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Tracking progress towards global drinking water and sanitation targets: A within and among country analysis

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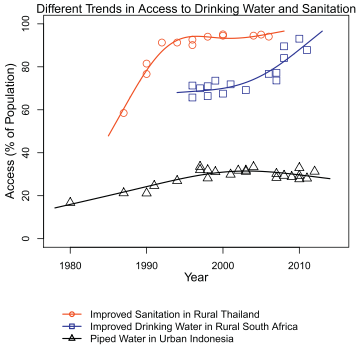
HIGHLIGHTS

- Global analysis shows an underlying sigmoidal trend over time.
- Non-linear trajectories (acceleration, saturation, and deceleration) are common.
- Different trajectories can help distinguish countries with different needs.

GRAPHICAL ABSTRACT



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ABSTRACT

Introduction: Global access to safe drinking water and sanitation has improved dramatically during the Millennium Development Goal (MDG) period. However, there is substantial heterogeneity in progress between countries and inequality within countries.
Methods: We assessed countries' temporal patterns in access to drinking water and sanitation using publicly available data. We then classified countries using non-linear modeling techniques as having one of the following trajectories: 100% coverage, linear growth, linear decline, no change, saturation, acceleration, deceleration, negative acceleration, or negative deceleration. We further assessed the degree to which temporal profiles follow a sigmoidal pattern and how these patterns might vary within a given country between rural and urban settings.
Results: Among countries with more than 10 data points, between 15% and 38% showed a non-linear trajectory, depending on the indicator. Overall, countries' progress followed a sigmoidal trend, but some countries are making better progress and some worse progress than would be expected. We highlight several countries that are not on track to meet the MDG for water or sanitation, but whose access is accelerating, suggesting better performance during the coming years. Conversely, we also highlight several countries that have made sufficient progress to meet the MDG target, but in which access is decelerating.
Discussion: Patterns were heterogeneous and non-linearity was common. Characterization of these heterogeneous patterns will help policy makers allocate resources more effectively. For example, policy makers can identify countries that could make use of additional resources or might be in need of additional institutional capacity

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development to properly manage resources; this will be essential to meet the forthcoming Sustainable Development Goals.

1. Introduction

At a global level, access to safe drinking water and sanitation has increased. For example, from 1990 to 2012, use of improved drinking water sources has increased worldwide from 76% to 89%, and use of improved sanitation has increased from 45% to 64% (World Health Organization and UNICEF, 2014a). While these worldwide improvements are encouraging, there remains substantial heterogeneity between countries and inequality within countries (World Health Organization and UNICEF, 2014a; Luh et al., 2013; Pullan et al., 2014). Many countries have made substantial progress, while others have stagnated.

Since before the adoption of the Millennium Development Goals (MDGs) in 2001, the task of tracking global use of drinking water and sanitation was undertaken by the World Health Organization and the United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation (JMP). The MDG target for drinking water and sanitation, Target 7C, was finalized after several revisions in 2006 and is "to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation" (Bartram et al., 2014; United Nations Millennium Development Goals, 2008). The 'halving' refers to the baseline level in 1990. During the MDG period of 1990 to 2015, country status was estimated by simple linear regression of coverage against year, separately for urban and rural areas. It has been increasingly recognized that countries may show short-term changes that cannot be captured with a linear trend line and progress may follow an overall sigmoidal pattern (Bartram et al., 2014). That is, countries may show lower rates when coverage is very low, followed by acceleration and subsequently saturation (when reaching 100%) or stagnation (when plateauing below 100%) (World Health Organization and UNICEF, 2014a; Bartram et al., 2014). Other sectors, such as child mortality estimation, already employ non-linear methods for estimating trends (Alkema et al., 2014). The JMP dataset has been greatly enriched in recent years, and in December 2014, the JMP taskforce on methods convened to discuss these as well as other challenges related to the JMP methods (World Health Organization and UNICEF, 2014b). An earlier version of this paper was presented at this meeting and feedback was received from the JMP and other experts.

As we look forward to developing programs to meet the Sustainable Development Goals (SDGs) for 2030, we can learn much from a more detailed understanding of the progress made in recent decades. In this paper, we sought to characterize and quantify the extent of non-linear trajectories in the JMP dataset during the MDG period. We also describe tools for modeling these non-linear trajectories, which can improve the accuracy of estimates for some countries and help identify countries that are in need of additional support, whether in the form of increased financing or institutional support to properly absorb and manage resources.

