expected that field workers would mislabel some proportion of samples as blanks, and including these in statistical analysis would unnecessarily inflate the Limit of Detection (LOD) calculation. Using a dissimilarity matrix, 21(10.3%) out of the 203 labelled blanks were excluded. The mean and standard deviation of the remaining 182 accepted blank samples was calculated for each analyte, and the LOD was taken as the sum of the mean plus three standard deviations (Table A1).

All field quality control samples (blanks and field replicates) should have been linked with a regular sample through the Sample ID number, but approximately 75% of the time no pair could be made. Analysis of data from blanks was made without the linked information from the field samples, but it is not possible to analyze the field replicates without having a linked field sample. Thus statistical analysis could only be made on 34 matched pairs of field replicates (Table A3).

COMPARISON OF FIELD AND LABORATORY DATA

The distributions of arsenic found in the laboratory and Digital Arsenator datasets are substantially different. In the laboratory data, only 8.5% and 17.9% of samples exceed the Bangladesh standard and WHO guideline value, respectively. The larger Digital Arsenator set finds higher levels of contamination: 13.4% and 32.0% above these limits.

One possible explanation for this difference would be a systematic bias among one of the analytical methods – for instance, if the Digital Arsenator consistently gave higher results than the laboratory tests. However, analysis of linked data indicates that this is not the case. Of the 1,925 samples for which both Digital Arsenator and laboratory data are available, the correlation is very good, with an r^2 of 0.906. The slope of 1.03, while significantly greater than unity, is not large enough to account for the difference in distributions (Figure A5). Figures A6 through A9 show that even at lower concentrations, the linear relation between laboratory and Digital Arsenator is good, and slopes near unity indicate that there is no large systemic bias.

When the frequency distribution of these 1,925 quality control samples is plotted for laboratory and Digital Arsenator data (Figures A10 and A11), it is clear that the distribution is nearly identical above 0.01 mg/L. There is a clear tendency for Digital Arsenator data to show greater contamination at low levels (< 0.01 mg/L), which is consistent with the higher LOD for this technique. However, this bias at low levels cannot lead to the observed differences at higher levels.

The correlation plots and distribution frequency serve to validate the Digital Arsenator results above 0.01 mg/L. Since the Digital Arsenator dataset is much larger than the laboratory dataset, this dataset is much more powerful especially for disaggregated analysis. Therefore, greater weight should be given to the Arsenator dataset for risk assessment.

Figure A5: **Comparison of laboratory and Arsenator data (all samples). 95% confidence interval on slope: [1.016, 1.045]**

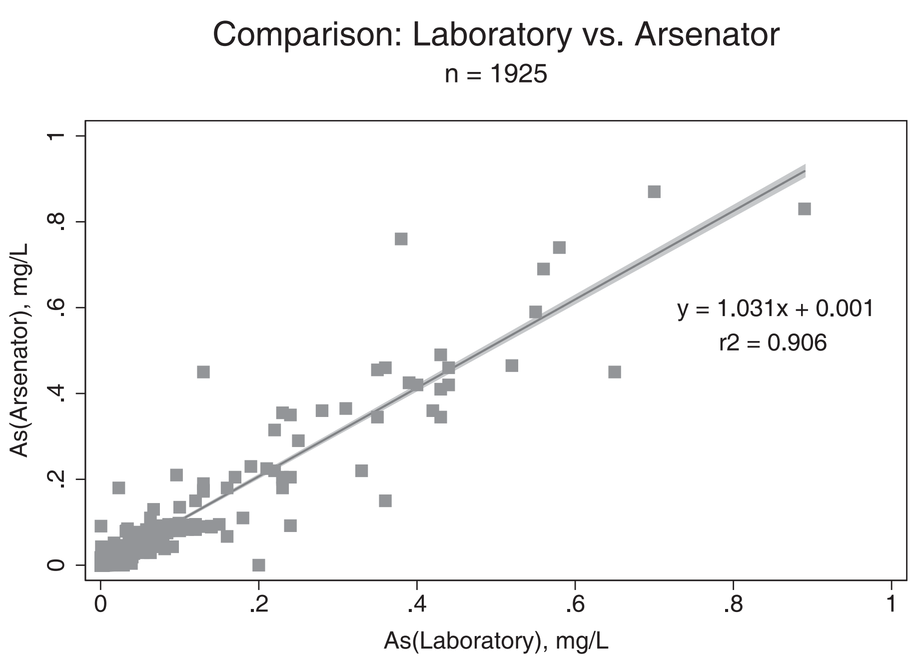


Figure A6: **Comparison of laboratory and Arsenator data (As<0.5 mg/L). 95% confidence interval on slope: [1.016, 1.045]**

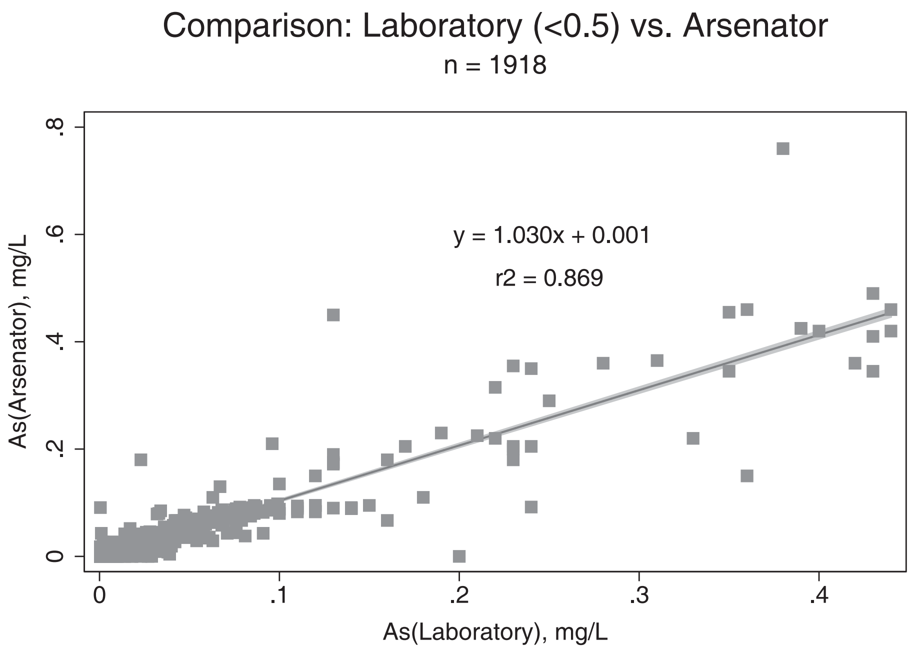


Figure A7: **Comparison of laboratory and Arsenator data (As<0.1 mg/L). 95% confidence interval on slope: [1.022, 1.066]**

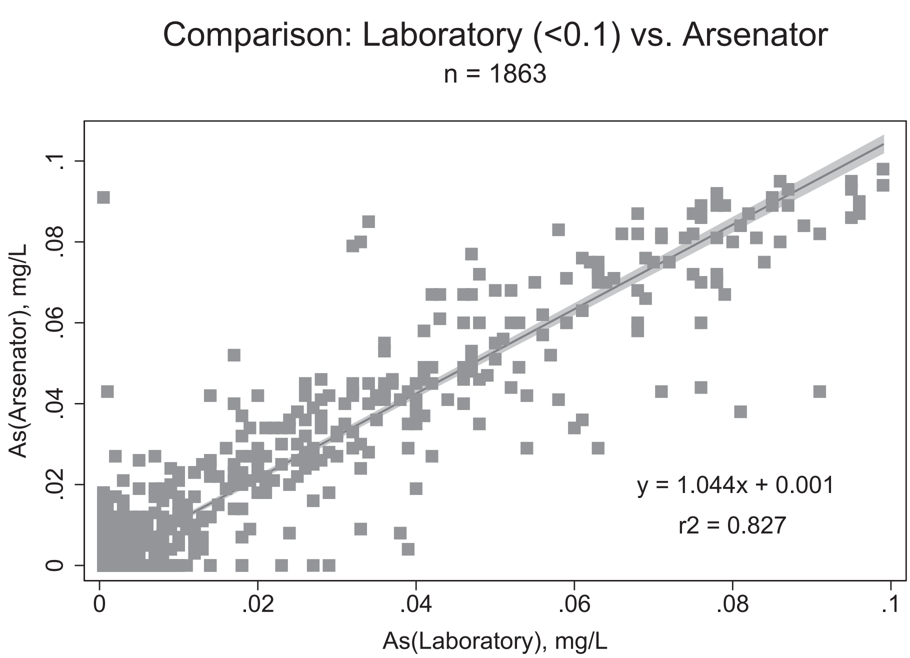


Figure A8: **Comparison of laboratory and Arsenator data (As<0.05 mg/L). 95% confidence interval on slope: [1.091, 1.164]**

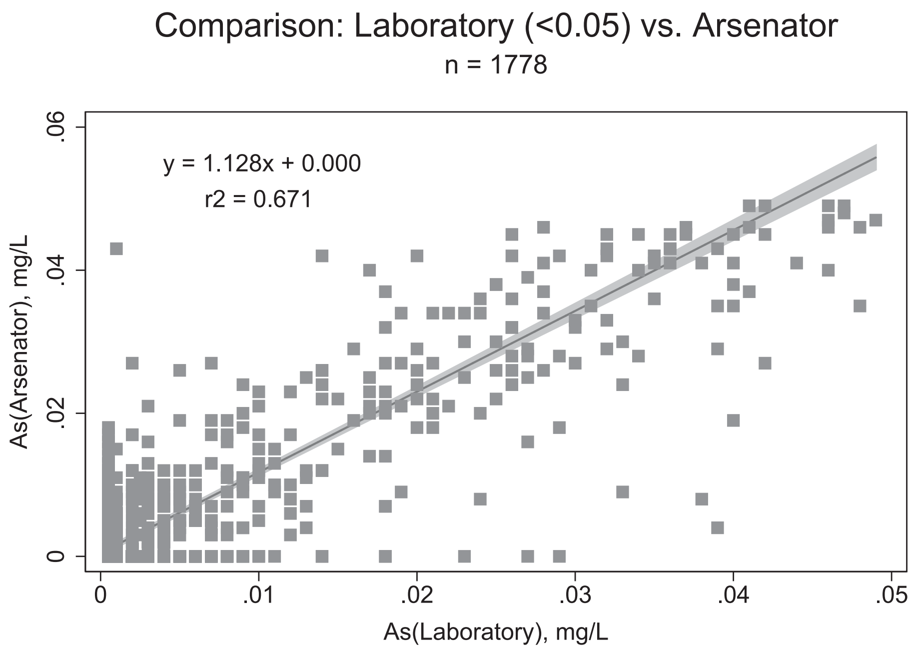


Figure A9: **Comparison of laboratory and Arsenator data (As<0.02 mg/L). 95% confidence interval on slope: [0.959, 1.112]**

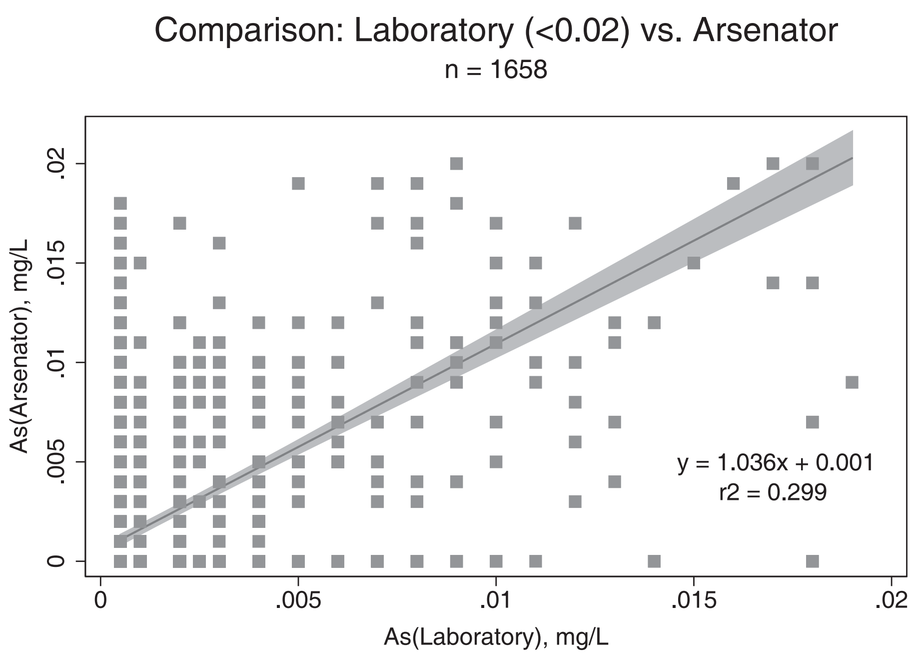


Figure A10: **Comparison of arsenic distribution from Arsenator and laboratory datasets**

