SIASAR

Conceptual Model SIASAR 2.0

Version 10.1

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1. Background

SIASAR is an information platform for managing, planning and monitoring the rural water and sanitation sector. In essence, SIASAR is presented as a tool to support decision-making, and is defined by a set of indicators that are aggregated in a reduced number of indices or dimensions.

During 2015 and first half of 2016, the SIASAR team has defined a new conceptual model, with a focus on indicators and indices. This new model has been developed through a participatory process, partially tested in the field, and formally approved by the SIASAR community. During this process, remarkable milestones included i) the organisation of four regional meetings, ii) the elaboration of seven follow-up reports, and iii) the participation in twenty two regional videoconferences. The new SIASAR 2.0 includes a more comprehensive description of the rural water and sanitation service level, based on more reliable and accurate indicators and indices.

Taking SIASAR 1.0 as starting point, the process of re-defining the conceptual framework has focused on i) the identification and definition of indicators, and ii) the conceptualization of the classification rules through the multi attribute utility theory and aggregate indices.

SIASAR 2.0 is based on a set of aggregated indices, as shown in Table 1. The conceptual model is first made up of a battery of indicators (60), classified into 24 components, which in turn are grouped into a reduced number of dimensions (6): i) Water Service Level (WSL), ii) Sanitation and Hygiene Service Level (SHL), iii) Schools and Health Centres - WaSH (SHC), iv) Water System Infrastructure (WSI), v) Service Provision (SEP), and vi) Technical Assistance Provision (TAP). At a higher level, these dimensions are aggregated in two sub-indices: i) Water, Sanitation and Hygiene Service Level Index (WSHL), and ii) Water Services Sustainability Index (WSSI). These two partial indices generate a final aggregated index: the Water and Sanitation Performance Index (WSP). Furthermore, the conceptual model incorporates two complementary indices, providing additional and useful information: i) Lack of Components Index (LOC), and ii) Low Performance Components Index (LPC).

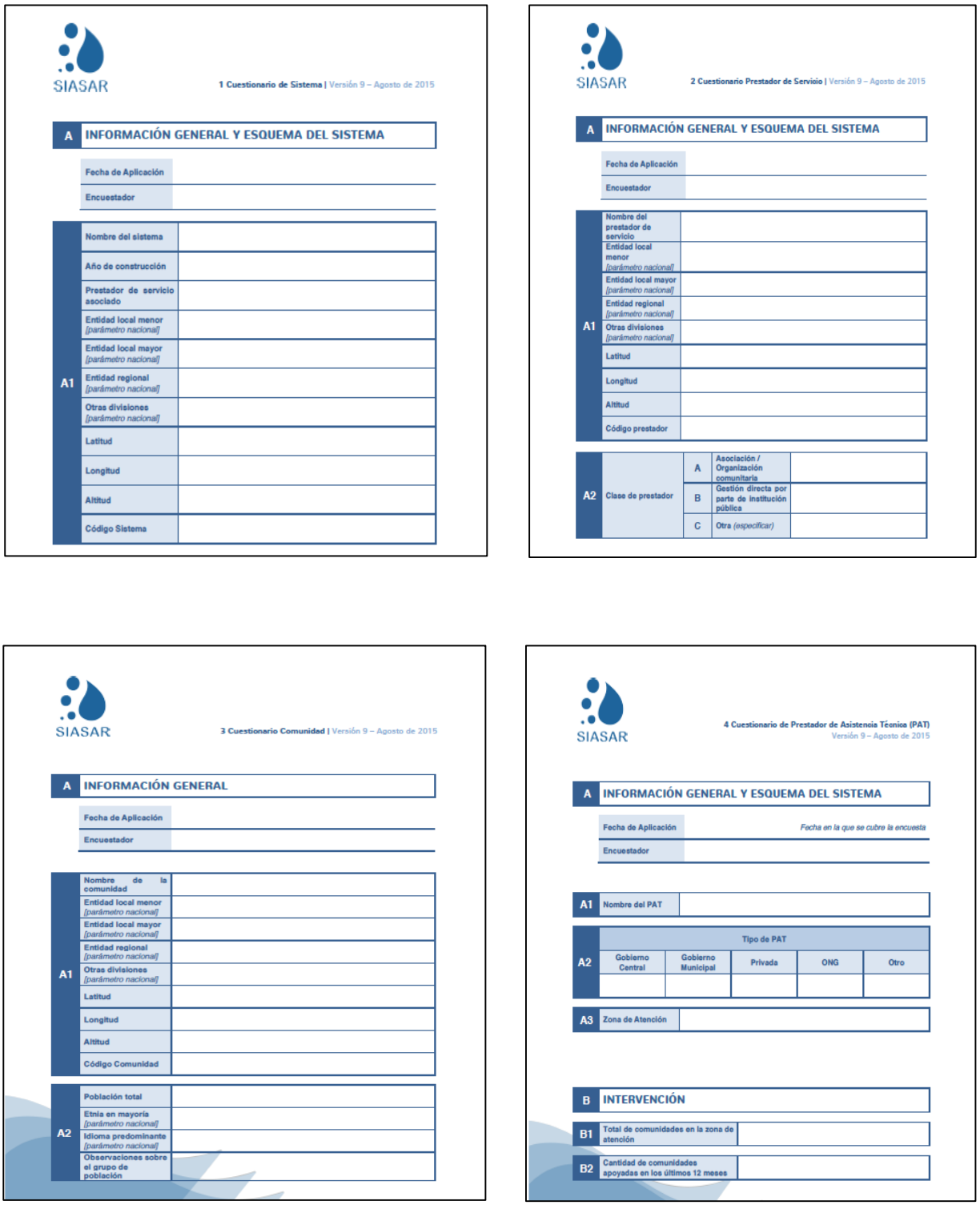
Water and Sanitation Performance index for rural communities (WSP)	
Water, Sanitation and Hygiene service Level Index (WSHL)	**Water Services Sustainability Index (WSSI)**
Water Service Level (WSL)	**Water System Infrastructure (WSI)**
Accessibility (ACC) Continuity (CON) Seasonality (SEA) Quality (QUA)	System Autonomy (AUT) Production Infrastructure (INF) Water Catchment Area Protection (PRO) Treatment system (TRE)
Sanitation and Hygiene Service Level (SHL)	**Service Provision (SEP)**
Sanitation Service Level (SSL) Personal Hygiene (PER) Household Hygiene (WAT) Community Hygiene (COM)	Organization (ORG) Operation & Maintenance (OPM) Economic Management (ECO) Environmental Management (ENV)
Schools and Health Centres (SHC)	**Technical Assistance Provision (TAP)**
Water Supply in Schools (SWA) Water Supply in Health Centres (HWA) Sanitation and Hygiene in Schools (SSH) Sanitation and Hygiene in Health Centres (HSH)	Information Systems (ICT) Institutional Capacity (INS) Community Coverage (COV) Assistance Intensity (INT)

Table 1 General Index, Partial Indices, Dimensions and Components of SIASAR 2.0 conceptual model.

