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SUSTAINABLE DEVELOPMENT AND MULTISECTORAL APPROACHES

Enhancing sector data management to target the water poor

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Appropriate data management as the basis of effective performance reporting is crucial if sector institutions are to track whether they achieve their objectives. This paper shows how a post process of readily available data to construct water poverty maps can be used to identify effectively the most water poor communities, and thus improve the targeting of sector development policies and projects. To this end, water poverty takes its definition from the Water Poverty Index, which combines biophysical, social, economic and environmental data in one single and comparable number to produce a holistic and user-friendly tool for policy making. The study is based on a comprehensive record of the water sources developed by UNICEF in Turkana District, in Kenya. The main conclusion is that such an index allows decision-makers to determine and target priority needs for interventions in the water sector, while assessing the impacts of sector-related development policies.

Introduction

Water is increasingly seen as one of the most critically stressed resources and yet it plays a major role in poverty alleviation in developing countries (Sullivan and Meigh, 2003). Its efficient allocation is a key international concern, and it demands the attention of policy makers, resource managers, and governments. In particular in arid and semi-arid areas, where access to and reliability of water sources have such a large influence on promoting sustainable livelihoods, and where environmental impact associated with inadequate resource management is significant. Accordingly, appropriate policy frameworks are required as essential tools to support sound water management and to foster sustainability. A key prerequisite to effective policy making is to access consistent information through accurate monitoring backed up by rigorous interdisciplinary science, which is mainly dependent on a set of reliable and objective indicators. Similarly, with limited resources, targeting their allocation requires transparency of decisions to be made and of priorities to be assessed, so that water can be delivered to where it is most needed. Once more, a comprehensive compilation of meaningful indicators is needed.

Against this background much effort has gone into the development of indicators of water problems (Joint Monitoring Programme, 2000; Ohlsson, 2000; Sullivan, 2002; Chaves and Alipaz, 2007), since the international commitment to the Millennium Development Goals has increased the necessity to come up with feasible indicators. Aiming to assess water scarcity and to measure accessibility to water of poor populations, Sullivan (2002) developed the Water Poverty Index (WPI). The index identifies regions facing severe water stress, by linking physical estimates of water availability and the socio-economic factors which impact on access and use of this resource. At the same time, the increasing use of geographic information systems (GIS) to produce poverty maps allows identifying target groups by geographical location, which in terms of poverty reduction and allocation of resources is more efficient and cost-effective than to launch an equally expensive universal distribution programme (Cullis and O'Regan, 2004).

This paper is the result of a case study developed using data provided by a comprehensive management information system carried out by UNICEF for the Turkana District, in Kenya. It is believed that decision-making processes based on information presented in current database are not straightforward. Disparate pieces of information (often correlated) are not adequately integrated, hindering their use for policy and planning purposes. The study is aimed at showing that a post process of available data can produce easy-to-use water poverty maps (where water poverty takes its definition from the WPI), and provide a simple, practical and powerful tool to both support water resource management and effectively tackle water poverty.

Developing a management information system for Turkana District, in Kenya

UNICEF has been working in Turkana District for many years supporting water supply development and management for both refugee populations and local communities. Despite their long term involvement, only few and ineffective attempts existed to compile and record key information relating to water supplies (UNICEF, 2006). As a result, decisions on water development, especially during disaster periods (such as drought or floods), were frequently made in an ad hoc way with no reference to basic sector information.

In recognition of this critical constraint, UNICEF in collaboration with local government authorities launched a thorough water and sanitation assessment and mapping project in Turkana District, aimed at supporting strategic planning in the water sector. The project was based on similar exercises undertaken in other rural districts, namely Mandera, Wajir, Marsabit and Garissa. On the strength and experience of these previous projects, the Turkana District project was designed to collect data on water sources, rural water supply and sanitation service level, and related institutional information for schools and health centres. A second phase (still not implemented) would focus on building the capacity of district actors to operate and use the database for planning and monitoring.

Turkana District

Turkana District is located in Rift Valley Province, and borders on Uganda to the west, Sudan to the north west, Ethiopia to the north east, West Pokot and Baringo Districts to the south west, Samburu District to the south east and Marsabit District to the west (see Figure 1). Administratively, the District is made up of 17 divisions, 58 locations and 158 sub-locations.