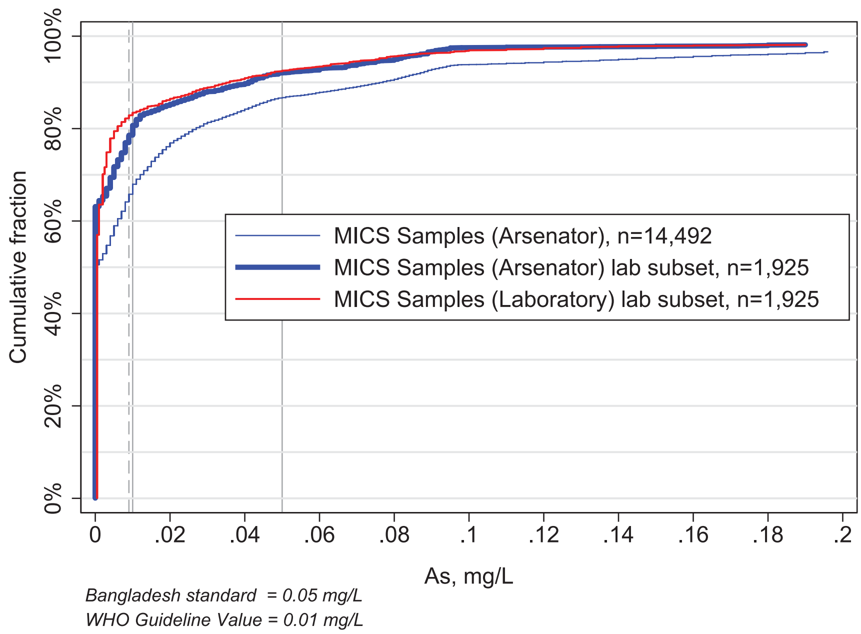
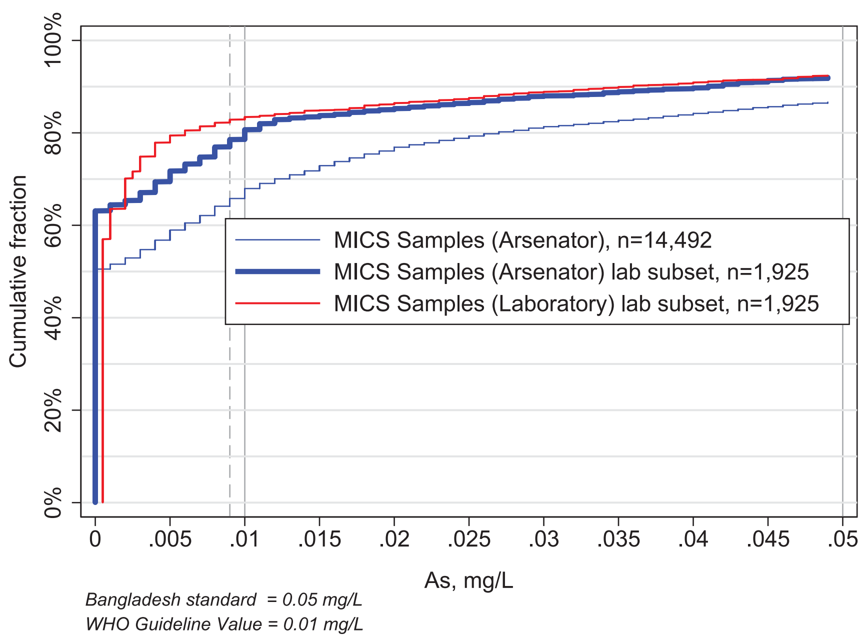


Figure A11: **Comparison of arsenic distribution from Arsenator and laboratory datasets (As < 0.05 mg/L)**



FLUORIDE SURVEY

To analyze fluoride, unacidied samples must be collected. It was too complicated for the MICS enumerators to collect both acidified and unacidified bottles, in addition to quality control samples, while their main task was to fill in a lengthy questionnaire. Accordingly, DPHE made its own survey to collect unacidified samples for fluoride analysis. With unacidified samples other anions can also be measured, especially chloride. A similar sample coding scheme was used as for the MICS survey, with the difference that Sample ID numbers ranged from 700-899 for field samples, and from 900-999 for field quality control samples. Bottle stickers were colored red instead of green to prevent confusion with the MICS samples. Figure X shows the third sample to be collected from District 12 (Brahmanbaria).

Figure A12: **Sample bottle labels for MICS Fluoride survey.**

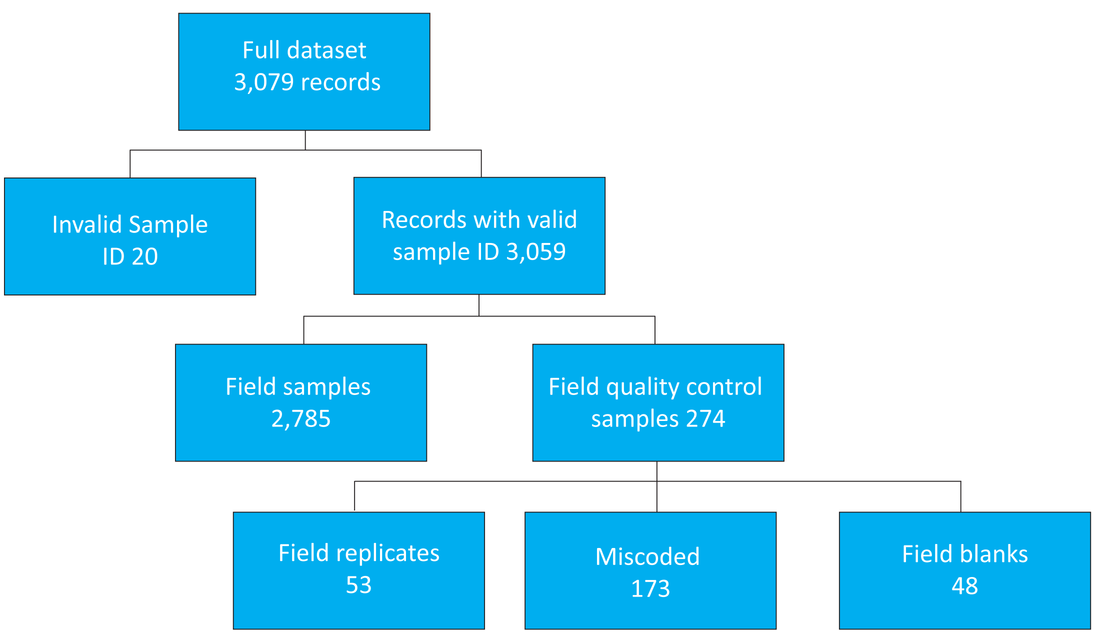
12-803 Cluster ID _ _ _ _ _ _   Household ID _ _ _   Date: ________________   *No. Preservative*

FIELD KIT DATA

The same local consulting firm, PMID, was contracted and trained to use portable photometric fluoride test kits (Wagtech 5100) for analysis of unacidified samples. The colorimetric test is made by adding two reagents (zirconyl chloride and eriochrome cyanine R) with a 10 mL sample. The reagents react to form a red complex, which is destroyed by the fluoride ion. Fluoride concentration is measured by the reduction in absorbance at 570 nm.

Of the full set of 3,079 samples analyzed by PMID, only 20 records were excluded because of invalid Sample IDs. 274 (9.0%) of the field samples were coded as quality control samples. However, most of these were not from Clusters ending in 0, which should have been the basis for selecting quality control samples. This discrepancy likely arose because of difficulties faced by DPHE in getting details cluster lists from BBS. As a result, only 19% of quality control samples could be identified as replicates, and 18% as blanks.

Figure A13: **Data management, Fluoride survey field kit analysis**

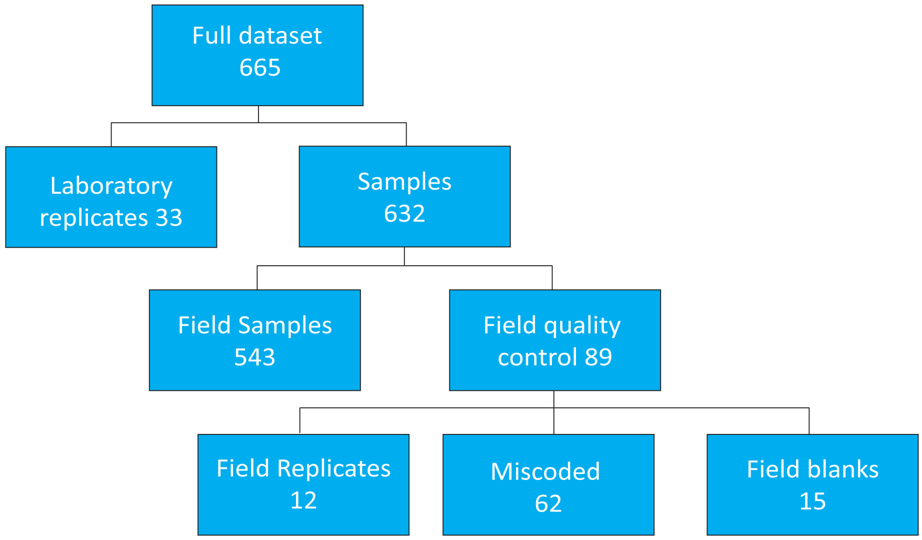


Quality control analysis showed poor agreement between 46 matched field replicates ($r^2 = 0.20$) and significant error in the blanks (levels up to 1.6 mg/L). Agreement was also poor between field test and laboratory data ($r^2 = 0.31$, see below), so the field dataset are considered unreliable and are not analyzed further.

LABORATORY DATA

As in the MICS survey, 20% of samples collected from each district were sent to an external laboratory (Maxxam Analytics, Canada) for cross-checking. These unacidified samples were analyzed for fluoride with an ion-selective electrode (APHA 4500 FC) and for chloride using the ferricyanide method (SM 4500 Cl E).

Figure A14: Data management, laboratory data of Fluoride survey

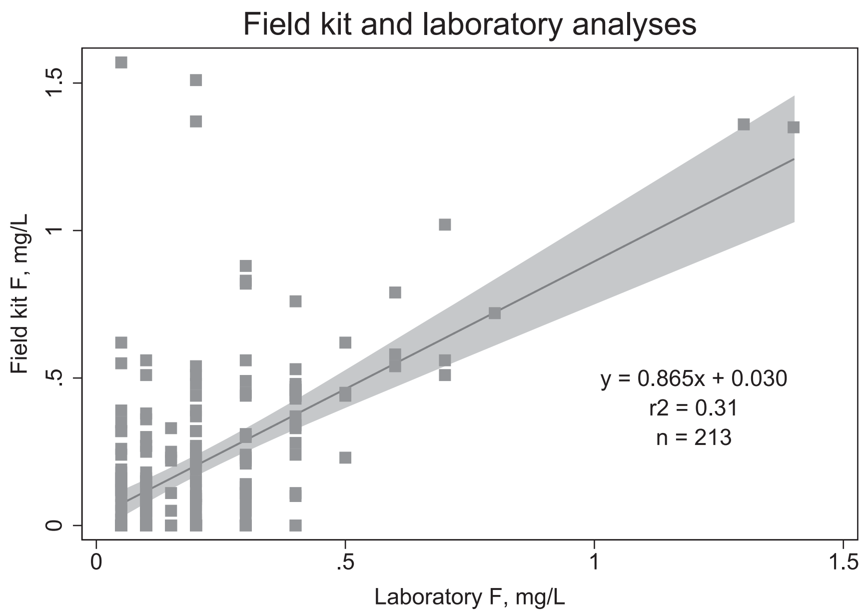


Laboratory reproducibility was high (Table A2), and samples coded as Field Blanks had low levels of fluoride (median 0.05 mg/L; maximum 0.2 mg/L).

Although 543 field samples were analyzed in the laboratory, only 213 could be matched with samples tested by PMID, using the sample code (e.g. 64-801-12345). Of these 213, the correlation between field test and laboratory result was poor, with an r^2 of only 0.31 (Figure A15). (One outlier was excluded: the field kit analysis for sample 47-824-08980 read 24 mg/L while the laboratory read 0.2 mg/L).

Because of this poor agreement, and considering the aforementioned limitations of the field dataset, only the laboratory dataset for fluoride is analysed in this report.

Figure A15: Comparison of fluoride measured in laboratory and with field kit



Although the slope is close to one in this regression, the poor correlation suggests that the field kit data should not be used. In addition, there are a significant number of samples in the field kit dataset with missing data. Of the 82 samples (excluding QC samples) showing F above 1.5 mg/L, 58 (70%) have no cluster ID and cannot be fully identified.

LIMITS OF DETECTION

Method Detection Limits (MDLs) were reported by the external laboratory for each analyte. Limits of Detection (LODs) for each of the analytes were calculated by statistical analysis of the accepted blanks[12]. A LOD was defined as the sum of the mean and three times the standard deviation of blank samples. Note that the Method Detection Limit (MDL) reported by the laboratory should be equal or less than the LOD. To calculate means, samples below the MDL were fixed at one half of the MDL rather than zero or the MDL, to minimize bias. In the case of analytes for which most samples were below the MDL, this could lead to an LOD below the MDL, which is incorrect. In such cases the LOD was fixed at the MDL.

[12] 182 accepted blanks for acidified samples analyzed in the laboratory. For the Digital Arsenator dataset, 632 accepted blanks were used. For the chloride and fluoride survey, only 10 accepted blanks were available

Table A1: **Detection limits**

Analyte	MDL (mg/L)	Number Below MDL	Mean of blanks (mg/L)	Standard deviation of blanks (mg/L)	LOD (mg/L)	Number Below LOD
Aluminum	0.005	6	0.043	0.029	0.131	178
Antimony	0.0005	174	0.00027	0.00009	0.00054	175
Arsenic (lab)	0.001	180	0.00053	0.00034	0.00153	181
Arsenic (field)	0.005	576	0.0010	0.0025	0.0086	632
Barium	0.005	0	0.062	0.035	0.167	177
Beryllium	0.0005	182	0.00025	0	0.0005	182
Bismuth	0.001	182	0.0005	0	0.001	182
Boron	0.01	108	0.021	0.065	0.214	180
Cadmium	0.0001	0	0.018	0.021	0.082	176
Calcium	0.2	0	1.5	2.4	8.6	175
Chloride	7	0	0.75	0.49	2.2	10
Chromium	0.005	181	0.0025	0.0003	0.005	181
Cobalt	0.0005	182	0.00025	0	0.0005	182
Copper	0.001	0	0.029	0.015	0.073	181
Fluoride	0.1	10	0.05	0	0.1	10
Hardness	0.5	0	5.5	7.2	27.1	175
Iron	0.1	147	0.077	0.082	0.324	179
Lead	0.0005	2	0.022	0.024	0.095	179
Lithium	0.005	181	0.0025	0.0005	0.005	181
Magnesium	0.05	0	0.41	0.38	1.55	179
Manganese	0.002	6	0.0070	0.010	0.0369	179
Molybdenum	0.001	182	0.0005	0	0.001	182
Nickel	0.001	49	0.0013	0.001	0.0044	181
Phosphorus	0.1	76	0.12	0.068	0.32	182
Potassium	0.2	160	0.14	0.19	0.70	180
Selenium	0.002	181	0.001	0.0001	0.002	181
Silicon	0.05	1	5.2	5.5	21.7	182
Silver	0.0001	181	0.00005	0.000004	0.0001	181
Sodium	0.1	0	2.0	1.1	5.1	179
Strontium	0.001	0	0.0064	0.0063	0.0254	177
Tellurium	0.001	182	0.0005	0	0.001	182
Thallium	0.00005	182	0.000025	0	0.00005	182
Thorium	0.001	182	0.0005	0	0.001	182
Tin	0.001	134	0.0042	0.0100	0.0342	174
Titanium	0.005	179	0.0026	0.0006	0.005	179
Tungsten	0.001	182	0.0005	0	0.001	182
Uranium	0.0001	180	0.000052	0.000016	0.0001	180
Vanadium	0.001	181	0.0005	0.00004	0.001	181
Zinc	0.005	6	0.018	0.010	0.048	179
Zirconium	0.001	182	0.0005	0	0.001	182

LABORATORY REPLICATES

As a quality control measure, 169 samples from the MICS survey were analyzed twice for all analytes at the laboratory. Linear regression was made for these laboratory replicates, and agreement was excellent in all cases. For a few analytes[13] most or all of the samples were below the Method Detection Limit (MDL), and linear regression was not performed.