All information is collected through four questionnaires that analyze the level of service from different perspectives: i) the community, ii) the water system, iii) the service provision, and iv) the technical assistance provision (see Figure 2). The proposed conceptual model:

i) *provides a detailed perspective of different aspects concerning water and sanitation services.* Information is structured to allow an easy interpretation and avoid misleading messages, as well as

ii) *defines methodologies to aggregate the information in thematic indices*. Robust methodologies are in place to properly combine all the information in a short battery of aggregated indices. To avoid wrong results, it is important to employ robust, reliable and transparent methods in index construction.



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1 Cuestionario de Sistema | Versión 9 – Agosto de 2015

A INFORMACIÓN GENERAL Y ESQUEMA DEL SISTEMA

Fecha de Aplicación	
Encuestador	

A1	Nombre del sistema	
	Año de construcción	
	Prestador de servicio asociado	
	Entidad local menor *[parámetro nacional]*	
	Entidad local mayor *[parámetro nacional]*	
	Entidad regional *[parámetro nacional]*	
	Otras divisiones *[parámetro nacional]*	
	Latitud	
	Longitud	
	Altitud	
	Código Sistema	

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2 Cuestionario Prestador de Servicio | Versión 9 – Agosto de 2015

A INFORMACIÓN GENERAL Y ESQUEMA DEL SISTEMA

Fecha de Aplicación	
Encuestador	

A1	Nombre del prestador de servicio	
	Entidad local menor *[parámetro nacional]*	
	Entidad local mayor *[parámetro nacional]*	
	Entidad regional *[parámetro nacional]*	
	Otras divisiones *[parámetro nacional]*	
	Latitud	
	Longitud	
	Altitud	
	Código prestador	

A2	Clase de prestador	A	Asociación / Organización comunitaria
		B	Gestión directa por parte de institución pública
		C	Otra *(especificar)*

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3 Cuestionario Comunidad | Versión 9 – Agosto de 2015

A INFORMACIÓN GENERAL

Fecha de Aplicación	
Encuestador	

A1	Nombre de la comunidad	
	Entidad local menor *[parámetro nacional]*	
	Entidad local mayor *[parámetro nacional]*	
	Entidad regional *[parámetro nacional]*	
	Otras divisiones *[parámetro nacional]*	
	Latitud	
	Longitud	
	Altitud	
	Código Comunidad	

A2	Población total	
	Etnia en mayoría *[parámetro nacional]*	
	Idioma predominante *[parámetro nacional]*	
	Observaciones sobre el grupo de población	

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4 Cuestionario de Prestador de Asistencia Técnica (PAT)
Versión 9 – Agosto de 2015

A INFORMACIÓN GENERAL Y ESQUEMA DEL SISTEMA

Fecha de Aplicación		*Fecha en la que se cubre la encuesta*
Encuestador		

A1	Nombre del PAT	

	Tipo de PAT				
A2	Gobierno Central	Gobierno Municipal	Privada	ONG	Otro

A3	Zona de Atención	

B INTERVENCIÓN

B1	Total de comunidades en la zona de atención	
B2	Cantidad de comunidades apoyadas en los últimos 12 meses	

Figure 1 SIASAR questionnaires for data collection. From up to down, and left to right: 1. System, 2. Service Provision, 3. Community and 4. Technical Service Provision.

2. SIASAR 2.0 Conceptual Model

Dimensions	Components	Indicators
WSL. Water Service Level	WSL.ACC: Accessibility	Improved water supply coverage Access time
	WSL.CON: Continuity	Service hours per day
	WSL.SEA: Seasonality	Minimum supply during the year
	WSL.QUA: Quality	Physiochemical quality Bacteriological quality
SHL. Sanitation and Hygiene Service Level	SHL.SSL: Sanitation Service Level	T1 / T2 improved sanitation coverage Own / Shared improved sanitation coverage
	SHL.PER: Personal Hygiene	All household members hand-washing Partial household members hand-washing Improved sanitation use
	SHL.WAT: Household Hygiene	Household safety water management
	SHL.COM: Community Hygiene	Garbage collection or treatment Household open defecation
EHC. Schools and Health Centres	EHC.SWA: Water Supply in Schools	Water service level
	EHC.HWA: Water Supply in Health Centres	Water service level
	EHC.SSA: Sanitation in Schools	Sanitation service level - Student body Sanitation service level - Staff Hygiene service level - Student body Hygiene service level - Staff
	EHC.HSA: Sanitation in Health Centres	Sanitation service level - User Sanitation service level - Staff Hygiene service level - User Hygiene service level - Staff
WSI. Water System Infrastructure	WSI.AUT: System Autonomy	Service days without production
	WSI.INF: Production Infrastructure	Catchment area status Conduction status Storage status Distribution status
	WSI.PRO: Water Catchment Area Protection	Catchment protection area status
	WSI.TRE: Treatment System	Treatment system typology Treatment system functioning Chlorine disinfection

SEP. Service Provision	SEP.ORG: Organization Management	Legalization and directive structure Ordinary operation Equity within the organization Economic management and accountability
	SEP.OPM: Operation & Maintenance Management	O&M general assessment Basic operation with chlorine O&M Regulation Operative micro-reading coverage
	SEP.ECO: Economic Management	Collection efficiency rate Cost coverage rate Liquid assets rate Billing efficiency rate Solvency rate Debt service coverage rate
	SEP.ENV: Environmental Management	Catchment area preventive measures Catchment area corrective measures Environmental sanitation promotion
TAP. Technical Assistance Provision	TAP.ICT: Information Systems	Computer equipment Internet access
	TAP.INS: Institutional Capacity	Transport equipment Water quality measurement equipment Technicians / Community rate Economic resources
	TAP.COV: Community Coverage	Supported communities percentage
	TAP.INT: Intensity of Assistance	Technical assistance typologies Technical assistance concentration

Table 2 SIASAR 2.0: Dimensions, Components and Indicators.

