Costing water services in a refugee context - Methodological report

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Methodological report

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Supporting water sanitation and hygiene services for life

UNHCR
The UN Refugee Agency

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LCCA is a cost / benefit approach where real financial expenditure on water is converted into unit costs and compared with the water service actually delivered to a given population in a given area. This report explains how this approach can also apply in a refugee context.

For more information about IRC and UNHCR collaboration, please go here:
http://www.ircwash.org/projects/life-cycle-cost-approach-refugee-camps

For more information on LCCA in other contexts, please go here: http://www.ircwash.org/washcost

Executive Summary

UNHCR aims at improving the budgeting of post-construction expenditure for the provision of water in camps, in particular those in post-emergency situations.

This report presents a methodology to cost water services that has been adapted from the life-cycle costs approach (LCCA) initially developed and tested in regular settlements and which has currently been adopted by more than 80 organisations across the world.

LCCA identifies the true costs for providing a water service, not only for a few years but for an unlimited period of time, to a given population in a targeted area.

In a refugee context, this methodology is particularly adapted to post-emergency situations, when more permanent water systems are built and financial resources must be budgeted for to cover the operation and (minor and capital) maintenance of systems, but also the support for administration, management, monitoring and reporting functions endorsed by international agencies. However, the methodology could fit first emergency situations as well, as all the expenditure made on the provision of water is documented since the creation of the camp. The costs of providing water during the first emergency phase are thus identified, and could be compared across camps, time and countries to refine budgeting processes and budgeted expenditure also for a specific and usually short period of time.

LCCA is a cost / benefit approach where real financial expenditure is converted into unit costs and compared with the service actually delivered to a given population in a given area.

The report details the information required to cost the provision of a water service, the tool that has been developed to assess the level of service delivered to refugees and the calculations that convert financial expenditure into cost per system, per capita and m3. It also explains how to estimate the life-cycle costs for providing a targeted level of service to a given population.

This methodology will be tested in two camps by IRC and UNHCR with the objective of scaling it up in more camps and settlements in 2015 and further improve planning and budgeting processes. As a consequence, data collection will build on the financial and technical monitoring and reporting processes that have been developed by UNHCR. Along the piloting of LCCA, the limitations of these systems will be identified and copying strategies proposed in order to systematise LCCA in a cost-effective way in all intervention areas of UNHCR.

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Introduction

At the beginning of an emergency response, humanitarian aid organisations rarely plan for long-term water infrastructures despite the fact that the average lifespan of a refugee camp is 17 years. However, the temporary water systems inevitably require upgrading within a few years to cater for long-term use and potential expansion of networks. This inevitably infers retrofitting or adaptation of an emergency system to function as a long-term sustainable water supply system. Overall UNHCR allocates 25 to 30 million US$ for the operation and maintenance of water supply systems across its operations, in a context of increasing unpredictability of funding for post-emergency situations.

The objective of the UNHCR and IRC collaboration is to define cost and service benchmarks for prioritizing and setting up strategic planning for the operation of water systems in the long term. How much does it cost to run water systems and deliver an acceptable level of service? What are the right levels of staff and equipment? Beyond operation and maintenance, how much should be provisioned every year to cover capital maintenance when systems have to be rehabilitated or renewed? How much is spent by international agencies to fulfil the functions of a local water authority and a water service provider for a camp of 10,000 or 20,000 refugees? What does it mean in terms of tariffs when handing over the service management to a local community or a service provider?

The first step of this collaboration consists in piloting the life-cycle costs approach (LCCA) in two camps. LCCA has been successively implemented in regular settlements since 2008 to identify the real cost for delivering water services to a given population in a given area, not only for a few years but for an unlimited period. This report presents the methodology adapted to a refugee context, identifies the information to be collected to calculate unit costs and to assess the levels of service provided, and explains how to calculate costs per service level.

In the first section, the cost categories that compose the life-cycle costs are defined and the tool that will be used to assess the level of service provided to refugees is presented. The second section identifies data sources for both expenditure and levels of service. The third section focuses on the calculation of unit costs and the last section explains how to cost the different levels of service delivered to refugees.

1. Life-cycle costing the provision of a water service: Definition and tool

The provision of safe water relies on functioning water systems, but not only that. For systems to be built and well operated, a number of activities such as planning, operational and financial management, tariff setting / fund raising, monitoring and reporting are also required. Thus a water service is composed of, but not limited to water systems.

