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Piloting water quality testing coupled with a national socioeconomic survey in Yogyakarta province, Indonesia, towards tracking of Sustainable Development Goal 6

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ABSTRACT

There remains a pressing need for systematic water quality monitoring strategies to assess drinking water safety and to track progress towards the Sustainable Development Goals (SDG). This study incorporated water quality testing into an existing national socioeconomic survey in Yogyakarta province, Indonesia; the first such study in Indonesia in terms of SDG tracking. Multivariate regression analysis assessed the association between faecal and nitrate contamination and drinking water sources household drinking water adjusted for wealth, education level, type of water sources and type of sanitation facilities. The survey observed widespread faecal contamination in both sources for drinking water (89.2%, 95%CI: 86.9–91.5%; n = 720) and household drinking water (67.1%, 95%CI: 64.1–70.1%; n = 917) as measured by *Escherichia coli*. This was despite widespread improved drinking water source coverage (85.3%) and commonly self-reported boiling practices (82.2%). *E.coli* concentration levels in household drinking water were associated with wealth, education levels of a household head, and type of water source (i.e. vender water or local sources). Following the proposed SDG definition for Target 6.1 (water) and 6.2 (sanitation), the estimated proportion of households with access to safely managed drinking water and sanitation was 8.5% and 45.5%, respectively in the study areas, indicating substantial difference from improved drinking water (82.2%) and improved sanitation coverage (70.9%) as per the MDGs targets. The greatest contamination and risk factors were found in the poorest households indicating the urgent need for targeted and effective interventions here. There is suggested evidence that sub-surface leaching from on-site sanitation adversely impacts on drinking water sources, which underscores the need for further technical assistance in promoting latrine construction. Urgent action is still needed to strengthen systematic monitoring efforts towards tracking SDG Goal 6.

1. Introduction

1.1. The need for linking water safety and WASH surveys

Improvements to WASH (water, sanitation and hygiene) services can reduce diarrhoeal disease (Wolf et al., 2014). Water quality improvement and the impact of water quantity improvements have both been shown to have diarrhoea morbidity reductions (Waddington et al., 2009) while distance to the water source has been shown to positively impact on hygiene and so was associated with a reduction in diarrhoea prevalence, improved nutritional status and reduction in under-five child mortality (Pickering and Davis, 2012). A significant association between poor water quality and diarrhoea has been noted (Gruber et al., 2014), while Luby et al. (2015) found an increasing risk of diarrhoea with higher levels of water quality contamination (significant above 100 *E. coli* colony forming units (cfu)/100 mL).

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Though some examples exist of linked water quality work, for example in Ghana (WHO/UNICEF, 2015) Bangladesh (BBS/UNICEF, 2011), Nepal, Pakistan and Congo, there have been few examples of testing of water quality parameters into regular national household surveys and few, if any, to the authors knowledge, in the East Asia and Pacific region. Indeed such an approach is essential to better understand these interactions and design policy and operational responses (Cronin et al., 2015).

1.2. Indonesian and millennium development goals & Sustainable Development Goals for WASH

Though expenditure in the water & sanitation sector has grown consistently in Indonesia, measured as a share of GDP, water supply and sanitation sector spending remains small at 0.2% of GDP or just less than 1% of total expenditure (World Bank, 2015); this is extremely low from an international perspective (OPM and UNICEF, 2016).

One pressing concern is the low level of piped water supply onto household premises; currently only 22% nationally but the rural value is only 9% (WHO/UNICEF, 2015). Although 29.5% of the public use bottled and refilled water (i.e. water filled to a container belonging to the household) as their primary drinking source, the majority of these use re-filled water bottles (SUSENAS, 2015) and this entire supply mechanism is poorly regulated. The Millennium Development Goal (MDG) relating to water targeted increasing the access of the population to an improved water source and Indonesia has made good progress on provision of water from improved sources rising from 123 million in 1990–222 million in 2015 resulting in Indonesia meeting the water target of the MDGs. However, there is strong evidence that even improved water sources are not always safe Bain et al. (2014). This is especially urgent in Indonesia given the high rates of open defecation (51 million) (WHO/UNICEF, 2015).