3. Constructing SIASAR 2.0 Conceptual Model

In index construction, several decisions are required which may have an impact on the final values, such as: i) the definition of utility functions, ii) the technique for weight assignment, iii) the aggregation method, and iv) the methodology for classifying communities in A - B - C - D. In following sections, main considerations for each of these four stages are summarized.

3.1. Definition of utility functions

A utility function assigns numeric values ("utility") to the data collected with SIASAR questionnaires. The indicators selected for aggregation convey at this stage quantitative information of different kinds. Some indicators can be incommensurate with others, and have different measurement units. Therefore, to avoid "*adding up apples and pears*", before going to the aggregation stage it is necessary to bring the indicators to the same standard, by transforming them in pure, dimensionless, numbers.
In the process of defining SIASAR 2.0 utility functions, special attention was paid to the following aspects:

- defining simple utility functions (easy to calculate and easy to explain);
- defining functions that allow adequate discrimination of different situations; and
- normalizing the functions within the range 0 to 1 (both inclusive).

It is important to note that different normalization methods will supply different results for the composite indicator. Therefore, overall robustness tests should be carried out to assess their impact on the outcomes. A detailed description of each utility function can be consulted in Annex I.

3.2. Technique for weight assignment

The different techniques for weight assignment seek to quantify the relative importance of a criterion or a variable against another in a given context. In this sense, components, dimensions and partial indices of the conceptual model should undergo this process. In SIASAR 2.0, two different techniques were compared: i) equal weights, and ii) weights based on expert opinion (see Annex II).

Based on the results from this analysis, SIASAR 2.0 conceptual model employs **equal weights for each of the components** that construct the 6 existing dimensions. This technique offers various advantages, such as i) greater transparency when dealing with index construction, ii) greater simplicity, and iii) increased facility to interpret obtained results.

Similarly, SIASAR 2.0 assigns **equal weights to dimensions** in order to build both partial indices (WSHL and WSSI), and also when constructing the general index (WSP), i.e. **both partial indices** have **same relative importance**.

3.3. Aggregation method

In the aggregation process, two different methodologies were compared: i) additive aggregation, and ii) geometric aggregation. Major virtues of an additive approach are simplicity, transparency, and ease of understanding for non-experts. However, in linear aggregation rules, compensability among the different individual indicators is implicit. Obviously, a complete compensability is not desirable when different goals are equally legitimate, and then a non-compensatory logic might be necessary. In this respect, the use of a geometric aggregation might be a potential solution.

Based on the results provided in Annex III, SIASAR 2.0 conceptual model opts for an **additive aggregation** (compensatory) of the **4 components** to construct each dimension. However, **partial and general indices** construction is implemented through a **geometric function**.

3.4. Classification methodology

In the classification of indicators (the A - B - C - D methodology), two alternatives were compared: i) different intervals, and ii) equal intervals (see Annex IV).

SIASAR 2.0 conceptual model opts for employing **different intervals**, as shown below.

	D	C	B	A
Intervals	0 - 0.40	0.40 - 0.70	0.70 - 0.90	0.90 - 1

Each alternative produce significantly different results. However, the selected alternative imposes more strict requirements to achieve "good" or "top" ratings. Although it might be conceptually less simple, this classification method facilitates the definition of higher levels of service, which is considered as a positive factor for the sector.

4. SIASAR 2.0 Complementary Indices

The overall SIASAR index has a great potential to compare a complex reality that depends on multiple elements (water service level, water system infrastructure, service and technical assistance provision performance, sanitation and hygiene service level, etc.), which in turn are composed by several indicators or variables. In the aggregation process, however, certain detail of analysis is lost. It is therefore necessary to analyse disaggregated information to support decision-making processes or design corrective actions.

In addition, a lack of information to calculate any of the 24 components hampers the construction of indices, and therefore it would not be possible to compute a WSP value. Alternatively, other global measurements may be required, and two complementary indices are proposed for this purpose. These new indices:

- should be calculated for all types of communities (even if they do not have some components);
- should be useful for sectorial planning;
- should be useful for SIASAR self-management;
- should not be measurements of “central tendency” but "lack-of-performance" ones. These measurements would be useful to identify those sector needs that require special policy attention when comparing different criteria against a threshold value.

4.1. Lack of Components Index (LOC)

This first complementary index represents the proportion of components, regarding the general index WSP, whose information is not available.

Thus, a null value (LOC = 0) means that all dimensions can be calculated based on available data and a WSP value can be computed. A LOC value other than zero is associated with situations where no data is available and thus a WSP value cannot be obtained.

4.2. Low Performance Components Index (LPC)

The second complementary index is the proportion of components, regarding the general index WSP, whose values do not exceed a threshold value.

This measurement includes, in addition to the above, the comparison of each community component with a threshold value (which might be a fixed one or relative to the country context). The interpretation of this index value is carried out in conjunction with LOC index:

- If LOC = 0, a score for WSP will be obtained, representing the average value assigned as described above. In this case, LPC index measures the proportion of components of WSP which do not reach half of the reference performance (average value) of a particular country. The value of LPC is shown as a percentage of low performance components;
- If LOC > 0, although the value of WSP cannot be calculated, it exists the possibility to assess which components present a low performance. The meaning of LPC is the same, considering that, if any component is unknown (missing data), it is recorded as pending to reach the average value. From an interpretative point of view, LPC does not offer only a measure based on what is known (as in the case known values were compared with reference ones), but includes in its measure what is needed to know.

5. Synthesis

This section presents all indices discussed previously. Considering the structure of the utility functions detailed in Annex I, the expressions that define each dimension, partial and general indices entail equal weights. Aggregation methods include additive aggregation at the dimension level and geometric aggregation to construct partial and general indices. In terms of results dissemination, indices would be classified according to the SIASAR A - B - C - D methodology, and based on different intervals.