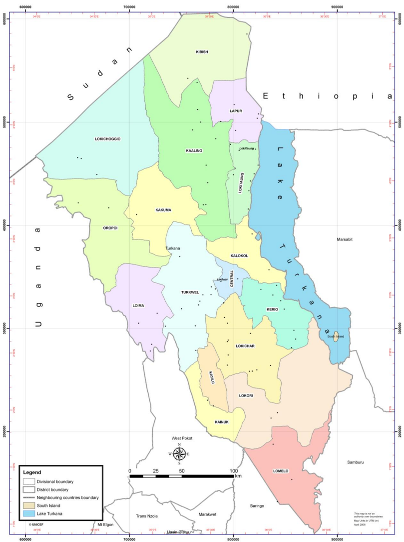

Figure 1. Administrative Boundaries of Turkana District

Source: UNICEF (2006)

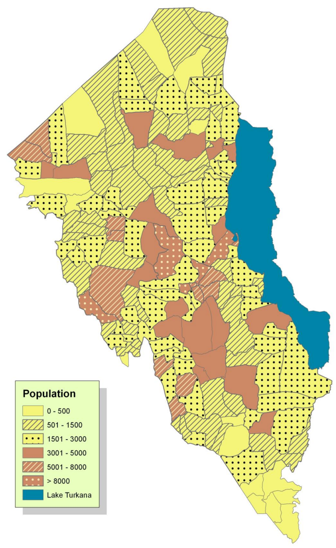

Figure 2. Population at sublocation level

Source: National Census (1999)

The district covers 70,720 km^2 of some of the most arid parts of Kenya, and it is characterised by severe and recurrent droughts. The traditional form of livelihood is nomadic pastoralism, although there is also significant food production along the Turkwel River in the central and southern parts of the District. The total population is estimated at 450,860, according to 1999 National Census (see Figure 2).

Water management information system

Methodology

The 'Water, Schools and Health Management Information System (MIS) for Turkana District' was developed by the Government of Kenya in cooperation with UNICEF as a comprehensive record of all water resources available in the District. Data was collected between November 2005 and January 2006, visiting 644 water sources; 488 rural water supply and sanitation service (RWSS) level points, 225 schools and 66 health facilities.

Relevant data for each source were obtained and entered into a Geographical Information System (GIS). In particular, data regarding each waterpoint (WP) included, among others: (i) geo-referenced position; (ii) capacity; (iii) demand (both domestic and livestock); (iv) quality (salinity, pollution level); (v) operational status; (vi) ownership and management system; etc. On the other hand, information related to RWSS service level was captured through a questionnaire administered at a waterpoint addressing the service level of all those that access the source. Group discussions with key persons and PRA approaches were tools used to determine the relative proportion of population without acceptable level of service (water and sanitation separately). Issues covered were (i) water quality and quantity used for domestic purposes; (ii) service type; (iii) distance to water source; (iv) waiting time; and (v) cost of water. Education and Health sector data has not been included in this analysis.

Main outputs produced

A major risk for data collected throughout the project is to become useless. Information has to be accessible and presented in a user-friendly format to all sector-related stakeholders. Up to date, main outputs produced are: (i) comprehensive database of all waterpoints, where each type of source (e.g. borehole, well, spring ...) is entered on its particular form; (ii) a set of maps, in which main water problems are depicted; and (iii) thematic reports per administrative area.

However, to combine information from different disciplines (e.g. environmental data with system management of water sources) remains elusive in current outputs of database. In consequence, and though data is there, sector decision-makers only use small part of available information.

Mapping the water poverty index

The Water Poverty Index, introduced by Sullivan (2002), is an inter-disciplinary tool that integrates the key issues relating to water resources, aimed at identifying the ability of countries or regions to address their water supply needs. The development of such an index should enable decision makers to identify and track the physical, economic and social drivers which link water and poverty (Sullivan, 2002). The core theoretical framework of the index encompasses physical availability of water resources, extent of access to water, people's ability and capacity for sustaining access, ways in which water is used for different purposes, and the environmental factors which impact on the ecology which water sustains. There is consensus on stating that this multidimensional approach to water poverty assessments appears attractive, and its accuracy has already proved to be meaningful at all different levels: national (Lawrence *et al.*, 2002; Komnenic, 2007), regional (Heidecke, 2006), and local scale (Sullivan *et al.*, 2003; Cullis and O'Regan, 2004).