2. Methods

2.1. Current JMP method

The JMP currently monitors coverage of sanitation and drinking water in 212 countries and territories. In this paper, we include several indicators, each of which is reported separately for urban and rural populations. For drinking water, we include the percent of the population with an improved source and the percent of the population with piped water on the premises, piped water being a subset of improved sources. For sanitation, we use the percent of the population with an improved facility (excluding those that are shared between households) and the percent of the population not practicing open defecation. The JMP's annual reports contain definitions of improved sources and facilities (World Health Organization and UNICEF, 2014a). The JMP data points are point estimates from nationally-representative household surveys (e.g., the Demographic and Health Surveys, Multiple Indicator Cluster Surveys, and World Health Surveys) and censuses conducted by governments. For a given indicator, some countries have few data points available, while others have more than 20 (Table 1).

The JMP uses ordinary least squares (linear) regression to estimate the coverage of each indicator across time in each country. The linear model is used to project 2 years before the earliest data point and 2 years past the latest data point. This projection is then extended as a flat line for 4 years in each direction (Fig. 1 — Panel A), or extended indefinitely if the estimated coverage is <5% or >95%. For countries with a single data point, the value of that single data point is extended 6 years in each direction or indefinitely if the estimate is <5% or >95%. A more detailed description of this methodology has been described elsewhere (Bartram et al., 2014).

Each country's progress towards the MDGs is evaluated based on their estimated level of coverage in 2012 relative to the 2015 target or the 2012 target. The 2012 target is the required level of coverage in 2012 which is on the progress line between the 1990 baseline and 2015 target. The following criteria are used to assess MDG progress

Table 1
Data availability for each JMP indicator.

	Number (%) of countries with the following number of data points						
Indicator	0	1	2	3–5	6–10	11–15	16 or more
Sanitation indicators							
Improved (Rural)	27 (12.7)	19 (9)	12 (5.7)	53 (25)	53 (25)	28 (13.2)	20 (9.4)
Improved (urban)	24 (11.3)	18 (8.5)	12 (5.7)	59 (27.8)	51 (24.1)	29 (13.7)	19 (9)
Open Defecation (rural)	74 (34.9)	18 (8.5)	11 (5.2)	41 (19.3)	33 (15.6)	23 (10.8)	12 (5.7)
Open Defecation (urban)	72 (34)	18 (8.5)	12 (5.7)	43 (20.3)	33 (15.6)	23 (10.8)	11 (5.2)
Shared[a] (rural)	86 (40.6)	42 (19.8)	36 (17)	39 (18.4)	8 (3.8)	1 (0.5)	0 (0)
Shared[a] (urban)	85 (40.1)	43 (20.3)	35 (16.5)	39 (18.4)	9 (4.2)	1 (0.5)	0 (0)
Sewer (rural)	46 (21.7)	35 (16.5)	21 (9.9)	42 (19.8)	43 (20.3)	19 (9)	6 (2.8)
Sewer (Urban)	41 (19.3)	37 (17.5)	21 (9.9)	41 (19.3)	47 (22.2)	19 (9)	6 (2.8)
Drinking water indicators							
Improved (rural)	27 (12.7)	25 (11.8)	15 (7.1)	46 (21.7)	49 (23.1)	28 (13.2)	22 (10.4)
Improved (urban)	22 (10.4)	24 (11.3)	17 (8)	52 (24.5)	49 (23.1)	26 (12.3)	22 (10.4)
Piped on premises (rural)	34 (16)	25 (11.8)	17 (8)	44 (20.8)	42 (19.8)	31 (14.6)	19 (9)
Piped on Premises (Urban)	28 (13.2)	26 (12.3)	19 (9)	48 (22.6)	44 (20.8)	26 (12.3)	21 (9.9)
Surface water (rural)	77 (36.3)	22 (10.4)	10 (4.7)	34 (16)	34 (16)	23 (10.8)	12 (5.7)
Surface water (urban)	77 (36.3)	22 (10.4)	9 (4.2)	37 (17.5)	32 (15.1)	22 (10.4)	13 (6.1)

[a] Data on shared sanitation are reported as the proportion of improved facilities that are shared by more than 1 household. For each country, the mean of these proportions is used to estimate coverage of improved sanitation excluding shared.