Water and Sanitation Performance index for rural communities (WSP)

$$IAS = \prod_{i,j=0}^{i,j=1} x_j^{p_j} = (WSHL * WSSI)^{1/2}$$

Water, Sanitation and Hygiene service Level Index (WSHL)

$$WSHL = \prod_{i,j=0}^{i,j=1} x_j^{p_j} = (WSL * SHL * SHC)^{1/3}$$

Water Service Level (WSL)

$$WSL = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(ACC + CON + SEA + QUA)}{4}$$

ACC - Accessibility

CON - Continuity

SEA - Seasonality

QUA – Quality

Sanitation and Hygiene Service Level (SHL)

$$SLH = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(SSL + PER + WAT + COM)}{4}$$

SSL - Sanitation Service Level

PER - Personal Hygiene

WAT - Household Hygiene

COM - Community Hygiene

Schools and Health Centres (SHC)

$$SHC = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(SWA + HWA + SSH + HSH)}{4}$$

SWA - Water Supply in Schools

HWA – Water Supply in Health Centres

SSH - Sanitation and Hygiene in Schools

HSH – Sanitation and Hygiene in Health Centres

Water Services Sustainability Index (WSSI)

$$WSSI = \prod_{i,j=0}^{i,j=1} x_j^{p_j} = (WSI * SEP * TAP)^{1/3}$$

Water System Infrastructure (WSI)

$$WSI = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(AUT + INF + PRO + TRE)}{4}$$

AUT- System Autonomy

INF - Production Infrastructure

PRO - Water Catchment Area Protection

TRE - Treatment system

Service Provision - SEP

$$SEP = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(ORG + OPM + ECO + ENV)}{4}$$

ORG - Organization Management

OPM - Operation & Maintenance Management

ECO - Economic Management

ENV - Environmental Management

Technical Assistance Provision (TAP)

$$TAP = \sum_{i,j=0}^{i,j=1} x_i . p_j = \frac{(ICT + INS + COV + INT)}{4}$$

ICT - Information Systems

INS - Institutional Capacity

COV - Community Coverage

INT - Assistance Intensity

Annex I: Utility Functions

SIASAR 2.0 Conceptual Model

SIASAR 2.0: Utility functions

In this Annex, utility functions, corresponding to those indicators detailed in Table 2 (Section 2), are defined. For each utility function, information source is indicated by using questionnaire code (COM, SYS, SEP, TAP) and question number.

1. Water Service Level (WSL)

The necessary information comes mainly from the **System** (SYS) entity. Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated. **Exceptions**: Total number of households and number of households with no water system, specified in the Community (COM) survey.

WSL.ACC: Accessibility

Information sources

- Households without system: COM_A6
- Total number of households: COM_A4
- Average distance to public standpipes: SYS_F3

Utility function

F(x)	0	Linear variation	1
Effective coverage: Coverage * Accessibility factor	Coverage = 0	[(total households - households without system) / total households] * Accessibility factor Acc. fact. = 1 (if average dist. ≤ 100 m) Acc. fact. = 2/3 (if average dist. > 100 m)	Coverage = 1 Average distance < 100 m

- Coverage is defined as the ratio of the number of households using improved water to the total number of households in the community
- In the case where all the houses have a connection to the distribution network, the accessibility will be equal to 1.
- In cases where there is a multiple relationship between systems and communities, coverage is calculated as the population-weighted average served by each system in each community

WSL.CON: Continuity

Information sources

- Service hours per day: SYS_F1.2

Utility function

F(x)	0	Linear variation	1
Service hours per day	0 hours	Service hour per day / 24	24 hours

WSL.SEA: Seasonality

Information sources

- Water flow: SYS_G1
- Enough water at source level to meet demand during dry season: SYS_A6.1
- Enough water at source level to meet demand during rainy season: SYS_A6.2
- Total population: COM_A3.1
- Total number of households: COM_A4
- Number of households served by each System - Provider: COM_A5

Utility function

Attached Table summarizes utility assignment. The theoretical demand D_t (litres / min) is defined as the reference endowment for the number of inhabitants supplied by the system in a period of 24 hours. For each person, the standard of 80 litres per day is considered (WHO, 2003) [1].

F(x)	0	0.33	0.66	1
Seasonality	Dt > Q system	Dt < Q system NOT enough water during dry AND rainy seasons	Dt < Q system NOT enough water during dry season OR rainy season	Dt < Q system Enough water during dry AND rainy seasons

- To obtain the number of inhabitants served by the system, the average number of inhabitants per family (total population / total number of households) will be obtained and multiplied by the number of households served by the system.

[1] World Health Organization (WHO). 2003. *Domestic Water Quantity, Service, Level and Health*. Geneva, Switzerland.

- For systems that supply several communities, all served households by the system are added, even if they come from different communities.

WSL.QUA

Information sources

- Date of analysis: SIS_G4.1
- Bacteriological: SIS_G4.2
- Physiochemical: SIS_G4.3

Utility function

F(x)	0	0.33	0.66	1
Water quality	No date of analysis AND both answers with "NO INFORMATION" Date of analysis AND both tests with "UNACCEPTABLE VALUES"	Date of analysis AVAILABLE At least, 1 of the 2 tests is done and with "ACCEPATABLE VALUES" (the remaining with "NO INFORMATION")	Both tests are done. 1 gets "ACCEPTABLE VALUES" (the remaining NO)	Both tests are done. Both get "ACCEPTABLE VALUES"

- For systems that supply several communities, all served households by the system are added, even if they come from different communities.

2. Sanitation and Hygiene Service Level (SHL)

The necessary information comes from the **Community** entity (COM). Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated.

SHL.SSL: Sanitation Service Level

Information sources

- Total number of households: COM_A4

  Note: If COM_B1.3 is equal to "YES", use COM_B1.4 instead of COM_A4

- Number of households that **HAVE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 1**): COM_B2.1
- Number of households that **HAVE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 2**): COM_B2.2
- Number of households that **USE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.1 / COM_B3.3
- Number of households that **USE** a **SHARED IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.2 / COM_B3.4

Utility function

The utility function is defined as the arithmetic mean of the two criteria presented in attached Table. This defines the average utility, considering different utilities depending on the type of sanitation: Value "1" for sanitation type 1 and value "0.5" for sanitation type 2. Likewise, it penalizes the use of shared improved sanitation (type 1 and type 2) in relation to the use of own sanitation.