Table A2: **Laboratory replicates**

Analyte	Number of Replicates	Number <MDL	Slope	(95% Confidence Interval)	Intercept	(95% Confidence Interval)	Adjusted r^2
Aluminum	169	8	0.979	(0.9770.982)	0.002	(0.001 0.003)	0.9997
Antimony	169	163	0.240	(0.1190.362)	0.000	(0.000 0.000)	0.0782
Arsenic	169	87	0.991	(0.9870.994)	0.000	(-0.000 0.000)	0.9994
Barium	169	1	0.996	(0.9921.001)	0.000	(-0.000 0.001)	0.9992
Boron	169	40	1.009	(1.003 1.015)	-0.001	(-0.002 0.000)	0.9986
Cadmium	169	0	1.001	(0.998 1.005)	0.000	(-0.000 0.000)	0.9995
Calcium	169	0	1.004	(0.998 1.010)	-0.003	(-0.412 0.405)	0.9984
Chloride	30	0	0.950	(0.9440.956)	3.04	(0.92 5.17)	0.9998
Chromium	169	166	0.962	(0.954 0.971)	0.000	(0.000 0.000)	0.9967
Cobalt	169	123	1.000	(0.994 1.005)	0.000	(-0.000 0.000)	0.9987
Copper	169	16	1.021	(1.020 1.023)	-0.000	(-0.000 0.000)	0.9999
Fluoride	22	0	0.975	(0.898 1.051)	0.001	(-0.018 0.020)	0.9713
Iron	169	24	1.000	(0.997 1.003)	-0.003	(-0.015 0.010)	0.9997
Lead	169	15	0.993	(0.987 0.999)	0.000	(-0.000 0.000)	0.9985
Lithium	169	119	1.004	(0.988 1.019)	0.000	(-0.000 0.000)	0.9900
Magnesium	169	0	1.006	(1.001 1.011)	-0.039	(-0.157 0.079)	0.9989
Manganese	169	6	1.002	(0.998 1.007)	0.001	(-0.002 0 .005)	0.9992
Molybdenum	169	140	0.984	(0.961 1.006)	0.000	(-0.000 0.000)	0.9781
Nickel	169	91	0.975	(0.950 1.001)	0.000	(-0.000 0.000)	0.9709
Phosphorus	169	27	0.997	(0.991 1.002)	0.001	(-0.005 0 .006)	0.9987
Potassium	169	4	1.001	(0.994 1.007)	0.011	(-0.030 0.051)	0.9981
Selenium	169	165	0.973	(0.950 0.996)	0.000	(-0.000 0.000)	0.9762
Silicon	169	0	0.998	(0.987 1.001)	0.092	(-0.118 0 .303)	0.9946
Sodium	169	0	1.007	(1.003 1.011)	-0.276	(-0.864 0.311)	0.9993
Strontium	169	0	1.002	(0.997 1.006)	0.000	(-0.001 0.002)	0.9992
Tin	169	131	1.002	(0.995 1.009)	0.000	(-0.000 0.000)	0.9977
Titanium	169	159	1.037	(1.021 1.053)	-0.000	(-0.000 0.000)	0.9896
Tungsten	169	154	0.941	(0.921 0.961)	0.000	(0.000 0.000)	0.9805
Uranium	169	107	0.984	(0.979 0.989)	0.000	(0.000 0.000)	0.9988
Vanadium	169	124	0.978	(0.949 1.007)	0.000	(-0.000 0.000)	0.9637
Zinc	169	0	0.982	(0.973 0.992)	0.000	(-0.001 0.002)	0.9960

[13] Beryllium, bismuth, silver, tellurium, thallium, thorium and zirconium.

FIELD REPLICATES

Linear regression between field replicates showed less correlation than found in laboratory replicates, as expected. For some analytes the correlation was excellent (As, P, U), while for other analytes the correlation was very poor, in most cases because a high proportion of samples were below the LOD. No field replicates were collected for chloride and fluoride.

Table A3: Field replicates

Analyte	Number of Replicates	Number < LOD	Slope	(95% Confidence Interval)	Intercept	(95% Confidence Interval)	Adjusted r^2
Aluminum	34	30	-0.128	(-0.360 0.104)	0.064	(0.042 0.087)	0.008
Antimony	34	33	n.a.	n.a.	n.a.	n.a.	n.a.
Arsenic (lab)	34	25	1.016	(0.991 1.041)	0.000	(-0.002 0.002)	0.995
Arsenic (Arsenator)	590	376	0.813	(0.776 0.850)	0.003	(0.000 0.006)	0.757
Barium	34	29	0.572	(0.194 0.950)	0.065	(0.001 0.129)	0.205
Beryllium	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Bismuth	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Boron	34	25	1.076	(1.000 1.152)	-0.001	(-0.017 0.015)	0.962
Cadmium	34	31	0.242	(-0.185 0.669)	0.030	(-0.000 0.060)	0.010
Calcium*	33	6	0.988	(0.8931.082)	0.907	(-4.746.56)	0.934
Chromium	34	32	0.771	(0.614 0.928)	0.001	(0.000 0.001)	0.751
Cobalt	34	27	0.943	(0.863 1.022)	0.000	(-0.000 0.000)	0.946
Copper	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Hardness	34	3	0.723	(0.557 0.889)	43.6	(0.71 86.4)	0.702
Iron	34	13	0.841	(0.641 1.042)	0.243	(-0.428 0.913)	0.686
Lead	34	33	n.a.	n.a.	n.a.	n.a.	n.a.
Lithium	34	24	1.067	(0.925 1.209)	0.000	(-0.001 0.001)	0.876
Magnesium	34	2	0.914	(0.797 1.031)	2.27	(-0.15 4.70)	0.884
Manganese	34	9	0.926	(0.815 1.037)	0.009	(-0.0690.087)	0.897
Molybdenum	34	29	1.402	(1.231 1.573)	0.000	(-0.000 0.000)	0.894
Nickel	34	32	0.518	(0.307 0.728)	0.000	(-0.000 0.001)	0.422
Phosphorus	34	24	1.053	(1.009 1.098)	-0.011	(-0.0600.038)	0.986
Potassium*	33	0	0.991	(0.826 1.157)	0.201	(-0.380.78)	0.822
Selenium	34	32	-0.031	(-0.290 0.227)	0.001	(0.001 0.001)	0.002
Silicon	34	30	0.793	(0.563 1.024)	3.38	(-0.57 7.34)	0.593
Silver	34	33	n.a.	n.a.	n.a.	n.a.	n.a.
Sodium	34	3	1.017	(0.963 1.072)	2.14	(-7.51 11.79)	0.977
Strontium	34	1	0.910	(0.825 0.995)	0.009	(-0.018 0.036)	0.935
Tellurium	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Thallium	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Thorium	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Tin	34	34	n.a.	n.a.	n.a.	n.a.	n.a.
Titanium	34	31	-0.087	(-0.507 0.333)	0.003	(0.002 0.005)	0.006
Tungsten	34	32	1.216	(1.145 1.287)	-0.000	(-0.0000.000)	0.974
Uranium	34	20	1.042	(1.014 1.070)	-0.000	(-0.0000.000)	0.994
Vanadium	34	24	0.797	(0.532 1.062)	0.000	(-0.0000.001)	0.525
Zinc	34	27	0.687	(0.457 0.916)	0.007	(-0.0080.021)	0.523
Zirconium	34	34	n.a.	n.a.	n.a.	n.a.	n.a.

*One outlier sample was removed from the analysis.

APPENDIX 2: UPAZILA-WISE TABLES

Table A4 lists the geographic distribution of arsenic by upazila. Cells shaded yellow indicate that the concentration of arsenic (in mg/L) was below the Limit of Detection of 0.009 mg/L. Cells shaded light, medium, and dark blue indicate that the concentration of arsenic exceeded the WHO guideline value (0.01 mg/L), the Bangladesh standard (0.05 mg/L), or 0.2 mg/L, respectively.

Table A4: **Upazila-wise distribution of arsenic (Digital Arsenator data)**

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
BARISAL DIVISION												
BARGUNA	AMTALI	35	0.000	0.000	0.001	0.003	0.015	0.001	0.971	0.971	1.000	1.000
BARGUNA	BAMNA	30	0.000	0.000	0.000	0.000	0.007	0.000	1.000	1.000	1.000	1.000
BARGUNA	BARGUNA SADAR	37	0.000	0.000	0.000	0.002	0.020	0.001	0.946	0.946	1.000	1.000
BARGUNA	BETAGI	26	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
BARGUNA	PATHARGHATA	26	0.000	0.000	0.000	0.001	0.007	0.000	1.000	1.000	1.000	1.000
BARISAL	AGAILJHARA	23	0.000	0.000	0.007	0.011	0.048	0.005	0.870	0.870	1.000	1.000
BARISAL	BABUGANJ	26	0.000	0.000	0.008	0.026	0.215	0.014	0.808	0.808	0.923	0.962
BARISAL	BAKERGANJ	31	0.000	0.000	0.000	0.009	0.018	0.002	0.903	0.936	1.000	1.000
BARISAL	BANARI PARA	25	0.000	0.000	0.005	0.014	0.041	0.004	0.880	0.880	1.000	1.000
BARISAL	GAURNADI	37	0.000	0.000	0.000	0.010	0.019	0.002	0.865	0.973	1.000	1.000
BARISAL	HIZLA	24	0.000	0.000	0.003	0.018	0.046	0.005	0.833	0.833	1.000	1.000
BARISAL	BARISAL SADAR (KOTWA	65	0.000	0.000	0.000	0.007	0.018	0.002	0.939	0.954	1.000	1.000
BARISAL	MHENDIGANJ	36	0.000	0.000	0.002	0.019	0.059	0.005	0.778	0.833	0.972	1.000
BARISAL	MULADI	30	0.000	0.000	0.019	0.288	0.410	0.051	0.700	0.700	0.833	0.867
BARISAL	WAZIRPUR	25	0.000	0.000	0.005	0.010	0.016	0.003	0.840	0.920	1.000	1.000
BHOLA	BHOLA SADAR	33	0.000	0.000	0.000	0.000	0.010	0.001	0.970	1.000	1.000	1.000
BHOLA	BURHANUDDIN	25	0.000	0.000	0.000	0.006	0.030	0.002	0.920	0.960	1.000	1.000
BHOLA	CHAR FASSON	29	0.000	0.000	0.000	0.010	0.020	0.002	0.862	0.931	1.000	1.000
BHOLA	DAULAT KHAN	30	0.000	0.000	0.000	0.002	0.006	0.000	1.000	1.000	1.000	1.000
BHOLA	LALMOHAN	32	0.000	0.000	0.000	0.000	0.004	0.000	1.000	1.000	1.000	1.000
BHOLA	MANPURA	23	0.000	0.000	0.000	0.003	0.011	0.001	0.913	0.957	1.000	1.000
BHOLA	TAZUMUDDIN	24	0.000	0.000	0.000	0.008	0.016	0.001	0.958	0.958	1.000	1.000
JHALOKATI	JHALOKATI SADAR	46	0.000	0.000	0.008	0.013	0.023	0.004	0.804	0.870	1.000	1.000
JHALOKATI	KANTHALIA	24	0.000	0.000	0.005	0.014	0.038	0.004	0.792	0.833	1.000	1.000
JHALOKATI	NALCHITY	36	0.000	0.000	0.005	0.013	0.078	0.005	0.861	0.889	0.972	1.000
JHALOKATI	RAJAPUR	26	0.000	0.004	0.011	0.017	0.120	0.010	0.731	0.731	0.962	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
PATUAKHALI	BAUPHAL	27	0.000	0.000	0.006	0.014	0.017	0.003	0.889	0.889	1.000	1.000
PATUAKHALI	DASHMINA	22	0.000	0.000	0.006	0.011	0.022	0.004	0.818	0.864	1.000	1.000
PATUAKHALI	DUMKI	37	0.000	0.000	0.006	0.017	0.026	0.005	0.757	0.838	1.000	1.000
PATUAKHALI	GALACHIPA	28	0.000	0.004	0.010	0.014	0.016	0.005	0.714	0.821	1.000	1.000
PATUAKHALI	KALAPARA	31	0.000	0.000	0.012	0.021	0.025	0.007	0.710	0.742	1.000	1.000
PATUAKHALI	MIRZAGANJ	23	0.000	0.000	0.000	0.011	0.021	0.002	0.870	0.870	1.000	1.000
PATUAKHALI	PATUAKHALI SADAR	31	0.000	0.000	0.010	0.012	0.021	0.004	0.742	0.839	1.000	1.000
PIROJPUR	BHANDARIA	26	0.000	0.006	0.012	0.020	0.029	0.008	0.615	0.731	1.000	1.000
PIROJPUR	KAWKHALI	27	0.000	0.007	0.010	0.014	0.015	0.006	0.741	0.778	1.000	1.000
PIROJPUR	MATHBARIA	31	0.000	0.008	0.012	0.014	0.020	0.007	0.645	0.710	1.000	1.000
PIROJPUR	NAZIRPUR UPAZILA	25	0.000	0.010	0.030	0.057	0.125	0.020	0.480	0.560	0.880	1.000
PIROJPUR	PIROJPUR SADAR	45	0.000	0.008	0.014	0.023	0.047	0.011	0.533	0.600	1.000	1.000
PIROJPUR	NESARABAD (SWARUPKAT	30	0.000	0.000	0.008	0.010	0.012	0.004	0.900	0.933	1.000	1.000
PIROJPUR	ZIANAGAR	28	0.000	0.009	0.018	0.047	0.205	0.020	0.571	0.571	0.929	0.964
CHITTAGONG DIVISION												
BANDARBAN	ALIKADAM	26	0.000	0.000	0.006	0.016	0.025	0.004	0.808	0.846	1.000	1.000
BANDARBAN	BANDARBAN SADAR	48	0.000	0.000	0.000	0.011	0.018	0.002	0.854	0.875	1.000	1.000
BANDARBAN	LAMA	34	0.000	0.000	0.002	0.007	0.026	0.002	0.971	0.971	1.000	1.000
BANDARBAN	NAIKHONGCHHARI	26	0.000	0.000	0.007	0.013	0.015	0.003	0.885	0.885	1.000	1.000
BANDARBAN	ROWANGCHHARI	25	0.000	0.000	0.007	0.010	0.013	0.003	0.880	0.920	1.000	1.000
BANDARBAN	RUMA	29	0.000	0.000	0.003	0.011	0.013	0.003	0.828	0.897	1.000	1.000
BANDARBAN	THANCHI	26	0.000	0.000	0.004	0.007	0.014	0.002	0.962	0.962	1.000	1.000
BRAHMANBARIA	AKHAURA	30	0.000	0.000	0.002	0.010	0.070	0.005	0.900	0.933	0.967	1.000
BRAHMANBARIA	BANCHHARAMPUR	26	0.000	0.087	0.215	0.375	0.510	0.128	0.308	0.308	0.462	0.731
BRAHMANBARIA	BRAHMANBARIA SADAR	37	0.000	0.000	0.002	0.083	0.385	0.031	0.784	0.784	0.865	0.946
BRAHMANBARIA	ASHUGANJ	25	0.002	0.093	0.395	0.450	0.690	0.202	0.280	0.280	0.360	0.560
BRAHMANBARIA	KASBA	32	0.000	0.000	0.022	0.135	0.610	0.046	0.719	0.719	0.781	0.938
BRAHMANBARIA	NABINAGAR	30	0.038	0.253	0.390	0.455	0.800	0.235	0.067	0.067	0.300	0.433
BRAHMANBARIA	NASIRNAGAR	25	0.000	0.000	0.003	0.027	0.041	0.005	0.880	0.880	1.000	1.000
BRAHMANBARIA	SARAIL	24	0.000	0.005	0.033	0.146	0.360	0.044	0.583	0.583	0.792	0.917
CHANDPUR	CHANDPUR SADAR	36	0.000	0.000	0.003	0.083	0.690	0.045	0.861	0.861	0.889	0.917
CHANDPUR	FARIDGANJ	33	0.000	0.000	0.000	0.165	0.275	0.035	0.818	0.818	0.818	0.939
CHANDPUR	HAIM CHAR	22	0.000	0.000	0.003	0.008	0.142	0.009	0.909	0.909	0.955	1.000
CHANDPUR	HAJIGANJ	42	0.180	0.330	0.420	0.460	0.890	0.309	0.119	0.119	0.143	0.286