At the same time, the use of geo-referenced datasets provides a means of integration of data from different sources (Mlote et al., 2002; Sullivan, 2002) at any point on the globe. Mapping thus involves the presentation of certain information in a spatial context, and this enables policy planners to identify the geographic areas and communities in which to focus their efforts for maximum impact (Henninger, 1998). For instance, the use of layering might be used in identifying the underlying causes of water poverty in an area, and provide a practical way for decision makers to (i) identify and target the most water poor communities and to (ii) monitor the impacts and tangible benefits of water supply development policies (Cullis and O'Regan, 2004).

Assessing the water poverty index at Turkana District

In order to assist sector-related stakeholders to tackle water problems at Turkana District, a comprehensive assessment of the situation has been carried out based on the WPI framework. As previously mentioned, data used has been obtained from MIS database, in particular (i) water source audit forms, and (ii) RWSS service level questionnaires.

Since data collection methodology does not allow direct link between these two different information sources at a waterpoint, analysis has been undertaken at sublocation level, which has then been further scaled up to location and division scale. In particular, results of audit forms at waterpoint level have been averaged up to sublocation level. Due to inaccessibility and insecurity in parts of the district some water sources were not audited. On the other hand, the service level was captured through formal and informal survey techniques within beneficiaries, and they were not carried out neither for each water source nor at community level. This methodology resulted in various sub-locations being not covered. In case there was more than one questionnaire per sublocation, they have been weighted by population served to assess service level at this administrative scale. Table 1 shows number of water sources and service level assessed at each administrative scale, being percentage of population excluded of analysis roughly 22%.

Table 1. Number of WP and RWSS Service Level audited

Administrative Scale	Total	WP Audited	RWSS Service Level Audited
Sublocation	158	118	99
Location	58	51	49
Division	17	17	17

Equal to WPI, a number of indicators have been identified to describe each of five components of the index. To each parameter a score between 0 and 1 is assigned, where a value of 0 is assigned to the poorest level, and 1 to optimum conditions. The full description of parameters used and respective levels and scores is briefly discussed below and presented in Tables 2.

The 'Resource' (R) component measures availability of water resources, and since it cannot be determined at household level, lack of relevant data is often a major constraint when the index is applied at this scale. It has thus been assessed through qualitative analysis, averaging three different variables: (i) water quantity sufficiency, which considers if resource availability is enough to cover human and livestock demand; (ii) reliability of supply, meaning period of time system is not operational; and (iii) seasonal resource variability.

The 'Access' (A) variable considers whether or not people have access to safe water and improved sanitation, based on definition provided by the Joint Monitoring Programme (2000). Besides percentage of population accessing basic services, a set of related indicators have also been measured: (i) one way distance to source; (ii) waiting time spent in water collection; (iii) cost of water, as an equity criterion in service provision; and (iv) operational status of the supply.

The 'Capacity' (C) index tries to capture those socio-economic variables which can impact on abilities that communities should have to properly manage water resources. It should also assess adequacy of sector-related institutional framework, though reliable information sources at this scale are often scarce. The legal framework in Kenya (embodied in The Water Act, 2002) vests the responsibility of provision of water and sewerage services in Water Service Providers (namely individuals, communities, private companies, public companies, CBOs or NGOs); who are committed to meet all maintenance costs of water supply facilities. Therefore, local management and ownership of schemes compares favourably with other centralised types of system management. Additional indicators taken into account are related to ability of water entities to oversee operation and management of the supply.

The 'Use' (U) component captures the use communities make of the water, and tries to highlight that water availability for growing food (agriculture) should be as important as for domestic consumption. However, this study focuses on a qualitative assessment of domestic consumption rate. Reports of conflicts over water use are also included as an indicator (Sullivan *et al.*, 2003). In terms of hygienic practices, capacity of beneficiaries to treat water for drinking is as well evaluated.