F(x)	0	Linear variation	1
Improved sanitation service level	0	(Num. HH. Type 1 + 0.5 * Num. HH. Type 2) / Total number of households	1
Own sanitation coverage	0	(Num. HH. OWN USE + 0.5 * Num. HH. SHARED USE) / Total number of households with OWN improved sanitation	1

SHL.PER: Personal Hygiene

Information sources

- Total number of households: COM_A4

  Note: If COM_B1.3 is equal to "YES", use COM_B1.4 instead of COM_A4

- Number of households with a basic hand washing facility near the sanitation facility: COM_B5.1
- Number of households in which **ALL** members always **USE** the hand washing facility: COM_B5.2
- Number of households that ALL members **ALWAYS USE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.3
- Number of households that ALL members **ALWAYS USE** a **SHARED IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.4
- Number of households that HAVE their OWN improved sanitation infrastructure (**TYPE 1**): COM_B2.1
- Number of households that **HAVE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 2**): COM_B2.2
- Number of households that **HAVE** a **DIFFERENT UNIMPROVED** type of sanitation infrastructure of their **OWN**: COM_B2.3

Utility function

The utility function is defined as the arithmetic mean of the two criteria presented in attached Table. In both, the average utility is calculated in relation to the total number of households in the community. The utility per household varies according to its situation in relation to the criterion.

F(x)	0	Linear variation	1
Personal Hygiene	0	(Num. HH all use HW facility + 0.5 * (Num. HH have HW facility - Num. HH all use HW facility)) / Total number of households	1
Use of sanitation	0	(Num. HH all use OWN IMPROVED + Num. HH all use OWN SHARED) / Total number of households with access to sanitation (type 1, type 2 and unimproved)	1

SLH.WAT: Household Hygiene

Information sources

- Total number of households: COM_A4

  Note: If COM_B1.3 is equal to "YES", use COM_B1.4 instead of COM_A4

- Number of households in which drinking water is safely stored: COM_B5.3

Utility function

The utility function is defined in attached Table.

F(x)	0	Linear variation	1
Safely stored drinking water	Safely stored = 0	Safely stored / Total number of households	Safely stored = Total number of households

SLH.COM: Community Hygiene

Information sources

- Total number of households: COM_A4
- **Note:** If COM_B1.3 is equal to "YES", use COM_B1.4 instead of COM_A4
- Number of households that collect or dispose their solid waste: COM_B6.2
- Number of households that ALL members **ALWAYS USE** their **OWN IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.3
- Number of households that ALL members **ALWAYS USE** a **SHARED IMPROVED** sanitation infrastructure (**TYPE 1 OR 2**): COM_B3.4
- Number of households that ALL members **ALWAYS USE** an **UNIMPROVED** sanitation infrastructure: COM_B4.2

Utility function

The utility function is defined as the arithmetic mean of the two criteria presented in attached Table. The second one depends on the following values:

- Open Defecation (OD, Number of households practising open defecation - all members or not all of them) = COM_A4 - COM_B3.3 - COM_B3.4 - COM_B4.2

F(x)	0	Linear variation	1
Solid waste collection or disposal	Solid waste collection or disposal = 0	Solid waste collection or disposal / Total number of households	Solid waste collection or disposal = Total number of households
Absence of open defecation	OD = Total number of households	1 – (OD / Total number of households)	OD = 0

3. Schools and Health Centres (EHC)

The necessary information comes from the **Community** entity (COM). Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated.

EHC.SWA: Water Supply in Schools

Information sources

- Student body (total number of female and male students): COM_C2.5 + COM_C2.6
- Number of schools in community: COM_C2
- Associated water system: COM_C3.1

Utility function

The utility function is the weighted average per served student body in community schools, according to the individual utility assigned in attached Table.

F(x)	0	0.33	0.66	1
Water service level	No	Yes, but does NOT work	Functional but cannot meet periods of high demand (+ 15 min queuing)	Capacity to meet demand

EHC.HWA: Water Supply in Health Centres

Information sources

- Average number of health system users (total number of female and male users): COM_D2.5 + COM_D2.6
- Number of health centres in community: COM_D2
- Associated water system: COM_D3.1

Utility function

The utility function is the weighted average per served users by the community health system, according to the individual utility assigned in attached Table.

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F(x)	0	0.33	0.66	1
Water service level	No	Yes, but does NOT work	Functional but cannot meet periods of high demand (+ 15 min queuing)	Capacity to meet demand

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EHC.SSA: Sanitation in Schools

Information sources

- Teaching and Administrative Staff (total number of female and male teachers and employees): COM_C2.3 + COM_C2.4
- Student body (total number of female and male students): COM_C2.5 + COM_C2.6
- Number of sanitation and hygiene infrastructures (staff): COM_C4.1, C4.2, C4.3
- Number of sanitation and hygiene infrastructures (student body): COM_C4.4, C4.5, C4.6

Utility functions

The utility function is the arithmetic mean of the two criteria presented in the attached Tables. In relation to sanitation, three indicators are defined and the arithmetic mean is calculated. A ratio of 1 improved latrine for 10 workers and 1 improved latrine for 50 students[2] is set as optimal utility. Depending on the type of sanitation, different utilities are assigned. In relation to personal hygiene, the utility function is the arithmetic mean of the two criteria presented. A ratio of 1 basic hand washing facility for 20 workers and 1 basic installation for 100 students[3] is set as optimal utility.

- $T1_{TAS}$;$T2_{TAS}$: type 1 and 2 sanitation infrastructure used by teaching and administrative staff
- $T1_{EB}$;$T2_{EB}$: type 1 and 2 sanitation infrastructure used by student body
- IBL_{TAS}: basic hand washing facility used by teaching and administrative staff
- IBL_{EB}: basic hand washing facility used by student body

Utility function: Improved sanitation service level in Schools

F(x)	0	Linear variation	1
Improved sanitation coverage (student body)	$T1_{EB} = 0$ AND $T2_{EB} = 0$	$\frac{50 \cdot (T1_{EB} + 0.5 \cdot T2_{EB})}{\text{Total number students}}$	$T1_{EB} + 0.5 * T2_{EB} \geq$ (Tot. num. students / 50)
Improved sanitation coverage (female students)	$T1_{EB,\ feminine} = 0$ AND $T2_{EB,\ feminine} = 0$	$\frac{50 \cdot (T1_{EB,fem} + 0.5 \cdot T2_{EB,fem})}{\text{Total number female students}}$	$T1_{EB,\ fem} + 0.5 * T2_{EB,\ fem} \geq$ (Tot. num. female students / 50)
Improved sanitation coverage (staff)	$T1_{TAS} = 0$	$\frac{10 \cdot (T1_{TAS} + 0.5 \cdot T2_{TAS})}{\text{Staff}}$	$T1_{TAS} + 0.5 * T2_{TAS} \geq$ (Staff / 10)

[2] The proposed reference value is to be adjusted and validated. There are other proposals as the one reflected in "Normas sobre agua, saneamiento e higiene para escuelas en contextos de escasos recursos" (OMS, 2010).