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
CHANDPUR	KACHUA	23	0.135	0.165	0.340	0.400	0.445	0.210	0.087	0.087	0.087	0.609
CHANDPUR	MATLAB DAKSHIN	35	0.000	0.041	0.115	0.405	0.730	0.118	0.400	0.400	0.514	0.771
CHANDPUR	MATLAB UTTAR	31	0.000	0.000	0.068	0.210	0.380	0.059	0.710	0.710	0.742	0.871
CHANDPUR	SHAHRASTI	27	0.003	0.115	0.360	0.610	0.770	0.213	0.259	0.259	0.296	0.519
CHITTAGONG	ANOWARA	29	0.000	0.000	0.009	0.017	0.074	0.007	0.759	0.759	0.966	1.000
CHITTAGONG	BAYEJID BOSTAMI	2	0.000	0.010	0.020	0.020	0.020	0.010	0.500	0.500	1.000	1.000
CHITTAGONG	BANSHKHALI	18	0.000	0.000	0.008	0.011	0.015	0.004	0.833	0.889	1.000	1.000
CHITTAGONG	BAKALIA	3	0.010	0.012	0.012	0.012	0.012	0.011	0.000	0.333	1.000	1.000
CHITTAGONG	BOALKHALI	21	0.000	0.005	0.007	0.012	0.018	0.005	0.857	0.857	1.000	1.000
CHITTAGONG	CHANDANAISH	19	0.000	0.000	0.011	0.046	0.175	0.016	0.579	0.737	0.947	1.000
CHITTAGONG	CHANDGAON	14	0.000	0.000	0.004	0.012	0.021	0.004	0.786	0.786	1.000	1.000
CHITTAGONG	CHITTAGONG PORT	4	0.005	0.009	0.015	0.018	0.018	0.010	0.500	0.500	1.000	1.000
CHITTAGONG	DOUBLE MOORING	12	0.000	0.000	0.006	0.029	0.091	0.011	0.833	0.833	0.917	1.000
CHITTAGONG	FATIKCHHARI	20	0.000	0.004	0.011	0.020	0.040	0.007	0.700	0.700	1.000	1.000
CHITTAGONG	HALISHAHAR	4	0.003	0.007	0.010	0.012	0.012	0.007	0.750	0.750	1.000	1.000
CHITTAGONG	HATHAZARI	18	0.000	0.000	0.003	0.017	0.024	0.003	0.889	0.889	1.000	1.000
CHITTAGONG	KARNAFULI (POLICE ST	9	0.000	0.004	0.012	0.013	0.013	0.006	0.556	0.667	1.000	1.000
CHITTAGONG	KOTWALI	4	0.000	0.002	0.007	0.010	0.010	0.004	0.750	1.000	1.000	1.000
CHITTAGONG	KHULSHI	7	0.000	0.000	0.008	0.011	0.011	0.003	0.857	0.857	1.000	1.000
CHITTAGONG	LOHAGARA	24	0.003	0.008	0.012	0.019	0.039	0.010	0.583	0.708	1.000	1.000
CHITTAGONG	MIRSHARAI	20	0.008	0.030	0.075	0.114	0.185	0.048	0.300	0.300	0.600	1.000
CHITTAGONG	PAHARTALI	2	0.008	0.009	0.010	0.010	0.010	0.009	0.500	1.000	1.000	1.000
CHITTAGONG	PANCHLAISH	3	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
CHITTAGONG	PATIYA	17	0.000	0.005	0.010	0.012	0.015	0.005	0.706	0.824	1.000	1.000
CHITTAGONG	PATENGA	3	0.003	0.007	0.097	0.097	0.097	0.036	0.667	0.667	0.667	1.000
CHITTAGONG	RANGUNIA	4	0.000	0.002	0.008	0.012	0.012	0.004	0.750	0.750	1.000	1.000
CHITTAGONG	RAOZAN	23	0.000	0.006	0.010	0.013	0.015	0.006	0.739	0.783	1.000	1.000
CHITTAGONG	SANDWIP	14	0.000	0.008	0.037	0.094	0.365	0.045	0.571	0.571	0.857	0.929
CHITTAGONG	SATKANIA	24	0.000	0.006	0.012	0.025	0.037	0.008	0.625	0.667	1.000	1.000
CHITTAGONG	SITAKUNDA	23	0.000	0.007	0.023	0.047	0.440	0.032	0.609	0.609	0.913	0.957
COMILLA	BARURA	28	0.004	0.089	0.190	0.255	0.370	0.105	0.357	0.357	0.429	0.786
COMILLA	BRAHMAN PARA	23	0.009	0.084	0.200	0.235	0.435	0.108	0.261	0.261	0.435	0.739
COMILLA	BURICHANG	25	0.000	0.000	0.009	0.155	0.195	0.031	0.760	0.760	0.800	1.000
COMILLA	CHANDINA	25	0.125	0.230	0.325	0.445	0.540	0.250	0.000	0.000	0.000	0.320
COMILLA	CHAUDDAGRAM	27	0.000	0.000	0.041	0.073	0.245	0.029	0.704	0.704	0.852	0.926