Table 2. Structure of the Index: variables used, levels and scores

WPI Component	Indicator	Levels & Scores			
		Good	Fair	Acceptable	Risky
Resources	Water Quantity Sufficiency [b]	Always sufficient	For human & livestock	Only for human	Not sufficient for human
	Reliability of supply (% time not operational) [b]	< 5%	5-10%	10-25%	> 25%
	Seasonal variability of water resources (months per year with water) [b]	11-12	9-10	7-8	< 7
Access	Access to safe water [a]	% households with access to improved water supply [1]			
	Access to improved sanitation [a]	% households with access to improved sanitation [2]			
	One way distance to water source [a]	< 1 km	km	Km	> 5km
	Waiting time (minutes) [a]	< 30	30-60	60-120	> 120
	Cost of water (KSh per 20 l container) [a]	< 1	< 2	< 5	> 5
	Operational status of water source [b]	% water sources operational			
Use	Domestic water consumption rate [a]	Ample (>40 lpd)	Basic (20-40 lpd)	Limited (10-20 lpd)	Scarce (<10 lpd)
	Conflict over water sources (Human – Human) [b]	% facilities in conflict			
	Conflict over water sources (Human – Livestock) [b]	% facilities in conflict			
	Use of local water treatment (boil water) [b]	% households who treat water for drinking			
Capacity	Management system [b]	% facilities managed at local level			
	Ownership over water source [b]	% facilities owned at local level			
	Water Association registered [b]	% facilities managed by association legally registered			
	Records kept [b]	% water entities which keep records (minutes, correspondences ...)			
	Financial Control [b]	% water entities with financial control system in place			
	Funds Audited [b]	% water entities whose funds are regularly audited			
Environment	Qualitative assessment of water quality [a]	protected source	Open source but treated	Open source, local treatment	Open source, no treatment
	Protection of water sources [b]	% water facilities protected (fenced)			

	Number of pollution sources (P.S.) around WP [b]	None	1 P.S.	2 P.S.	> 2 P.S.
	Number of environmental impacts (E.I.) around WP [b]	None	1 E.I.	2 E.I.	> 2 E.I.
	Conflict over water sources (Human – Wildlife) [b]	% facilities in conflict			
a) Data from RWSS Service Level b) Data from water sources audit form					

Finally, the 'Environment' (E) component combines a number of environmental indicators which not only cover water quality, but also variables which are likely to impact on ecological integrity (such as environmental degradation, soil erosion...). This variable is calculated on the basis of an average of four different indicators: (i) water quality, as an important factor influencing its availability; (ii) water stress, based on the capacity to prevent water resources from being polluted; (iii) existence of pollutant sources around the waterpoint (human faeces, livestock faeces and rubbish); and (iv) environmental impact assessment, which considers inter alia overgrazing around the source, soil erosion, pest infestation, urban settlement.

Numerically, the WPI is given by (Sullivan, 2002):

$$WPI = (R + A + C + U + E) / 5$$

As seen from previous equation, an additive structure with equal indicator weights is preferred, since there is no evidence that it be otherwise. Likewise, it appears to make the index more transparent and acceptable to different stakeholders and decision-makers.

Developing the water poverty maps

To illustrate the complexity of water issues, a set of water poverty maps have been developed (Figure 3-10). At sublocation scale, Figure 8 shows final index value. However, different but complementary conclusions might be achieved if a thorough analysis is done focussing on the five components of the index (Figure 3-7), which highlights the fact that 'when observed separately the indicators offer a good view of the situation in that field; and when merged into one component, more information may be lost than gained' (Komnenic, 2007). By showing the values of all five components in a visually clear way, it directs attention to those water sector needs that require urgent policy attention.

According to both Table 3 and Figures 3-8, aspects needing special attention by stakeholders and decision-makers are those related to the 'Capacity' and 'Use' components. Thanks to the maps, to identify more risky sublocations is straightforward.

Table 3. Assessment of WPI at sublocation scale (No. of sublocations)

Range	Resources	Capacity	Access	Environment	Use	WPI
< 30%	7 (6%)	40 (35%)	10 (8%)	0 (0%)	27 (23%)	1 (1%)
31 – 50%	11 (10%)	58 (49%)	28 (24%)	15 (13%)	45 (38%)	36 (31%)
51 – 70%	25 (22%)	10 (8%)	55 (47%)	53 (46%)	34 (29%)	69 (58%)
71 – 90%	65 (57%)	5 (4%)	17 (14%)	41 (38%)	6 (5%)	12 (10%)
> 90%	6 (5%)	5 (4%)	8 (7%)	9 (8%)	6 (5%)	0 (0%)
Average	67,6%	39,9%	56,5%	67,7%	45,5%	54,9%
No data	4	0	0	0	0	0

It is evident (based on achieved results) that institutional framework to support communities to operate and maintain water facilities is far from being adequate. The direction to be adopted should be that all water sector actors at local level conduct capacity building through appropriate training so as to enable communities to manage the schemes. At present, few water entities are legally registered, and if registered, they are not able to assume their commitment (in terms of revenue collection, financial control, keeping records ...). Likewise, domestic water consumption is generally poor, and based on assessment of RWSS Service Level, more than 50% of population consumes less than 20 l.p.d. (minimum established by WHO) in 83 out of 99 sublocations.