[3] The proposed reference value is to be adjusted and validated.

	AND $T2_{TAS} = 0$		

Utility function: Hygiene service level in Schools

F(x)	0	Linear variation	1
Hand washing facility coverage (student body)	$IBL_{EB} = 0$	$(IBL_{EB} * 100)$ / Tot. num. students	$IBL_{EB} \geq$ (Tot. num. students / 100)
Hand washing facility coverage (staff)	$IBL_{TAS} = 0$	$(IBL_{TAS} * 20)$ / Staff	$IBL_{TAS} \geq$ (Staff / 20)

EHC.HSA: Sanitation in Health Centres

Information sources

- Medical and Administrative Staff (total number of female and male teachers and employees): COM_D2.3 + COM_D2.4
- Average number of health system users (total number of female and male users): COM_D2.5 + COM_D2.6
- Number of sanitation and hygiene infrastructures (staff): COM_D3.1, D3.2, D3.3
- Number of sanitation and hygiene infrastructures (users): COM_D3.4, D3.5, D3.6

Utility functions

The utility function is the arithmetic mean of the two criteria presented in the attached Tables. In relation to sanitation, three indicators are defined and the arithmetic mean is calculated. A ratio of 1 improved latrine for 10 workers and 1 improved latrine for 30 health system users[4] is set as optimal utility. Depending on the type of sanitation, different utilities are assigned. In relation to personal hygiene, the utility function is the arithmetic mean of the two criteria presented. A ratio of 1 basic hand washing facility for 20 workers and 1 basic installation for 60 users[5] is set as optimal utility.

- $T1_{MAS}$;$T2_{MAS}$: type 1 and 2 sanitation infrastructure used by medical and administrative staff
- $T1_{HSU}$;$T2_{EB}$: type 1 and 2 sanitation infrastructure used by health system users
- IBL_{MAS}: basic hand washing facility used by medical and administrative staff
- IBL_{HSU}: basic hand washing facility used by health system users

[4] The proposed reference value is to be adjusted and validated.

[5] The proposed reference value is to be adjusted and validated.

Utility function: Improved sanitation service level in Health Centres

F(x)	0	Linear variation	1
Improved sanitation coverage (health system users)	$T1_{HSU} = 0$ AND $T2_{HSU} = 0$	$\frac{30 \cdot (T1_{HSU} + 0.5 \cdot T2_{HSU})}{\text{Total number users}}$	$T1_{HSU} + 0.5 * T2_{HSU} \geq$ (Tot. num. users / 50)
Improved sanitation coverage (female users)	$T1_{HSU, feminine} = 0$ AND $T2_{HSU, feminine} = 0$	$\frac{30 \cdot (T1_{HSU,fem} + 0.5 \cdot T2_{HSU,fem})}{\text{Total number female users}}$	$T1_{HSU, fem} + 0.5 * T2_{HSU, fem} \geq$ (Tot. num. female users / 50)
Improved sanitation coverage (staff)	$T1_{MAS} = 0$ AND $T2_{MAS} = 0$	$\frac{10 \cdot (T1_{MAS} + 0.5 \cdot T2_{MAS})}{\text{Staff}}$	$T1_{MAS} + 0.5 * T2_{MAS} \geq$ (Staff / 10)

Utility function: Hygiene service level in Health Centres

F(x)	0	Linear variation	1
Hand washing facility coverage (users)	$IBL_{HSU} = 0$	$(IBL_{HSU} * 60)$ / Tot. num. students	$IBL_{HSU} \geq$ (Tot. num. students / 60)
Hand washing facility coverage (staff)	$IBL_{MAS} = 0$	$(IBL_{MAS} * 20)$ / Staff	$IBL_{MAS} \geq$ (Staff / 20)

4. Water System Infrastructure (WSI)

The necessary information comes mainly from the System (SYS) entity. Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated. **Exception**: Number of households served by each System - Provider, specified in the Community (COM) survey.

WSI.AUT: System Autonomy

Information sources

- Storage infrastructure capacity: SIS_E1.2
- Number of households served by each System - Provider: COM_A5

Utility function

The attached Table summarizes the utility assignment to determine the days of autonomy of the storage infrastructure, according to the comparison of the real storage capacity (volume) with the theoretical volume demanded by the users. As reference, 80 litres per day per person are considered[6].

If the storage infrastructure has autonomy of one day or more, the function takes the value "1". Otherwise, a continuous distribution function between "0" and "1" is obtained.

F(x)	0	Linear variation	1
Days of autonomy	Real volume = 0	Real volume / Theoretical volume	Real volume ≥ Theoretical volume

- To obtain the number of inhabitants demanding water from the system, the average number of inhabitants per family (total population / total number of households) will be obtained and multiplied by the number of households served by the system.
- For systems that supply several communities, all served households by the system are added, even if they come from different communities.

WSI.INF: Production Infrastructure

Information sources

- Water source and/or Catchment: SIS_B3, SIS_B4
- Water main: SIS_C1, SIS_ C2
- Storage infrastructure: SIS_E1, SIS_E2
- Distribution: SIS_F3

[6] World Health Organization (WHO). 2003. *Domestic Water Quantity, Service, Level and Health*. Geneva, Switzerland.

Utility function

The attached Tables summarize the utility assignment of the production system four components. For each part, if there are several entries, the arithmetic mean of the utilities is done. **The utility function is the geometric mean of the existing parts**.

F(x)	0	0.33	0.66	1
Water source and/or catchment infrastructure physical condition	D (Poor)	C (Deficient)	B (Acceptable)	A (Good)

F(x)	0	0.33	0.66	1
Water main physical condition	D (Poor)	C (Deficient)	B (Acceptable)	A (Good)

F(x)	0	0.33	0.66	1
Cleaning frequency	> 12 months	6 - 12 months	2 - 6 months	Monthly
Storage infrastructure physical condition	D (Poor)	C (Deficient)	B (Acceptable)	A (Good)

F(x)	0	0.33	0.66	1
Distribution physical condition	D (Poor)	C (Deficient)	B (Acceptable)	A (Good)

WSI.PRO: Water Catchment Area Protection

Information sources

- Status of the area near the source or water system intake: SIS_B2

Utility function

The utility assignment is presented in attached Table. It is the ratio between the answers, corresponding to the positive situation of each question, and the total answers (except NOT APPLICABLE). Positive rating: YES "Green or wooded areas"; NO "Eroded areas"; YES "Area protection (fences)"; NO "Contamination by solid waste"; NO "Chemical contamination".