District	Upazila	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maxi-mum	Average	Be-low LOD	Below WHO GV	Below BD Stan-dard	Below 0.2 mg/L
COMILLA	COMILLA SADAR DAKSHI	27	0.000	0.000	0.003	0.014	0.220	0.012	0.815	0.852	0.926	0.963
COMILLA	DAUDKANDI	28	0.000	0.104	0.288	0.405	0.760	0.168	0.321	0.321	0.393	0.607
COMILLA	DEBIDWAR	26	0.088	0.180	0.270	0.465	0.780	0.215	0.115	0.115	0.192	0.539
COMILLA	HOMNA	33	0.003	0.014	0.170	0.340	0.460	0.102	0.485	0.485	0.515	0.788
COMILLA	COMILLA ADARSHA SADA	26	0.000	0.000	0.000	0.001	0.029	0.001	0.962	0.962	1.000	1.000
COMILLA	LAKSAM	27	0.071	0.155	0.345	0.470	0.830	0.215	0.037	0.074	0.222	0.593
COMILLA	MANOHARGANJ	31	0.000	0.170	0.380	0.640	0.900	0.233	0.290	0.290	0.323	0.548
COMILLA	MEGHNA	26	0.000	0.002	0.075	0.130	0.215	0.043	0.539	0.539	0.654	0.962
COMILLA	MURADNAGAR	27	0.046	0.230	0.420	0.480	0.740	0.240	0.185	0.185	0.259	0.482
COMILLA	NANGALKOT	27	0.004	0.044	0.087	0.235	0.330	0.072	0.333	0.370	0.519	0.889
COMILLA	TITAS	29	0.000	0.000	0.077	0.375	0.450	0.066	0.552	0.552	0.690	0.897
COX'S BAZAR	CHAKARIA	24	0.000	0.000	0.000	0.000	0.008	0.000	1.000	1.000	1.000	1.000
COX'S BAZAR	COX'S BAZAR SADAR	10	0.000	0.000	0.000	0.002	0.003	0.000	1.000	1.000	1.000	1.000
COX'S BAZAR	KUTUBDIA	17	0.000	0.000	0.000	0.002	0.006	0.001	1.000	1.000	1.000	1.000
COX'S BAZAR	MAHESHKHALI	21	0.000	0.000	0.000	0.000	0.003	0.000	1.000	1.000	1.000	1.000
COX'S BAZAR	PEKUA	50	0.000	0.000	0.000	0.002	0.004	0.000	1.000	1.000	1.000	1.000
COX'S BAZAR	RAMU	25	0.000	0.000	0.000	0.005	0.050	0.003	0.920	0.920	0.960	1.000
COX'S BAZAR	TEKNAF	28	0.000	0.000	0.000	0.009	0.031	0.002	0.964	0.964	1.000	1.000
COX'S BAZAR	UKHIA UPAZILA	23	0.000	0.000	0.000	0.000	0.014	0.001	0.957	0.957	1.000	1.000
FENI	CHHAGALNAIYA	28	0.000	0.004	0.012	0.025	0.088	0.009	0.679	0.679	0.964	1.000
FENI	DAGANBHUIYAN	30	0.070	0.084	0.089	0.153	0.520	0.092	0.167	0.167	0.233	0.933
FENI	FENI SADAR	39	0.000	0.002	0.065	0.087	0.175	0.029	0.667	0.667	0.718	1.000
FENI	FULGAZI	26	0.002	0.008	0.018	0.037	0.078	0.015	0.577	0.615	0.923	1.000
FENI	PARSHURAM	30	0.000	0.002	0.008	0.034	0.046	0.008	0.800	0.800	1.000	1.000
FENI	SONAGAZI	26	0.000	0.072	0.089	0.215	0.710	0.094	0.308	0.308	0.385	0.885
KHAGRACHHARI	DIGHINALA	26	0.000	0.000	0.000	0.000	0.003	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	KHAGRACHHARI SADAR	39	0.000	0.000	0.000	0.000	0.002	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	LAKSHMICHHARI	26	0.000	0.000	0.000	0.000	0.057	0.003	0.923	0.923	0.962	1.000
KHAGRACHHARI	MAHALCHHARI	24	0.000	0.000	0.000	0.000	0.002	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	MANIKCHHARI	25	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	MATIRANGA	35	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	PANCHHARI	24	0.000	0.000	0.000	0.000	0.003	0.000	1.000	1.000	1.000	1.000
KHAGRACHHARI	RAMGARH	32	0.000	0.000	0.000	0.000	0.015	0.001	0.969	0.969	1.000	1.000
LAKSHMIPUR	KAMALNAGAR	26	0.000	0.007	0.023	0.025	0.072	0.013	0.539	0.577	0.962	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
LAKSHMIPUR	LAKSHMIPUR SADAR	37	0.002	0.017	0.071	0.125	0.420	0.055	0.432	0.432	0.730	0.919
LAKSHMIPUR	ROYPUR	30	0.000	0.000	0.004	0.016	0.590	0.025	0.833	0.867	0.933	0.967
LAKSHMIPUR	RAMGANJ	33	0.004	0.041	0.190	0.445	0.830	0.142	0.394	0.424	0.515	0.788
LAKSHMIPUR	RAMGATI	32	0.006	0.025	0.057	0.089	0.420	0.054	0.281	0.313	0.750	0.938
NOAKHALI	BEGUMGANJ	32	0.000	0.010	0.117	0.180	0.630	0.080	0.500	0.500	0.594	0.906
NOAKHALI	CHATKHIL	31	0.000	0.089	0.210	0.380	0.465	0.143	0.323	0.323	0.355	0.710
NOAKHALI	COMPANIGANJ	28	0.015	0.037	0.090	0.170	0.530	0.070	0.179	0.214	0.643	0.964
NOAKHALI	HATIYA	31	0.000	0.000	0.000	0.006	0.015	0.001	0.936	0.968	1.000	1.000
NOAKHALI	KABIRHAT	31	0.020	0.077	0.086	0.091	0.450	0.075	0.097	0.097	0.419	0.936
NOAKHALI	SENBAGH	27	0.073	0.135	0.325	0.450	0.870	0.205	0.074	0.074	0.148	0.630
NOAKHALI	SONAIMURI	26	0.000	0.010	0.190	0.295	0.455	0.108	0.500	0.500	0.577	0.769
NOAKHALI	SUBARNACHAR	25	0.000	0.000	0.008	0.015	0.046	0.005	0.760	0.800	1.000	1.000
NOAKHALI	NOAKHALI SADAR	34	0.000	0.019	0.076	0.103	0.680	0.060	0.324	0.353	0.706	0.912
RANGAMATI	BAGHAICHHARI	27	0.000	0.000	0.000	0.010	0.018	0.002	0.852	0.926	1.000	1.000
RANGAMATI	BARKAL	27	0.000	0.000	0.003	0.010	0.014	0.002	0.852	0.926	1.000	1.000
RANGAMATI	KAWKHALI (BETBUNIA)	27	0.000	0.000	0.007	0.013	0.042	0.005	0.852	0.852	1.000	1.000
RANGAMATI	BELAI CHHARI	26	0.000	0.000	0.000	0.012	0.016	0.002	0.885	0.885	1.000	1.000
RANGAMATI	KAPTAI	33	0.000	0.000	0.005	0.010	0.024	0.004	0.849	0.909	1.000	1.000
RANGAMATI	JURAI CHHARI	26	0.000	0.000	0.000	0.009	0.013	0.002	0.923	0.923	1.000	1.000
RANGAMATI	LANGADU	23	0.000	0.000	0.005	0.010	0.017	0.003	0.870	0.957	1.000	1.000
RANGAMATI	NANIARCHAR	26	0.000	0.000	0.000	0.012	0.015	0.002	0.846	0.885	1.000	1.000
RANGAMATI	RAJASTHALI	25	0.000	0.000	0.008	0.014	0.027	0.004	0.760	0.800	1.000	1.000
RANGAMATI	RANGAMATI SADAR	47	0.000	0.000	0.000	0.004	0.015	0.001	0.936	0.957	1.000	1.000
DHAKA DIVISION												
DHAKA	ADABOR	3	0.005	0.010	0.013	0.013	0.013	0.009	0.333	0.667	1.000	1.000
DHAKA	BADDA	9	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	CANTONMENT	6	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	DAKSHINKHAN	4	0.000	0.000	0.002	0.004	0.004	0.001	1.000	1.000	1.000	1.000
DHAKA	DEMRA	2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	DHAMRAI	24	0.000	0.000	0.029	0.046	0.059	0.015	0.583	0.583	0.917	1.000
DHAKA	DHANMONDI	5	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	DOHAR	24	0.000	0.000	0.039	0.170	0.195	0.036	0.583	0.583	0.792	1.000
DHAKA	GULSHAN	7	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	HAZARIBAGH	4	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
DHAKA	JATRABARI	4	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	KAFRUL	6	0.000	0.000	0.000	0.007	0.007	0.001	1.000	1.000	1.000	1.000
DHAKA	KAMRANGIR CHAR	3	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	KHILGAON	9	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	KHILKHET	2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	KERANIGANJ	25	0.000	0.000	0.000	0.000	0.240	0.010	0.920	0.960	0.960	0.960
DHAKA	KOTWALI	12	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	LALBAGH	11	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	MIRPUR	11	0.000	0.000	0.000	0.000	0.004	0.000	1.000	1.000	1.000	1.000
DHAKA	MOHAMMADPUR	13	0.000	0.000	0.000	0.000	0.005	0.000	1.000	1.000	1.000	1.000
DHAKA	MOTIJHEEL	4	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	NAWABGANJ	19	0.000	0.013	0.059	0.093	0.098	0.027	0.421	0.421	0.737	1.000
DHAKA	PALLABI	13	0.000	0.000	0.000	0.000	0.006	0.001	1.000	1.000	1.000	1.000
DHAKA	RAMNA	2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	SABUJBAGH	7	0.000	0.000	0.000	0.004	0.004	0.001	1.000	1.000	1.000	1.000
DHAKA	SAVAR	27	0.000	0.000	0.000	0.008	0.017	0.002	0.926	0.963	1.000	1.000
DHAKA	SHAH ALI	3	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	SHAHBAGH	1	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	SHYAMPUR	9	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	SUTRAPUR	7	0.000	0.000	0.005	0.008	0.008	0.002	1.000	1.000	1.000	1.000
DHAKA	TEJGAON	4	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
DHAKA	TEJGAON IND. AREA	3	0.000	0.000	0.008	0.008	0.008	0.003	1.000	1.000	1.000	1.000
DHAKA	UTTARA	1	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
FARIDPUR	ALFADANGA	26	0.007	0.027	0.052	0.090	0.300	0.043	0.269	0.269	0.731	0.962
FARIDPUR	BHANGA	30	0.005	0.035	0.190	0.360	0.455	0.115	0.300	0.300	0.600	0.767
FARIDPUR	BOALMARI	29	0.010	0.044	0.097	0.210	0.225	0.066	0.241	0.276	0.552	0.862
FARIDPUR	CHAR BHADRASAN	26	0.000	0.000	0.020	0.038	0.095	0.015	0.654	0.654	0.923	1.000
FARIDPUR	FARIDPUR SADAR	42	0.014	0.036	0.059	0.120	0.220	0.050	0.119	0.119	0.714	0.952
FARIDPUR	MADHUKHALI	23	0.000	0.013	0.059	0.126	0.188	0.039	0.435	0.435	0.739	1.000
FARIDPUR	NAGARKANDA	27	0.026	0.095	0.215	0.290	0.325	0.122	0.148	0.148	0.407	0.704
FARIDPUR	SADARPUR	26	0.006	0.022	0.032	0.077	0.145	0.029	0.308	0.308	0.846	1.000
FARIDPUR	SALTHA	26	0.040	0.085	0.160	0.255	0.355	0.112	0.077	0.077	0.308	0.808
GAZIPUR	GAZIPUR SADAR	49	0.000	0.000	0.000	0.000	0.005	0.000	1.000	1.000	1.000	1.000
GAZIPUR	KALIAKAIR	27	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
GAZIPUR	KALIGANJ	27	0.000	0.000	0.000	0.010	0.185	0.010	0.889	0.926	0.926	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
GAZIPUR	KAPASIA	23	0.000	0.000	0.000	0.000	0.033	0.001	0.957	0.957	1.000	1.000
GAZIPUR	SREEPUR	29	0.000	0.000	0.002	0.011	0.025	0.002	0.897	0.897	1.000	1.000
GOPALGANJ	GOPALGANJ SADAR	42	0.020	0.082	0.155	0.265	0.430	0.110	0.048	0.048	0.405	0.762
GOPALGANJ	KASHIANI	26	0.046	0.089	0.190	0.240	0.420	0.126	0.039	0.039	0.269	0.808
GOPALGANJ	KOTALIPARA	27	0.000	0.000	0.013	0.088	0.220	0.020	0.667	0.704	0.889	0.963
GOPALGANJ	MUKSUDPUR	29	0.045	0.092	0.155	0.220	0.425	0.114	0.035	0.035	0.310	0.828
GOPALGANJ	TUNGIPARA	24	0.000	0.005	0.030	0.140	0.205	0.035	0.583	0.625	0.792	0.958
JAMALPUR	BAKSHIGANJ	25	0.000	0.000	0.013	0.040	0.084	0.013	0.720	0.720	0.920	1.000
JAMALPUR	DEWANGANJ	28	0.000	0.004	0.009	0.016	0.044	0.006	0.786	0.821	1.000	1.000
JAMALPUR	ISLAMPUR	24	0.000	0.007	0.018	0.039	0.205	0.025	0.667	0.667	0.917	0.917
JAMALPUR	JAMALPUR SADAR	40	0.000	0.000	0.006	0.011	0.037	0.004	0.850	0.900	1.000	1.000
JAMALPUR	MADARGANJ	27	0.000	0.006	0.019	0.062	0.155	0.018	0.630	0.667	0.889	1.000
JAMALPUR	MELANDAHA	28	0.000	0.000	0.021	0.038	0.078	0.013	0.679	0.679	0.929	1.000
JAMALPUR	SARISHABARI	33	0.000	0.005	0.019	0.037	0.165	0.016	0.606	0.606	0.939	1.000
KISHOREGONJ	AUSTAGRAM	23	0.000	0.015	0.047	0.054	0.160	0.028	0.435	0.435	0.783	1.000
KISHOREGONJ	BAJITPUR	32	0.005	0.012	0.048	0.145	0.450	0.055	0.438	0.469	0.750	0.906
KISHOREGONJ	BHAIRAB	30	0.000	0.007	0.051	0.086	0.290	0.035	0.600	0.600	0.733	0.967
KISHOREGONJ	HOSSAINPUR	22	0.000	0.000	0.004	0.008	0.023	0.003	0.909	0.909	1.000	1.000
KISHOREGONJ	ITNA	26	0.016	0.035	0.067	0.081	0.225	0.045	0.192	0.231	0.615	0.962
KISHOREGONJ	KARIMGANJ	27	0.009	0.025	0.046	0.070	0.420	0.047	0.259	0.259	0.815	0.963
KISHOREGONJ	KATIADI	29	0.000	0.008	0.023	0.082	0.105	0.021	0.552	0.586	0.828	1.000
KISHOREGONJ	KISHOREGANJ SADAR	35	0.000	0.000	0.003	0.023	0.235	0.013	0.800	0.829	0.943	0.971
KISHOREGONJ	KULIAR CHAR	26	0.006	0.023	0.059	0.170	0.340	0.050	0.346	0.385	0.731	0.923
KISHOREGONJ	MITHAMAIN	28	0.022	0.035	0.062	0.071	0.088	0.039	0.143	0.143	0.679	1.000
KISHOREGONJ	NIKLI	25	0.012	0.031	0.050	0.086	0.245	0.045	0.160	0.200	0.720	0.960
KISHOREGONJ	PAKUNDIA	25	0.000	0.000	0.002	0.065	0.144	0.015	0.800	0.800	0.840	1.000
KISHOREGONJ	TARAIL	25	0.000	0.016	0.029	0.043	0.081	0.017	0.440	0.480	0.960	1.000
MADARIPUR	KALKINI	37	0.000	0.007	0.030	0.094	0.460	0.035	0.568	0.568	0.865	0.973
MADARIPUR	MADARIPUR SADAR	40	0.005	0.011	0.077	0.215	0.460	0.065	0.425	0.475	0.700	0.850
MADARIPUR	RAJOIR	23	0.024	0.115	0.230	0.310	0.475	0.142	0.130	0.174	0.304	0.739
MADARIPUR	SHIB CHAR	30	0.016	0.026	0.071	0.232	0.265	0.067	0.200	0.200	0.667	0.833
MANIKGANJ	DAULATPUR	26	0.000	0.008	0.024	0.072	0.089	0.020	0.539	0.539	0.846	1.000
MANIKGANJ	GHIOR	26	0.003	0.016	0.039	0.070	0.090	0.024	0.346	0.385	0.885	1.000
MANIKGANJ	HARIRAMPUR	27	0.000	0.042	0.084	0.320	0.760	0.087	0.333	0.333	0.593	0.889