Similar and more detailed maps could be easily elaborated at location and division scale (Figure 9 and 10).

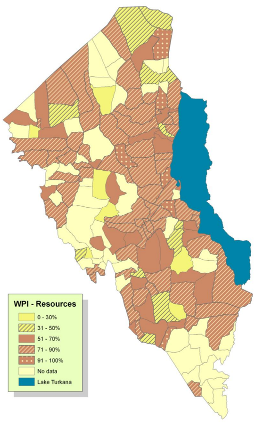

Figure 3. WPI - Resources

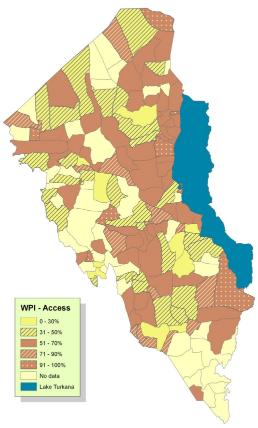

Figure 4. WPI - Access

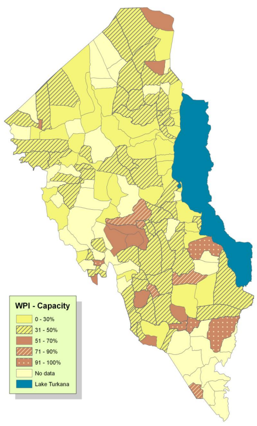

Figure 5. WPI - Capacity

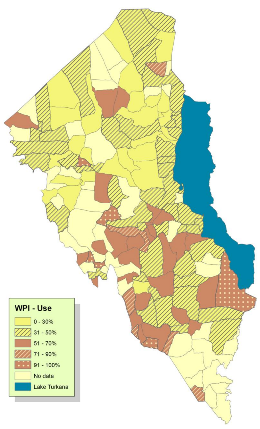

Figure 6. WPI - Use

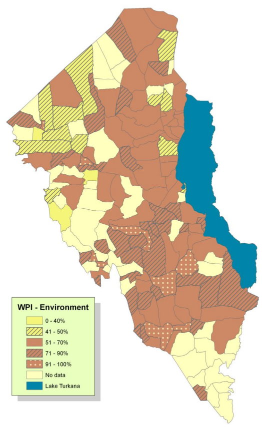

Figure 7. WPI - Environment

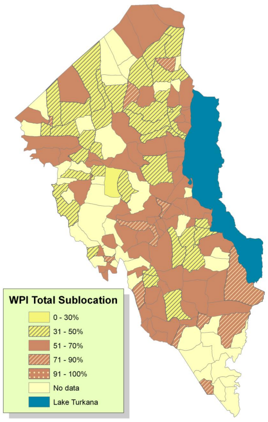

Figure 8. WPI – Total (at Sublocation scale)

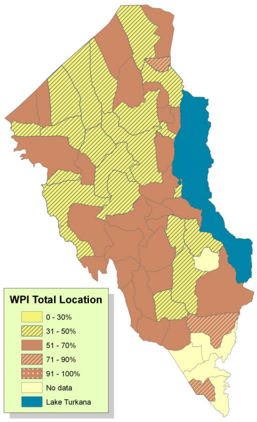

Figure 9. WPI at Location scale

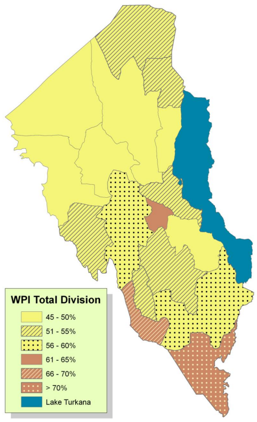

Figure 10. WPI at Division scale

Discussion

Main goal of this paper is not a deep analysis of water problems at a particular location but to underline usefulness of developing a water poverty composite index. It has been demonstrated that it can be a powerful tool with potential for wider implementation in other districts in Kenya, where the Government has launched similar MIS projects. Because of its simplicity, the WPI appeals to policy-makers, since complexities of water situation at a particular location result to be straightforward if represented through water poverty maps. However, the index needs to be advanced from its preliminary application. In this respect, different aspects need to be answered and improved, particularly with regard to the methodology used to construct the index from the set of indicators.