F(x)	0	Linear variation	1
Status of the protection area	Applicable criteria with NO POSITIVE answers OR NO APPLICABLE criteria	Number of criteria with POSITIVE answer / Total number of applicable criteria	ALL applicable criteria are evaluated as POSITIVE

WSI.TRE: Treatment System

Information sources

- Type of treatment system: SIS_D1.2
- Functionality of the treatment system: SIS_D1.3
- Treatment system physical condition: SIS_D2
- Disinfection using Chlorine: SIS_G2
- Household filtration: SIS_G3

Utility function

The attached Table summarizes the utility assignment according to two criteria: suspended solids removal and pathogens elimination.

Regarding suspended solids removal, treatment at "system" level and filtration at "household" level are treated separately. At "system" level, the assignment results from the arithmetic mean of the two utilities. In case both treatments (system and household) take place, the one obtaining a better score will be considered.

The utility function is the arithmetic mean of the two criteria mentioned:

WSI.TRE = 0.5 * (suspended solids removal) + 0.5 * (pathogens elimination)

F(x)	0	0.33	1
Type and functionality of treatment system	NO treatment system	Treatment system EXISTS but it does NOT WORK	Treatment system EXISTS AND it does WORK properly
Treatment system physical condition	NO treatment system OR D (Poor)	C (Deficient) OR B (Acceptable)	A (Good)
Household filtration	NO household filtration	Household filtration BUT it is not a majority practice	Household filtration AND it is a majority practice
Disinfection using Chlorine	NO treatment system OR Disinfection using Chlorine is not done	Disinfection using Chlorine is done BUT it does NOT WORK	Disinfection using Chlorine is done AND it does WORK

5. Service Provision (SEP)

The necessary information comes mainly from the Service Provider (SEP) entity. Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated. **Exceptions**: Residual Chlorine and number of distribution infrastructure connections, specified in the System (SYS) questionnaire; Number of households served by each System - Provider, specified in the Community (COM) survey.

SEP.ORG: Organization Management
Information sources - Legal status: SEP_B1.2 - Date of last Board of Directors member election: SEP_B2.1 - Board of Directors positions filled: SEP_B2.2 - Board of Directors meetings frequency: SEP_B2.3 - Number of women in Board of Directors: SEP_B3 - Existence of last accountability meeting minutes: SEP_B5.2 - Existence of tariff: SEP_C1 - Existence of rate payment mechanism and regularly applied: SEP_C3 - Existence of income and expenditure ledger up to date: SEP_F1

Utility function

The attached Table summarizes the utility assignment according to four criteria. The function is the arithmetic mean.

F(x)	0	0.33	0.66	1
Legal status, positions filled and date of member election	Not legally established	In process of legalization OR legally established AND NO positions filled OR filled 2 or more years ago	In process of legalization AND Positions filled less than 2 years ago	Legally established AND Positions filled less than 2 years ago
Meeting during the last 6 months	0	1	2	≥ 3
Number of women in Board of Directors / Total	0	Linear variation		Ratio ≥ 0.4
Tariff management and accountability	NO tariff	Existence of tariff AND community applied for it or not AND income and expenditure ledger not updated	Existence of tariff AND income and expenditure ledger up to date BUT there is NOT last accountability meeting minutes	Existence of tariff AND income and expenditure ledger up to date AND there is last accountability meeting minutes

SEP.OPM: Operation & Maintenance Management

Information sources

- Provision of maintenance: SEP_G1
- Existence of resources: SEP_G2
- Existence of technicians or operators for system operations and maintenance: SEP_G3
- Existence of service provision rules and regulations: SEP_G4
- Drinking water. Residual Chlorine: SYS_G4
- Number of installed micro-meters: SYS_F1.2
- Number of micro-meters with recorded consumption: SYS_F1.3
- Number of households served by each System - Provider: COM_A5

Utility function

The attached table summarizes the utility assignment according to four criteria. The second one contemplates the basic operation of chlorination. This one is valued by calculating the weighted average according to the population served for the cases of multiple systems. The function is the arithmetic mean.

F(x)	0	0.33	0.66	1
Operation and Maintenance general valuation	Do NOT provide any preventive or corrective maintenance	Preventive AND / OR corrective maintenance is provided AND does NOT HAVE resources or personnel	Preventive AND / OR corrective maintenance is provided AND does HAVE resources	Preventive AND corrective maintenance is provided AND does HAVE resources AND personnel
Basic operation of chlorination[7]	$Cl \leq 0.1$	0.1 mg/l $< Cl \leq 0.3$ mg/l	$Cl > 1$ mg/l	$0.3 < Cl \leq 1.$ mg/l
Operation and Maintenance rules and regulations	NO	YES, BUT they are not applied	YES, BUT they are partially applied	YES, AND they are fully applied
Operative micro-measurement operation	NO connection with operative micro-meter	Linear variation Number of micro-meters with recorded consumption / Number of installed micro-meters		ALL connections have operative micro-meters

SEP.ECO: Economic Management

Information sources

- Water produced (monthly): SEP_C4.1 and Water invoiced (monthly): SEP_C4.2
- Billing (monthly): SEP_C5.2 and Billing income (monthly): SEP_C5.4
- Number of users who should pay an invoice: SEP_C5.1 and Number of users up to date with invoice payments: SEP_C5.3
- Additional income from operations (last year): SEP_D1.1
- Additional income from operations (expected this year): SEP_D2.2
- Special contributions not directly related to water service (expected this year): SEP_D2.2
- Actual expenditure: SEP_E1.1 and Expected expenditure: SEP_E1.2

[7] World Health Organization (WHO). 2009. *Guías técnicas sobre saneamiento, agua y salud*. Geneva.

- Available funds: SEP_F2

- Total income (last year): SEP_F1.1 and Total expenditure (last year): SEP_F1.2
- Balance sheet: SEP_F3

Utility function

The attached table summarizes the utility assignment according to six criteria. Calculation alternatives are defined for those cases where SEP_F3 is not available. The proposed utility function is the geometric mean of the available information.