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
MANIKGANJ	MANIKGANJ SADAR	35	0.000	0.011	0.016	0.038	0.076	0.014	0.429	0.486	0.914	1.000
MANIKGANJ	SATURIA	24	0.004	0.007	0.013	0.019	0.087	0.013	0.625	0.625	0.917	1.000
MANIKGANJ	SHIBALAYA	24	0.012	0.026	0.073	0.090	0.160	0.044	0.167	0.208	0.625	1.000
MANIKGANJ	SINGAIR	33	0.000	0.010	0.056	0.081	0.230	0.032	0.455	0.515	0.727	0.970
MUNSHIGANJ	GAZARIA	25	0.001	0.034	0.140	0.330	0.790	0.121	0.360	0.360	0.560	0.880
MUNSHIGANJ	LOHAJANG	26	0.000	0.003	0.150	0.310	0.360	0.079	0.615	0.654	0.654	0.808
MUNSHIGANJ	MUNSHIGANJ SADAR	55	0.000	0.000	0.003	0.073	0.130	0.013	0.836	0.836	0.873	1.000
MUNSHIGANJ	SERAJDIKHAN	25	0.000	0.000	0.004	0.037	0.074	0.010	0.760	0.760	0.920	1.000
MUNSHIGANJ	SREENAGAR	26	0.000	0.003	0.082	0.175	0.220	0.051	0.539	0.577	0.615	0.923
MUNSHIGANJ	TONGIBARI	23	0.000	0.000	0.004	0.075	0.360	0.028	0.783	0.783	0.826	0.957
MYMENSINGH	BHALUKA	26	0.000	0.000	0.009	0.011	0.015	0.004	0.846	0.885	1.000	1.000
MYMENSINGH	DHOBAURA	23	0.025	0.056	0.076	0.090	0.460	0.071	0.087	0.087	0.435	0.957
MYMENSINGH	FULBARIA	30	0.000	0.002	0.008	0.013	0.017	0.004	0.800	0.833	1.000	1.000
MYMENSINGH	GAFFARGAON	27	0.000	0.002	0.007	0.014	0.020	0.004	0.815	0.852	1.000	1.000
MYMENSINGH	GAURIPUR	27	0.000	0.005	0.023	0.039	0.165	0.017	0.593	0.630	0.963	1.000
MYMENSINGH	HALUAGHAT	26	0.000	0.024	0.038	0.042	0.045	0.020	0.385	0.385	1.000	1.000
MYMENSINGH	ISHWARGANJ	25	0.000	0.004	0.011	0.015	0.033	0.007	0.720	0.720	1.000	1.000
MYMENSINGH	MYMENSINGH SADAR	38	0.000	0.004	0.011	0.018	0.046	0.007	0.684	0.737	1.000	1.000
MYMENSINGH	MUKTAGACHHA	30	0.000	0.000	0.008	0.015	0.059	0.005	0.833	0.867	0.967	1.000
MYMENSINGH	NANDAIL	19	0.000	0.008	0.013	0.023	0.046	0.010	0.632	0.632	1.000	1.000
MYMENSINGH	PHULPUR	25	0.000	0.000	0.008	0.013	0.063	0.008	0.760	0.760	0.960	1.000
MYMENSINGH	TRISHAL	20	0.000	0.000	0.007	0.014	0.015	0.004	0.750	0.750	1.000	1.000
NARAYANGANJ	ARAIHAZAR	23	0.000	0.007	0.069	0.132	0.200	0.041	0.565	0.565	0.652	0.957
NARAYANGANJ	SONARGAON	11	0.000	0.000	0.006	0.007	0.093	0.010	0.909	0.909	0.909	1.000
NARAYANGANJ	BANDAR	12	0.009	0.033	0.168	0.190	0.235	0.085	0.417	0.500	0.500	0.917
NARAYANGANJ	NARAYANGANJ SADAR	31	0.000	0.000	0.001	0.024	0.078	0.006	0.871	0.871	0.968	1.000
NARAYANGANJ	RUPGANJ	27	0.000	0.000	0.000	0.021	0.042	0.004	0.889	0.889	1.000	1.000
NARSINGDI	BELABO	25	0.000	0.000	0.000	0.016	0.054	0.005	0.840	0.840	0.960	1.000
NARSINGDI	MANOHARDI	25	0.000	0.007	0.045	0.160	0.550	0.058	0.520	0.520	0.760	0.920
NARSINGDI	NARSINGDI SADAR	40	0.000	0.001	0.073	0.183	0.640	0.058	0.625	0.625	0.725	0.900
NARSINGDI	PALASH	30	0.000	0.000	0.009	0.022	0.144	0.009	0.767	0.833	0.967	1.000
NARSINGDI	ROYPURA	28	0.000	0.002	0.021	0.093	0.165	0.022	0.679	0.679	0.857	1.000
NARSINGDI	SHIBPUR	27	0.000	0.000	0.016	0.037	0.084	0.010	0.741	0.741	0.926	1.000
NETRAKONA	ATPARA	27	0.000	0.000	0.016	0.081	0.100	0.018	0.704	0.741	0.852	1.000

District	Upazila	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maxi-mum	Average	Be-low LOD	Below WHO GV	Below BD Stan-dard	Below 0.2 mg/L
NETRAKONA	BARHATTA	21	0.013	0.042	0.067	0.097	0.170	0.048	0.191	0.238	0.667	1.000
NETRAKONA	DURGAPUR	30	0.019	0.041	0.084	0.153	0.355	0.062	0.200	0.200	0.667	0.933
NETRAKONA	KHALIAJURI	26	0.039	0.055	0.080	0.125	0.160	0.066	0.000	0.000	0.500	1.000
NETRAKONA	KALMAKANDA	28	0.038	0.062	0.150	0.220	0.245	0.086	0.071	0.107	0.429	0.893
NETRAKONA	KENDUA	28	0.000	0.000	0.011	0.038	0.067	0.009	0.679	0.750	0.929	1.000
NETRAKONA	MADAN	28	0.022	0.039	0.077	0.155	0.210	0.058	0.107	0.107	0.571	0.929
NETRAKONA	MOHANGANJ	28	0.025	0.077	0.104	0.210	0.390	0.095	0.071	0.071	0.321	0.893
NETRAKONA	NETROKONA SADAR	36	0.000	0.011	0.021	0.044	0.310	0.022	0.444	0.500	0.917	0.972
NETRAKONA	PURBADHALA	29	0.000	0.000	0.013	0.044	0.089	0.011	0.690	0.690	0.931	1.000
RAJBARI	BALIAKANDI	26	0.000	0.000	0.010	0.065	0.087	0.014	0.731	0.769	0.885	1.000
RAJBARI	GOALANDA	38	0.000	0.000	0.025	0.075	0.168	0.018	0.658	0.658	0.868	1.000
RAJBARI	PANGSHA	31	0.000	0.000	0.007	0.018	0.260	0.013	0.774	0.807	0.968	0.968
RAJBARI	RAJBARI SADAR	31	0.000	0.000	0.027	0.043	0.180	0.021	0.581	0.613	0.903	1.000
SHARIATPUR	BHEDARGANJ	24	0.000	0.005	0.028	0.073	0.140	0.022	0.625	0.625	0.833	1.000
SHARIATPUR	DAMUDYA	28	0.000	0.005	0.010	0.016	0.023	0.006	0.714	0.821	1.000	1.000
SHARIATPUR	GOSAIRHAT	25	0.000	0.006	0.013	0.035	0.445	0.040	0.600	0.640	0.920	0.920
SHARIATPUR	NARIA	31	0.000	0.000	0.011	0.018	0.081	0.008	0.677	0.742	0.968	1.000
SHARIATPUR	SHARIATPUR SADAR	38	0.000	0.008	0.037	0.082	0.440	0.031	0.605	0.632	0.816	0.974
SHARIATPUR	ZANJIRA	28	0.001	0.008	0.031	0.077	0.410	0.033	0.571	0.571	0.857	0.964
SHERPUR	JHENAIGATI	26	0.000	0.004	0.018	0.030	0.040	0.010	0.539	0.577	1.000	1.000
SHERPUR	NAKLA	33	0.000	0.000	0.005	0.016	0.280	0.013	0.849	0.849	0.970	0.970
SHERPUR	NALITABARI	30	0.000	0.009	0.028	0.063	0.190	0.022	0.567	0.600	0.900	1.000
SHERPUR	SHERPUR SADAR	41	0.000	0.000	0.006	0.022	0.080	0.007	0.781	0.805	0.976	1.000
SHERPUR	SREEBARDI	29	0.000	0.000	0.006	0.026	0.090	0.008	0.793	0.828	0.966	1.000
TANGAIL	BASAIL	21	0.000	0.003	0.017	0.024	0.041	0.009	0.667	0.667	1.000	1.000
TANGAIL	BHUAPUR	28	0.000	0.000	0.005	0.019	0.024	0.004	0.821	0.857	1.000	1.000
TANGAIL	DELDUAR	26	0.002	0.009	0.026	0.043	0.210	0.023	0.500	0.539	0.923	0.962
TANGAIL	DHANBARI	34	0.000	0.004	0.016	0.029	0.081	0.011	0.647	0.677	0.971	1.000
TANGAIL	GHATAIL	28	0.000	0.000	0.005	0.028	0.030	0.006	0.786	0.786	1.000	1.000
TANGAIL	GOPALPUR	28	0.000	0.006	0.017	0.034	0.050	0.011	0.643	0.679	0.964	1.000
TANGAIL	KALIHATI	31	0.000	0.000	0.021	0.042	0.126	0.013	0.710	0.710	0.936	1.000
TANGAIL	MADHUPUR	29	0.000	0.000	0.003	0.061	0.132	0.013	0.793	0.828	0.897	1.000
TANGAIL	MIRZAPUR	26	0.000	0.000	0.023	0.031	0.043	0.011	0.615	0.615	1.000	1.000
TANGAIL	NAGARPUR	25	0.000	0.003	0.017	0.047	0.195	0.020	0.720	0.720	0.920	1.000
TANGAIL	SAKHIPUR	26	0.000	0.000	0.000	0.000	0.004	0.000	1.000	1.000	1.000	1.000

District	Upazila	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maxi-mum	Average	Be-low LOD	Below WHO GV	Below BD Stan-dard	Below 0.2 mg/L
TANGAIL	TANGAIL SADAR	37	0.000	0.000	0.007	0.030	0.081	0.010	0.757	0.757	0.946	1.000
KHULNA DIVISION												
BAGERHAT	BAGERHAT SADAR	36	0.000	0.000	0.000	0.004	0.135	0.008	0.917	0.917	0.944	1.000
BAGERHAT	CHITALMARI	25	0.006	0.019	0.084	0.215	0.235	0.056	0.320	0.320	0.680	0.880
BAGERHAT	FAKIRHAT	24	0.000	0.000	0.016	0.110	0.810	0.055	0.667	0.708	0.833	0.917
BAGERHAT	KACHUA	23	0.002	0.020	0.061	0.079	0.110	0.030	0.391	0.391	0.739	1.000
BAGERHAT	MOLLAHAT	24	0.000	0.000	0.005	0.040	0.088	0.010	0.833	0.833	0.917	1.000
BAGERHAT	MONGLA	34	0.000	0.000	0.005	0.005	0.023	0.002	0.971	0.971	1.000	1.000
BAGERHAT	MORRELGANJ	30	0.000	0.001	0.005	0.007	0.036	0.004	0.933	0.933	1.000	1.000
BAGERHAT	RAMPAL	25	0.000	0.000	0.000	0.015	0.044	0.004	0.880	0.880	1.000	1.000
BAGERHAT	SARANKHOLA	26	0.000	0.000	0.004	0.005	0.013	0.002	0.962	0.962	1.000	1.000
CHUADANGA	ALAMDANGA	31	0.000	0.005	0.034	0.047	0.250	0.023	0.548	0.581	0.903	0.968
CHUADANGA	CHUADANGA SADAR	38	0.002	0.016	0.036	0.086	0.170	0.031	0.368	0.368	0.816	1.000
CHUADANGA	DAMURHUDA	30	0.002	0.017	0.040	0.083	0.365	0.037	0.467	0.467	0.767	0.967
CHUADANGA	JIBAN NAGAR	29	0.002	0.019	0.041	0.070	0.105	0.026	0.448	0.448	0.793	1.000
JESSORE	ABHAYNAGAR	34	0.000	0.000	0.015	0.095	0.180	0.023	0.735	0.735	0.824	1.000
JESSORE	BAGHER PARA	25	0.003	0.013	0.046	0.087	0.230	0.034	0.400	0.440	0.800	0.960
JESSORE	CHAUGACHHA	26	0.007	0.037	0.074	0.185	0.295	0.059	0.308	0.308	0.539	0.962
JESSORE	JHIKARGACHHA	28	0.013	0.033	0.057	0.235	0.610	0.073	0.214	0.214	0.714	0.893
JESSORE	KESHABPUR	27	0.000	0.019	0.088	0.275	0.455	0.077	0.444	0.482	0.593	0.815
JESSORE	KOTWALI	36	0.000	0.000	0.009	0.057	0.190	0.016	0.750	0.778	0.889	1.000
JESSORE	MANIRAMPUR	26	0.005	0.028	0.083	0.175	0.235	0.056	0.308	0.346	0.615	0.962
JESSORE	SHARSHA	29	0.006	0.024	0.034	0.165	0.270	0.042	0.310	0.345	0.828	0.931
JHENAIDAH	HARINAKUNDA	24	0.000	0.003	0.036	0.064	0.075	0.018	0.625	0.625	0.833	1.000
JHENAIDAH	JHENAIDAH SADAR	33	0.000	0.011	0.022	0.042	0.178	0.021	0.424	0.424	0.909	1.000
JHENAIDAH	KALIGANJ	28	0.000	0.004	0.015	0.036	0.085	0.012	0.679	0.679	0.929	1.000
JHENAIDAH	KOTCHANDPUR	30	0.000	0.014	0.039	0.087	0.094	0.027	0.467	0.500	0.767	1.000
JHENAIDAH	MAHESHPUR	24	0.007	0.019	0.034	0.044	0.205	0.029	0.333	0.375	0.917	0.958
JHENAIDAH	SHAILKUPA	30	0.000	0.003	0.038	0.085	0.090	0.023	0.533	0.533	0.833	1.000
KHULNA	BATIAGHATA	21	0.000	0.006	0.010	0.016	0.380	0.024	0.667	0.762	0.952	0.952
KHULNA	DACOPE	31	0.000	0.008	0.015	0.036	0.068	0.012	0.645	0.677	0.968	1.000
KHULNA	DAULATPUR	11	0.000	0.000	0.007	0.021	0.026	0.005	0.818	0.818	1.000	1.000
KHULNA	DUMURIA	23	0.000	0.004	0.024	0.061	0.230	0.023	0.652	0.652	0.870	0.957
KHULNA	DIGHALIA	25	0.000	0.001	0.009	0.017	0.044	0.006	0.760	0.760	1.000	1.000
KHULNA	KHALISHPUR	22	0.000	0.000	0.005	0.013	0.017	0.004	0.773	0.773	1.000	1.000