The findings

- Current MIS presents disparate pieces of relevant sector-related information. This hampers the possibility of simultaneously considering a variety of indicators required in decision-making processes, which clearly diminishes the utility of such a thorough database. The integrated nature of the WPI enables more comprehensive understanding of the water management challenge.
- Identifying the water poor through related maps compares favourably with other methods currently used (reports, tables, graphs...). These water poverty maps should be developed at a suitable scale to identify the regions in which sector policies and development will be most effective.
- Composite indices are only as strong as the underlying variables. Current database allows all components of the index to be assessed based on relevant sector-specific indicators (e.g. system management, operational status, water consumption ...), avoiding access to more general information (such as national census) and use of other proxy measures, which are often more inconsistent.
- The advantage of using readily available information is to avoid the expense of having to conduct additional data collection. The database developed by UNICEF would provide the baseline regarding to water poverty situation in the District. In contrast, and in terms of monitoring the sector performance (by updating this database at regular intervals), there is a need to allocate the funds required to instigate the establishment of routine data collection which should be used for this purpose.

Further refinement of the index

- Education and health sector-related data might provide relevant information from a different but complementary point of view. They should be somehow included, proposing new indicators (such as prevalence of water-borne diseases, boys/girls school enrolment as a gender indicator ...)
- Individual indicators have been selected based on available information, and little attention has been paid to the interrelationships between them. It is clear that components should not be highly correlated with each other, and the index should not be highly correlated with any single component. Different analytical approaches should be used to explore whether the variables and indicators are statistically

well-balanced in the aggregated index and is thus meaningful to include them. If they are not, a revision of the sub-indicators might be needed.

- Ideally, weights should reflect the contribution of each indicator and variable to the overall index. Since a composite index does allow for different weights, statistical models could be used to help the assignment process. Alternatively, participatory methods that incorporate various stakeholders could be also promoted. Regardless of the final weights, it should be noted that the information is in the components rather than the final single number, and it is possible that a straight average is as useful as a weighted one.
- Aggregation methods also vary. In a linear or geometric aggregation, weights express trade-offs between indicators. A shortcoming in one dimension thus can be offset by a surplus in another. In case there is a need to assure that weights remain a measure of importance or if different goals are equally legitimate, a non-compensatory logic might be necessary. If it is decided that an increase in economic performance cannot compensate a loss in social cohesion, or a worsening in environmental sustainability, then the linear aggregation is not suitable. A non-compensatory multi-criteria approach could assure non-compensability by finding a compromise between two or more legitimate goals.

Conclusions

In this study the strength of the proposed index was not in prescription of an 'answer to water scarcity', but rather the provision of a transparent and informative decision tool. The paper thus highlights the relevance of the use of an integrated indicator as an effective water management tool in decision making processes. Based on a post process of readily available but sector relevant data, water poverty maps at different scales have been produced. The great advantage is that presented in a user-friendly format, they combine knowledge from both the biophysical and social sciences to produce one single and comparable value. It should enable more comprehensive understanding of the water sector constraints and challenges, and enhance related decision-making processes accordingly.

In future, if the tool prove to be pertinent and sound for policy and planning purposes, similar post-processing could be replicated in other Kenyan districts.

We are aware of major limitations concerning the construction of a composite index: (i) correlation among indicators; (ii) weights assigned to the variables; and (iii) the method of aggregation. A great deal can be done in order to refine the water poverty index.

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Note/s

1 Access to improved water supply means that the main source of drinking water is either from a piped supply, protected well or spring, or rainwater collection (Joint Monitoring Programme, 2000).

2 Access to improved sanitation includes a connection to a public sewer, a connection to a septic tank, a pour-flush latrine, a simple pit latrine or a ventilated improved pit latrine (Joint Monitoring Programme, 2000).

Keywords

water poverty index, water poverty maps, data management tool, Turkana district.

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