I The need for integrated approaches on sanitation, hygiene and water management at household level are well understood by the Ministry of Health. An underlying piece of the national strategy towards Universal Coverage to safe water and sanitation in Indonesia is called "Scaling-up and Strengthening Community Approaches to Total Sanitation" (*Sanitasi Total Berbasis Masyarakat* or STBM in the Bahasa Indonesia language). STBM prioritizes behaviour, as well as social change and community empowerment, across key pillars of WASH. A better understanding of drinking water quality could inform better messaging on the water handling pillar at household level.

The Sustainable Development Goals (SGDs) have shifted the emphasis to quality and the proposed Goal 6 focuses on the achievement by 2030 of universal and equitable access to safe and affordable drinking water and safely managed sanitation systems (UNICEF, 2016); however no national baseline for safe water exists in Indonesia which is required to track progress towards the SDG Target 6. To this end, BPS Statistics – Indonesia (the national bureau of statistics), Ministry of Health's Centre for Environmental Health Engineering and Control of Diseases in Yogyakarta (BBTKLPP Yogyakarta), Ministry of Health (MoH), and the National Development Planning Agency (Bappenas) piloted a dedicated WASH survey with a water quality testing component as part of a national socio-economic survey (SUSENAS) in Yogyakarta province as a model with technical support from UNICEF.

Primary findings were published in government reports (BPS, 2016a, 2016b) and disseminated in government-organized national and sub-national meetings with a strong focus on the water quality elements though addressing sanitation and hygiene also. The present study builds on the government-led water quality survey by using their data and learnings to address following specific objectives:

- to develop and test a water quality component into a well-established national socioeconomic survey along with a dedicated WASH questionnaire,
- to better capture current drinking water quality status at the water source and household levels in Yogyakarta province, Indonesia,
- to establish a baseline estimate for the SDG Target 6.1 on safe water (i.e. access to safely managed drinking water) and also for SDG Target 6.2 (on safe sanitation) in the study area and as a model for other Provinces in Indonesia,
- to explore the factors associated with faecal and chemical contamination at the water source and at the household level,
- to develop recommendations, based on the lessons learnt, both for interventions to mitigate water quality contamination at community and household levels as well as on future scaling up the integration with a water quality-household survey.

2. Material & methods

2.1. Planning process, study area and design

The study was carried out in Yogyakata province, Indonesia, with a population of approximately 3.6 million and comprising of one Municipality and five Districts. The Province is regarded as one of the best served in Indonesia in WASH terms (and hence, potentially, a good comparative Province for any future potential similar studies) with 81.7% of the population with access to an improved water source and 72.1% with access to improved sanitation though access to piped water supply is still limited (14.1%) (RISKESDAS, 2013).

BPS led the survey work and MoH analysed the water samples at BBTKLPP Yogyakarta. UNICEF provided technical support on both aspects. Water quality samples were taken by the staff of BPS who were trained by BBTKLPP based on the water sample collection protocol developed by BBTKLPP (BBTKLPP, 2015). Water samples were collected by BPS staff as part of the national socioeconomic survey (SUSENAS), while these samples were analysed in BBTKLPP which is nationally accredited for water quality testing.

In addition to the collection of water samples and the administration of the planned SUSENAS survey questionnaire, that included standard socio-economic and demographic variables, an additional dedicated WASH survey was designed by BPS (with inputs from the other partners) and administered alongside the water quality sampling process (See Supplemental Material). In addition to a physical examination of the drinking water and direct observation of the place of handwashing by the enumerator, the household respondent was asked a series of questions concerning water storage, treatment, source of water and collection, hygiene, household and infant sanitation and recent illness among family members. This critical part of the work allowed a direct comparison of WASH parameters, water quality and socio-economic indicator making this one of the most comprehensive surveys of this type undertaken to date. The WASH survey was developed over a series of meetings between March and August 2015, hosted by BPS and attended by MoH, BBTKLPP Yogyakarta, Bappenas and UNICEF.

Water quality parameters were discussed in preparatory meetings with BPS, MoH and UNICEF. All samples were analysed for *Escherichia coli*, nitrate and chloride in BBTKLPP by the full-time staff in the laboratory. *Escherichia coli* is the standard indicator parameter for faecal contamination. *E. coli* was enumerated using the membrane filtration method with rapid E. coli 2 agar (Bio-Rad Laboratories, Indonesia), following the manufacturer protocol. Laboratory blanks (i.e. sterile distilled water) were included every day to ensure no contamination occurs in the laboratory, while a duplicate sample was tested every 20 samples

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