- Billing Efficiency Ratio. BER = Total volume of water invoiced / Total volume of water billed

- Collection Efficiency Ratio. CER = Monthly average billing income / Monthly average billing

  - **If there is no specific data for this calculation, ratio of users up to date with invoice payments should be used**

- Profitability. PRO = Total income / Total expenditure (administration, operation, maintenance and environmental services and others)

- Liquidity Ratio. LR = Current active assets / Current liabilities

  - **If there is no specific data from SEP_F3, information regarding available funds should be used**

- Solvency Ratio. SR = Total active assets (current + non-current) / total liabilities (current + non-current).

  - **If there is no specific data from SEP_F3, the following algorithm should be used: (Expected additional income from operations + Expected special contributions) - (Expected expenditure - Actual expenditure)**

- Debt Service Coverage Ratio (only when SEP_F3 available). DSCR = short and long term debt payments / (average monthly income - average monthly expenditure)

F(x)	0	Linear variation	1
BER = SEP_C4.2 / SEP_C4.1	BER = 0	BER	BER = 1
CER = SEP_C5.4 / SEP_C5.2 (If not: CER = SEP_C5.3 / SEP_C5.1)	CER = 0	CER	CER = 1
PRO = (12 * SEP_C5.4 + SEP_D1.1) / (12 * SEP_E1.1)	RCC = 0	RCC	RCC > 1
LR = (SEP_F3.1) / SEP_F3.3 (If not, [PSE_F2 > 0])	LR < 1 (NO)	2(LR - 1) -	LR > 1.5 (YES)
SR = (SEP_F3.1 + SEP_F3.2) / (SEP_F3.3 + SEP_F3.4) (If not, [(SEP_D1.2 + SEP_D2.2) – (SEP_E1.2 – SEP_E1.1) > 0])	SR = 1 (NO)	2(SR - 1) -	SR > 1.5 (YES)

DSCR = (SEP_F3.3+ SEP_F3.4) / (SEP_C5.4 - SEP_E1.1)	DSCR > 60	(1 - DSCR /60)	DSCR = 0

SEP.ENV: Environmental Management

Information sources

- Environmental sanitation promotion: PSE_H2
- Promotion of protection activities in the area near the water source or system intake: PSE_H3
- Corrective actions (area near the water source or system intake): PSE_H4
- Preventive actions (area near the water source or system intake): PSE_H5

Utility function

The attached Table summarizes the utility assignment according to three criteria. The function is the arithmetic mean.

F(x)	0	0.33	0.66	1
Environmental sanitation promotion	NO			YES
Preventive actions	NO actions are executed	Minimum, 1 action is promoted and executed	Minimum, 3 actions are promoted and executed (at least 1 action within the last 12 months)	Minimum, 3 actions are promoted and executed (ALL of them within the last 12 months)
Corrective actions	NO actions are carried out	Minimum, 1 action is promoted and executed	Minimum, 2 actions are promoted and executed (at least 1 action within the last 12 months)	Minimum, 2 actions are promoted and executed (ALL of them within the last 12 months)

6. Technical Assistance Provision (TAP)

The necessary information comes from the **Technical Assistance Provider** entity (TAP). Therefore, it is considered that this is the scale on which the partial index and its components and indicators are initially calculated.

TAP.ICT: Information Systems

Information sources

- IT equipment and status: PAT_C4.3
- Internet service and status: PAT_C4.6

Utility function

The attached table summarizes the utility assignment according to two criteria. The utility function is the geometric mean.

F(x)	0	0.33	0.66	1
IT equipment	With NO equipment or in POOR conditions		At least 1 equipment in ACCEPTABLE conditions	At least 1 equipment in GOOD conditions
Internet	With NO internet service	Internet service in POOR conditions	Internet service in ACCEPTABLE conditions	Internet service in GOOD conditions

TAP.INS: Institutional capacity

Information sources

- Total number of communities in service area: PAT_B1
- Number of technicians: PAT_C1
- Existence of annual operating budget: PAT_C2
- Annual operating budget amount: PAT_C3
- Transportation equipment and status: PAT_C4.1
- Water Quality measurement equipment and status: PAT_C4.2
- Travel and fuel budget: PAT_C4.4 + PAT_C4.5

Utility function

The attached Table summarizes the utility assignment according to four criteria. 10 communities per technician are considered as reference value; and 45,000 c $ (1,600 US $) as reference budget (third quartile in Nicaragua). The utility function is the arithmetic mean.

F(x)	0	0.33	0.66	1
Transportation equipment	NO equipment or only in POOR conditions	1 vehicle in GOOD or ACCEPTABLE conditions	2 vehicles in GOOD or ACCEPTABLE conditions	More than 2 vehicles in GOOD or ACCEPTABLE conditions
Water Quality measurement equipment	WITHOUT or WITH equipment, but in POOR conditions		1 equipment in ACCEPTABLE conditions	1 equipment in GOOD conditions
Human Resources Ratio = Number technicians / Total number of communities in service area	0 IF ratio = 0	$10 \cdot (\text{ratio})$ IF ratio > 0 and IF ratio < 0.1		1 IF ratio ≥ 0.1
Economic Resources Travel and fuel budget (if there is no information about budget)	Does NOT have either (NO annual operating budget amount)	Does HAVE any of them but POOR/ACCEPTABLE (Annual operating budget amount LOWER than reference)	Does HAVE both of them, but POOR or just ACCEPTABLE one of them	Does HAVE both of them, AND they are GOOD (Annual operating budget amount HIGHER than reference)

TAP.COV: Community Coverage

Information sources

- Total number of communities in service area: PAT_B1
- Number of communities served in the past 12 months: PAT_B2

Utility function

The attached Table summarizes the utility assignment.

F(x)	0	Linear variation	1

Ratio of supported/served communities	Ratio = 0	Number of communities served / Total number of communities in service area	Ratio = 1

TAP.INT: Intensity of Assistance

Information sources

- Number of communities served in the past 12 months: PAT_B2
- Type of support: PAT_D1

Utility function

The attached Table summarizes the utility assignment. The utility function is the arithmetic mean.

F(x)	0	Linear variation	1
Service provision diversity	NO support provided	Number of supports provided / Total type of support	7 or more different type of support provided
Concentration of support to communities	NO support provided to MORE than 50% of communities	Number of supports provided to MORE than 50% of communities / Total number of type of support carried out	ALL type of support carried out is provided to MORE than 50% of communities