District	Upazila	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maxi-mum	Average	Be-low LOD	Below WHO GV	Below BD Stan-dard	Below 0.2 mg/L
KHULNA	KHAN JAHAN ALI	9	0.000	0.000	0.008	0.022	0.022	0.006	0.778	0.778	1.000	1.000
KHULNA	KHULNA SADAR	24	0.000	0.000	0.007	0.011	0.015	0.004	0.833	0.875	1.000	1.000
KHULNA	KOYRA	24	0.000	0.005	0.016	0.073	0.210	0.023	0.625	0.708	0.833	0.958
KHULNA	PAIKGACHHA	21	0.008	0.029	0.082	0.096	0.610	0.069	0.286	0.333	0.619	0.952
KHULNA	PHULTALA	22	0.000	0.004	0.015	0.065	0.087	0.016	0.591	0.591	0.864	1.000
KHULNA	RUPSA	21	0.010	0.017	0.043	0.079	0.095	0.030	0.238	0.333	0.810	1.000
KHULNA	SONADANGA	14	0.000	0.000	0.008	0.010	0.010	0.004	0.857	1.000	1.000	1.000
KHULNA	TEROKHADA	23	0.000	0.010	0.030	0.093	0.145	0.029	0.435	0.522	0.826	1.000
KUSHTIA	BHERAMARA	29	0.000	0.008	0.021	0.063	0.083	0.018	0.517	0.517	0.897	1.000
KUSHTIA	DAULATPUR	20	0.000	0.006	0.018	0.030	0.081	0.013	0.600	0.600	0.950	1.000
KUSHTIA	KHOKSA	26	0.000	0.005	0.009	0.018	0.044	0.007	0.769	0.769	1.000	1.000
KUSHTIA	KUMARKHALI	29	0.000	0.003	0.010	0.089	0.105	0.015	0.724	0.759	0.897	1.000
KUSHTIA	KUSHTIA SADAR	31	0.000	0.002	0.013	0.027	0.085	0.010	0.710	0.710	0.968	1.000
KUSHTIA	MIRPUR	18	0.000	0.003	0.022	0.024	0.030	0.010	0.611	0.611	1.000	1.000
MAGURA	MAGURA SADAR	57	0.000	0.017	0.036	0.084	0.335	0.034	0.386	0.404	0.807	0.965
MAGURA	MOHAMMADPUR	26	0.000	0.000	0.038	0.084	0.115	0.022	0.615	0.615	0.808	1.000
MAGURA	SHALIKHA	24	0.000	0.031	0.047	0.081	0.088	0.031	0.375	0.417	0.792	1.000
MAGURA	SREEPUR	24	0.000	0.000	0.004	0.019	0.050	0.005	0.792	0.792	0.958	1.000
MEHERPUR	GANGNI	35	0.000	0.011	0.029	0.057	0.067	0.020	0.429	0.486	0.886	1.000
MEHERPUR	MUJIB NAGAR	22	0.000	0.019	0.034	0.136	0.320	0.043	0.455	0.455	0.818	0.909
MEHERPUR	MEHERPUR SADAR	45	0.003	0.020	0.037	0.089	0.295	0.037	0.356	0.378	0.844	0.956
NARAIL	KALIA	35	0.000	0.005	0.081	0.165	0.195	0.043	0.514	0.514	0.657	1.000
NARAIL	LOHAGARA	34	0.000	0.013	0.082	0.200	0.310	0.055	0.441	0.471	0.706	0.882
NARAIL	NARAIL SADAR	37	0.000	0.010	0.034	0.086	0.295	0.033	0.487	0.541	0.811	0.946
SATKHIRA	ASSASUNI	22	0.000	0.007	0.025	0.037	0.084	0.016	0.591	0.636	0.909	1.000
SATKHIRA	DEBHATA	25	0.000	0.005	0.011	0.029	0.375	0.022	0.600	0.640	0.960	0.960
SATKHIRA	KALAROA	33	0.074	0.120	0.195	0.255	0.690	0.159	0.030	0.030	0.121	0.758
SATKHIRA	KALIGANJ	23	0.003	0.012	0.028	0.064	0.115	0.022	0.478	0.478	0.870	1.000
SATKHIRA	SATKHIRA SADAR	42	0.004	0.020	0.031	0.145	0.225	0.037	0.310	0.310	0.833	0.976
SATKHIRA	SHYAMNAGAR	26	0.000	0.001	0.014	0.024	0.025	0.007	0.654	0.654	1.000	1.000
SATKHIRA	TALA	24	0.009	0.040	0.138	0.195	0.385	0.080	0.292	0.292	0.542	0.917
RAJSHAHI DIVISION												
BOGRA	ADAMDIGHI	27	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
BOGRA	BOGRA SADAR	37	0.000	0.000	0.000	0.010	0.089	0.004	0.892	0.919	0.973	1.000
BOGRA	DHUNAT	25	0.000	0.007	0.029	0.052	0.190	0.023	0.560	0.600	0.880	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
BOGRA	DHUPCHANCHIA	28	0.000	0.000	0.000	0.003	0.017	0.001	0.964	0.964	1.000	1.000
BOGRA	GABTALI	27	0.000	0.003	0.012	0.019	0.026	0.006	0.741	0.741	1.000	1.000
BOGRA	KAHALOO	28	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
BOGRA	NANDIGRAM	24	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
BOGRA	SARIAKANDI	24	0.000	0.001	0.024	0.036	0.125	0.016	0.583	0.625	0.917	1.000
BOGRA	SHAJAHANPUR	27	0.000	0.000	0.000	0.005	0.063	0.003	0.926	0.926	0.963	1.000
BOGRA	SHERPUR	22	0.000	0.000	0.000	0.004	0.077	0.005	0.909	0.909	0.955	1.000
BOGRA	SHIBGANJ	26	0.000	0.000	0.009	0.017	0.165	0.011	0.769	0.769	0.962	1.000
BOGRA	SONATOLA	24	0.000	0.000	0.011	0.040	0.051	0.008	0.750	0.750	0.958	1.000
DINAJPUR	BIRAMPUR	30	0.000	0.000	0.000	0.006	0.017	0.001	0.933	0.967	1.000	1.000
DINAJPUR	BIRGANJ	27	0.000	0.000	0.000	0.022	0.029	0.004	0.815	0.815	1.000	1.000
DINAJPUR	BIRAL	25	0.000	0.000	0.000	0.002	0.029	0.001	0.960	0.960	1.000	1.000
DINAJPUR	BOCHAGANJ	28	0.000	0.000	0.003	0.009	0.013	0.002	0.929	0.964	1.000	1.000
DINAJPUR	CHIRIRBANDAR	26	0.000	0.000	0.002	0.003	0.012	0.001	0.962	0.962	1.000	1.000
DINAJPUR	FULBARI	28	0.000	0.000	0.000	0.001	0.001	0.000	1.000	1.000	1.000	1.000
DINAJPUR	GHORAGHAT	29	0.000	0.000	0.000	0.000	0.006	0.000	1.000	1.000	1.000	1.000
DINAJPUR	HAKIMPUR	29	0.000	0.000	0.000	0.000	0.024	0.001	0.966	0.966	1.000	1.000
DINAJPUR	KAHAROLE	24	0.000	0.000	0.001	0.008	0.017	0.002	0.917	0.917	1.000	1.000
DINAJPUR	KHANSAMA	25	0.000	0.000	0.006	0.017	0.025	0.005	0.760	0.800	1.000	1.000
DINAJPUR	DINAJPUR SADAR	20	0.000	0.000	0.000	0.006	0.012	0.001	0.950	0.950	1.000	1.000
DINAJPUR	NAWABGANJ	26	0.000	0.000	0.000	0.000	0.006	0.000	1.000	1.000	1.000	1.000
DINAJPUR	PARBATIPUR	29	0.000	0.000	0.000	0.001	0.010	0.001	0.966	1.000	1.000	1.000
GAIBANDHA	FULCHHARI	23	0.000	0.000	0.011	0.023	0.046	0.007	0.739	0.739	1.000	1.000
GAIBANDHA	GAIBANDHA SADAR	39	0.000	0.009	0.026	0.047	0.350	0.024	0.513	0.564	0.923	0.974
GAIBANDHA	GOBINDAGANJ	37	0.000	0.005	0.029	0.049	0.320	0.024	0.514	0.541	0.919	0.973
GAIBANDHA	PALASHBARI	26	0.000	0.010	0.024	0.067	0.205	0.026	0.385	0.539	0.808	0.962
GAIBANDHA	SADULLAPUR	27	0.000	0.015	0.028	0.078	0.155	0.024	0.482	0.482	0.852	1.000
GAIBANDHA	SHAGHATA	23	0.000	0.010	0.017	0.034	0.180	0.020	0.478	0.522	0.913	1.000
GAIBANDHA	SUNDARGANJ	31	0.000	0.011	0.039	0.047	0.077	0.019	0.452	0.484	0.903	1.000
JOYPURHAT	AKKELPUR	32	0.000	0.000	0.002	0.014	0.026	0.003	0.875	0.875	1.000	1.000
JOYPURHAT	JOYPURHAT SADAR	41	0.000	0.000	0.006	0.013	0.043	0.005	0.805	0.854	1.000	1.000
JOYPURHAT	KALAI	32	0.000	0.000	0.007	0.012	0.014	0.004	0.781	0.875	1.000	1.000
JOYPURHAT	KHETLAL	27	0.000	0.000	0.005	0.011	0.042	0.004	0.889	0.889	1.000	1.000
JOYPURHAT	PANCHBIBI	29	0.000	0.000	0.000	0.010	0.011	0.002	0.897	0.966	1.000	1.000
KURIGRAM	BHURUNGAMARI	25	0.000	0.000	0.012	0.021	0.033	0.007	0.720	0.720	1.000	1.000

District	Upazila	Sam-ples	25th %ile	Median	75th %ile	90th %ile	Maxi-mum	Average	Be-low LOD	Below WHO GV	Below BD Stan-dard	Below 0.2 mg/L
KURIGRAM	CHAR RAJIBPUR	24	0.000	0.000	0.012	0.026	0.195	0.013	0.708	0.750	0.958	1.000
KURIGRAM	CHILMARI	26	0.000	0.000	0.016	0.048	0.087	0.012	0.692	0.731	0.923	1.000
KURIGRAM	PHULBARI	28	0.000	0.000	0.016	0.035	0.046	0.010	0.607	0.679	1.000	1.000
KURIGRAM	KURIGRAM SADAR	40	0.000	0.003	0.014	0.022	0.039	0.008	0.625	0.675	1.000	1.000
KURIGRAM	NAGESHWARI	34	0.000	0.000	0.009	0.018	0.067	0.007	0.794	0.824	0.971	1.000
KURIGRAM	RAJARHAT	26	0.000	0.000	0.017	0.034	0.105	0.012	0.615	0.615	0.962	1.000
KURIGRAM	RAUMARI	25	0.000	0.004	0.016	0.027	0.057	0.011	0.520	0.600	0.960	1.000
KURIGRAM	ULIPUR	32	0.000	0.016	0.041	0.055	0.275	0.029	0.438	0.438	0.875	0.969
LALMONIRHAT	ADITMARI	27	0.000	0.000	0.000	0.018	0.037	0.003	0.852	0.889	1.000	1.000
LALMONIRHAT	HATIBANDHA	24	0.000	0.000	0.006	0.008	0.009	0.002	1.000	1.000	1.000	1.000
LALMONIRHAT	KALIGANJ	25	0.000	0.000	0.003	0.009	0.025	0.003	0.920	0.960	1.000	1.000
LALMONIRHAT	LALMONIRHAT SADAR	46	0.000	0.000	0.011	0.015	0.045	0.005	0.739	0.739	1.000	1.000
LALMONIRHAT	PATGRAM	33	0.000	0.000	0.002	0.010	0.022	0.003	0.879	0.909	1.000	1.000
NAOGAON	ATRAI	20	0.000	0.000	0.002	0.011	0.018	0.002	0.850	0.900	1.000	1.000
NAOGAON	BADALGACHHI	25	0.000	0.000	0.021	0.042	0.051	0.012	0.640	0.640	0.960	1.000
NAOGAON	DHAMOIRHAT	23	0.000	0.000	0.014	0.016	0.019	0.004	0.739	0.739	1.000	1.000
NAOGAON	MANDA	27	0.000	0.000	0.017	0.043	0.044	0.010	0.741	0.741	1.000	1.000
NAOGAON	MAHADEBPUR	24	0.000	0.000	0.005	0.018	0.030	0.004	0.750	0.792	1.000	1.000
NAOGAON	NAOGAON SADAR	45	0.000	0.000	0.000	0.015	0.020	0.003	0.800	0.822	1.000	1.000
NAOGAON	NIAMATPUR	24	0.000	0.000	0.000	0.015	0.017	0.002	0.875	0.875	1.000	1.000
NAOGAON	PATNITALA	29	0.000	0.000	0.000	0.015	0.021	0.002	0.862	0.897	1.000	1.000
NAOGAON	PORSHA	24	0.000	0.000	0.000	0.013	0.018	0.002	0.875	0.875	1.000	1.000
NAOGAON	RANINAGAR	24	0.000	0.000	0.005	0.016	0.019	0.003	0.875	0.875	1.000	1.000
NAOGAON	SAPAHAR	26	0.000	0.000	0.000	0.001	0.016	0.001	0.962	0.962	1.000	1.000
NATORE	BAGATIPARA	28	0.000	0.000	0.000	0.002	0.009	0.001	1.000	1.000	1.000	1.000
NATORE	BARAIGRAM	26	0.000	0.000	0.000	0.002	0.004	0.000	1.000	1.000	1.000	1.000
NATORE	GURUDASPUR	29	0.000	0.000	0.000	0.000	0.002	0.000	1.000	1.000	1.000	1.000
NATORE	LALPUR	33	0.000	0.000	0.003	0.007	0.019	0.002	0.909	0.909	1.000	1.000
NATORE	NATORE SADAR	27	0.000	0.000	0.000	0.002	0.068	0.003	0.963	0.963	0.963	1.000
NATORE	SINGRA	29	0.000	0.000	0.000	0.001	0.010	0.001	0.966	1.000	1.000	1.000
CHAPAI NABABGANJ	BHOLAHAT	26	0.000	0.000	0.000	0.002	0.018	0.001	0.923	0.923	1.000	1.000
CHAPAI NABABGANJ	GOMASTAPUR	29	0.000	0.000	0.005	0.015	0.027	0.004	0.828	0.828	1.000	1.000
CHAPAI NABABGANJ	NACHOLE	26	0.000	0.000	0.000	0.000	0.003	0.000	1.000	1.000	1.000	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
CHAPAI NABABGANJ	CHAPAI NABABGANJ SADAR	37	0.000	0.021	0.063	0.190	0.250	0.047	0.378	0.405	0.649	0.946
CHAPAI NABABGANJ	SHIBGANJ	26	0.000	0.000	0.013	0.070	0.130	0.015	0.731	0.731	0.885	1.000
NILPHAMARI	DIMLA	25	0.000	0.010	0.019	0.030	0.044	0.011	0.480	0.520	1.000	1.000
NILPHAMARI	DOMAR	28	0.000	0.003	0.008	0.012	0.023	0.005	0.857	0.893	1.000	1.000
NILPHAMARI	JALDHAKA	33	0.000	0.004	0.011	0.015	0.026	0.006	0.667	0.697	1.000	1.000
NILPHAMARI	KISHOREGANJ	26	0.000	0.000	0.005	0.015	0.025	0.004	0.846	0.885	1.000	1.000
NILPHAMARI	NILPHAMARI SADAR	28	0.002	0.007	0.010	0.013	0.017	0.007	0.607	0.786	1.000	1.000
NILPHAMARI	SAIDPUR	42	0.000	0.005	0.007	0.011	0.026	0.005	0.881	0.881	1.000	1.000
PABNA	ATGHARIA	28	0.000	0.000	0.006	0.020	0.270	0.014	0.821	0.857	0.964	0.964
PABNA	BERA	29	0.014	0.037	0.083	0.185	0.220	0.060	0.207	0.241	0.552	0.931
PABNA	BHANGURA	27	0.000	0.000	0.005	0.008	0.012	0.002	0.963	0.963	1.000	1.000
PABNA	CHATMOHAR	28	0.000	0.000	0.007	0.012	0.017	0.004	0.750	0.786	1.000	1.000
PABNA	FARIDPUR	27	0.000	0.000	0.008	0.019	0.084	0.008	0.815	0.815	0.926	1.000
PABNA	ISHWARDI	29	0.000	0.000	0.003	0.018	0.020	0.003	0.793	0.862	1.000	1.000
PABNA	PABNA SADAR	33	0.000	0.000	0.006	0.010	0.290	0.012	0.879	0.909	0.970	0.970
PABNA	SANTHIA	29	0.000	0.000	0.017	0.053	0.180	0.017	0.655	0.690	0.897	1.000
PABNA	SUJANAGAR	25	0.000	0.000	0.022	0.096	0.200	0.026	0.640	0.640	0.880	0.960
PANCHAGARH	ATWARI	14	0.007	0.009	0.010	0.011	0.015	0.009	0.714	0.857	1.000	1.000
PANCHAGARH	BODA	32	0.005	0.008	0.011	0.014	0.015	0.008	0.688	0.719	1.000	1.000
PANCHAGARH	DEBIGANJ	25	0.006	0.009	0.009	0.010	0.020	0.008	0.840	0.960	1.000	1.000
PANCHAGARH	PANCHAGARH SADAR	43	0.004	0.007	0.008	0.009	0.020	0.007	0.907	0.930	1.000	1.000
PANCHAGARH	TENTULIA	21	0.006	0.008	0.009	0.010	0.018	0.008	0.857	0.905	1.000	1.000
RAJSHAHI	BAGHA	25	0.000	0.000	0.005	0.010	0.048	0.004	0.840	0.920	1.000	1.000
RAJSHAHI	BAGHMARA	29	0.000	0.000	0.009	0.072	0.095	0.015	0.759	0.793	0.862	1.000
RAJSHAHI	BOALIA	32	0.000	0.000	0.004	0.010	0.029	0.004	0.875	0.906	1.000	1.000
RAJSHAHI	CHARGHAT	24	0.000	0.000	0.000	0.006	0.047	0.003	0.917	0.917	1.000	1.000
RAJSHAHI	DURGAPUR	25	0.000	0.000	0.000	0.005	0.029	0.002	0.960	0.960	1.000	1.000
RAJSHAHI	GODAGARI	32	0.000	0.000	0.000	0.000	0.023	0.001	0.969	0.969	1.000	1.000
RAJSHAHI	MATIHAR	10	0.000	0.000	0.000	0.006	0.006	0.001	1.000	1.000	1.000	1.000
RAJSHAHI	MOHANPUR	27	0.000	0.000	0.012	0.058	0.335	0.022	0.741	0.741	0.889	0.963
RAJSHAHI	PABA	32	0.000	0.000	0.011	0.039	0.370	0.021	0.750	0.750	0.906	0.969
RAJSHAHI	PUTHIA	27	0.000	0.000	0.001	0.020	0.069	0.006	0.815	0.815	0.963	1.000
RAJSHAHI	RAJPARA	17	0.000	0.000	0.014	0.034	0.056	0.009	0.706	0.706	0.941	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
RAJSHAHI	SHAH MAKHDUM	4	0.000	0.000	0.038	0.076	0.076	0.019	0.750	0.750	0.750	1.000
RAJSHAHI	TANORE	26	0.000	0.000	0.000	0.001	0.003	0.000	1.000	1.000	1.000	1.000
RANGPUR	BADARGANJ	30	0.000	0.000	0.005	0.014	0.017	0.003	0.867	0.867	1.000	1.000
RANGPUR	GANGACHARA	24	0.000	0.000	0.000	0.010	0.015	0.002	0.875	0.917	1.000	1.000
RANGPUR	KAUNIA	30	0.000	0.004	0.009	0.031	0.051	0.009	0.767	0.767	0.967	1.000
RANGPUR	RANGPUR SADAR	43	0.000	0.000	0.008	0.017	0.072	0.006	0.791	0.791	0.977	1.000
RANGPUR	MITHA PUKUR	24	0.000	0.000	0.009	0.014	0.032	0.005	0.792	0.833	1.000	1.000
RANGPUR	PIRGACHHA	20	0.000	0.002	0.011	0.018	0.032	0.006	0.700	0.700	1.000	1.000
RANGPUR	PIRGANJ	18	0.000	0.000	0.000	0.011	0.035	0.003	0.889	0.889	1.000	1.000
RANGPUR	TARAGANJ	19	0.000	0.000	0.000	0.008	0.022	0.002	0.947	0.947	1.000	1.000
SIRAJGANJ	BELKUCHI	35	0.000	0.007	0.018	0.032	0.045	0.012	0.543	0.543	1.000	1.000
SIRAJGANJ	CHAUHALI	31	0.000	0.000	0.008	0.012	0.030	0.004	0.774	0.774	1.000	1.000
SIRAJGANJ	KAMARKHANDA	23	0.000	0.008	0.024	0.042	0.081	0.016	0.565	0.609	0.913	1.000
SIRAJGANJ	KAZIPUR	26	0.000	0.002	0.027	0.070	0.190	0.021	0.654	0.692	0.885	1.000
SIRAJGANJ	ROYGANJ	26	0.000	0.009	0.021	0.060	0.095	0.018	0.500	0.500	0.885	1.000
SIRAJGANJ	SHAHJADPUR	27	0.000	0.012	0.038	0.058	0.092	0.022	0.407	0.444	0.852	1.000
SIRAJGANJ	SIRAJGANJ SADAR	30	0.000	0.002	0.020	0.039	0.044	0.011	0.600	0.667	1.000	1.000
SIRAJGANJ	TARASH	23	0.000	0.000	0.005	0.010	0.074	0.005	0.870	0.957	0.957	1.000
SIRAJGANJ	ULLAH PARA	17	0.004	0.013	0.022	0.032	0.073	0.016	0.353	0.412	0.941	1.000
THAKURGAON	BALIADANGI	24	0.000	0.000	0.000	0.000	0.001	0.000	1.000	1.000	1.000	1.000
THAKURGAON	HARIPUR	22	0.000	0.000	0.000	0.000	0.006	0.000	1.000	1.000	1.000	1.000
THAKURGAON	PIRGANJ	33	0.000	0.000	0.000	0.004	0.038	0.003	0.939	0.939	1.000	1.000
THAKURGAON	RANISANKAIL	31	0.000	0.000	0.000	0.000	0.019	0.001	0.968	0.968	1.000	1.000
THAKURGAON	THAKURGAON SADAR	43	0.000	0.000	0.000	0.002	0.011	0.001	0.977	0.977	1.000	1.000
SYLHET DIVISION												
HABIGANJ	AJMIRIGANJ	28	0.024	0.044	0.088	0.094	0.185	0.055	0.036	0.036	0.607	1.000
HABIGANJ	BAHUBAL	24	0.002	0.011	0.029	0.044	0.073	0.017	0.458	0.500	0.958	1.000
HABIGANJ	BANIACHONG	29	0.015	0.023	0.055	0.094	0.215	0.045	0.138	0.207	0.724	0.931
HABIGANJ	CHUNARUGHAT	28	0.000	0.004	0.015	0.065	0.095	0.014	0.679	0.714	0.893	1.000
HABIGANJ	HABIGANJ SADAR	38	0.000	0.009	0.028	0.044	0.087	0.017	0.500	0.526	0.947	1.000
HABIGANJ	LAKHAI	24	0.008	0.026	0.091	0.097	0.270	0.055	0.375	0.375	0.542	0.958
HABIGANJ	MADHABPUR	27	0.000	0.000	0.009	0.012	0.027	0.005	0.778	0.815	1.000	1.000
HABIGANJ	NABIGANJ	23	0.006	0.020	0.072	0.092	0.240	0.045	0.304	0.304	0.739	0.913
MAULVIBAZAR	BARLEKHA	23	0.007	0.010	0.034	0.046	0.080	0.021	0.435	0.565	0.913	1.000
MAULVIBAZAR	JURI	21	0.007	0.008	0.010	0.026	0.073	0.014	0.714	0.810	0.905	1.000

District	Upazila	Samples	25th %ile	Median	75th %ile	90th %ile	Maximum	Average	Below LOD	Below WHO GV	Below BD Standard	Below 0.2 mg/L
MAULVIBAZAR	KAMALGANJ	33	0.006	0.008	0.011	0.023	0.067	0.012	0.576	0.697	0.970	1.000
MAULVIBAZAR	KULAURA	28	0.010	0.023	0.056	0.098	0.140	0.039	0.250	0.321	0.750	1.000
MAULVIBAZAR	MAULVIBAZAR SADAR	35	0.009	0.040	0.088	0.097	0.230	0.053	0.257	0.286	0.600	0.971
MAULVIBAZAR	RAJNAGAR	22	0.005	0.010	0.067	0.093	0.165	0.037	0.500	0.591	0.727	1.000
MAULVIBAZAR	SREEMANGAL	31	0.007	0.015	0.045	0.078	0.085	0.028	0.355	0.419	0.807	1.000
SUNAMGANJ	BISHWAMBARPUR	25	0.000	0.022	0.042	0.064	0.068	0.026	0.360	0.360	0.800	1.000
SUNAMGANJ	CHHATAK	32	0.000	0.047	0.075	0.092	0.155	0.048	0.281	0.313	0.531	1.000
SUNAMGANJ	DAKSHIN SUNAMGANJ	37	0.041	0.063	0.093	0.120	0.145	0.069	0.000	0.000	0.432	1.000
SUNAMGANJ	DERAI	31	0.052	0.074	0.088	0.091	0.110	0.071	0.000	0.000	0.194	1.000
SUNAMGANJ	DHARAMPASHA	21	0.059	0.090	0.140	0.185	0.345	0.109	0.000	0.000	0.191	0.905
SUNAMGANJ	DOWARABAZAR	24	0.016	0.038	0.073	0.145	0.190	0.052	0.208	0.208	0.667	1.000
SUNAMGANJ	JAGANNATHPUR	30	0.018	0.030	0.060	0.081	0.180	0.041	0.200	0.200	0.667	1.000
SUNAMGANJ	JAMALGANJ	26	0.025	0.050	0.090	0.120	0.150	0.059	0.077	0.077	0.500	1.000
SUNAMGANJ	SULLA	26	0.027	0.042	0.083	0.092	0.135	0.053	0.115	0.115	0.577	1.000
SUNAMGANJ	SUNAMGANJ SADAR	36	0.018	0.042	0.063	0.082	0.200	0.047	0.111	0.111	0.639	0.972
SUNAMGANJ	TAHIRPUR	22	0.000	0.032	0.085	0.100	0.335	0.060	0.364	0.364	0.636	0.909
SYLHET	BALAGANJ	24	0.023	0.049	0.082	0.085	0.145	0.051	0.167	0.167	0.542	1.000
SYLHET	BEANI BAZAR	32	0.000	0.000	0.005	0.026	0.390	0.018	0.813	0.813	0.938	0.969
SYLHET	BISHWANATH	28	0.007	0.022	0.060	0.080	0.083	0.033	0.286	0.321	0.643	1.000
SYLHET	COMPANIGANJ	28	0.000	0.015	0.072	0.102	0.205	0.043	0.500	0.500	0.643	0.964
SYLHET	DAKSHIN SURMA	24	0.001	0.006	0.017	0.046	0.140	0.017	0.625	0.625	0.917	1.000
SYLHET	FENCHUGANJ	25	0.000	0.000	0.007	0.014	0.075	0.007	0.760	0.840	0.960	1.000
SYLHET	GOLAPGANJ	33	0.000	0.000	0.005	0.011	0.017	0.003	0.879	0.879	1.000	1.000
SYLHET	GOWAINGHAT	28	0.000	0.000	0.076	0.180	0.290	0.044	0.679	0.679	0.679	0.964
SYLHET	JAINTIAPUR	26	0.000	0.001	0.027	0.053	0.180	0.019	0.692	0.692	0.846	1.000
SYLHET	KANAIGHAT	32	0.000	0.000	0.003	0.030	0.440	0.018	0.875	0.875	0.969	0.969
SYLHET	SYLHET SADAR	69	0.000	0.000	0.003	0.022	0.210	0.007	0.870	0.870	0.971	0.986
SYLHET	ZAKIGANJ	30	0.000	0.003	0.052	0.089	0.145	0.028	0.600	0.667	0.733	1.000

BANGLADESH NATIONAL
DRINKING WATER QUALITY
SURVEY OF 2009

ISBN # 978-984-8969-03-8