A water system can be defined as the technology that is developed to supply water to a given population at a certain time. It may include a number of water facilities (decentralised technologies such as boreholes equipped with hand pumps, shallow wells, etc.) or a single facility supplying a number of water points (centralised technology such as a piped scheme). The initial water system or technology can be extended after some time to cope with an increase in population: additional shallow wells are drilled or the network is extended to supply additional tap stands.

Definition: the life-cycle cost components of a water service

The life-cycle costs of a water service are broken into six components. These components cover all the costs that occur in providing water to a given population in a particular area, not only for a few years but for an unlimited period. Four components are linked to the water system while two components are related to the management of the service.

Table 1 defines the composition of the life-cycle costs, as used in the water development sector.

Table 1 The six life-cycle cost components of a water service in the development sector

Type of cost component	Components	Component definitions
System related	CapEx	Capital invested in constructing or purchasing fixed assets such as concrete structures, pumps and pipes, boreholes, reservoirs, etc. It includes the first time the system has been built and the extension of the system. It also includes one-off software such as community training and consultation, design, procurement, etc.
	OpEx	Operating and minor maintenance expenditure typically comprises regular expenditure such as labour, fuel, chemicals, spare parts, and purchases of any bulk water.
	CapManEx	Capital maintenance expenditure consists of asset renewal and replacement. This occasional and 'lumpy' expenditure seeks to restore the functionality of a system, such as replacing pump rods in hand pumps, or a diesel generator in motorised systems.
	Cost of capital	Cost of interest payment on any loans to finance capital investment.
Management related	ExDS	Direct support is structured support to decentralised service authorities, service providers and users related to the organisation and management of a water service. It covers technical advice and administrative, organisational or legal support, and monitoring. Direct support is often synonymous with "post-construction support".
	ExIDS	Indirect support expenditure covers macro-level support, as well as sector planning, policy making and regulatory framework, both in terms of development and enforcement.

Differences for a refugee context are the following:

- Capital Expenditure or capital investment is broken into shorter cycles with an emergency phase preceding the construction of a permanent water system the extension of which poses a high burden on coping with a sudden population increase. The life span of a water system is uncertain and there is a risk of over/under-designing water systems depending on the predictability of the change in refugee population.
- Cost of capital in a refugee context is absent since water systems are fully subsidized.
- Direct support must be redefined to align with a context where international agencies organize, manage and operate water services in camps, substituting water authorities and service providers. In the development sector, the support to the decentralized water authority is notably provided by the government while the support to service providers could come from the water authority itself (notably for community based organisations), or from the headquarters of the private operator (in case of delegation to a private

operator). In the refugee context, the support is given to the establishment of a local office by an international agency to organize and operate the provision of water. In small camps (10,000 to 25,000 refugees), a single agency is in charge for a few years while in larger camps, two or more international agencies organize and operate water systems in different parts of the camp.

- Indirect support must be redefined to take into account a context where strategies, policies and fund raising activities are not carried out by governments, but by international agencies and platforms such as UNHCR or the Global WASH cluster. The expenditure related to indirect support is not being captured in the current pilot.

Table 2 defines each cost component in a refugee context. Cost components related to water systems are defined in the same way as in regular settlements while cost components related to the management of the service must be redefined.

Table 2 The five life-cycle cost components of a water service in a refugee context

Type of cost component	Components	Components definitions
System related	CapEx	Capital invested in constructing or purchasing fixed assets such as concrete structures, pumps and pipes, boreholes, reservoirs, etc. It includes the first emergency system and the more permanent water system, in their initial setting and after extension. It also includes one-off software such as community training and consultation, design, procurement, etc.
	OpEx	Operating and minor maintenance expenditure typically comprises regular expenditure such as labour, fuel, chemicals, spare parts, and purchases of any bulk water, in particular during the emergency phase.
	CapManEx	Capital maintenance expenditure consists of asset renewal and replacement. This occasional and 'lumpy' expenditure seeks to restore the functionality of a system, such as replacing pump rods in hand pumps, or a diesel generator in motorised systems.
Management related	ExDS	Direct support is structured support to the camp or settlement office of an international agency to organise, operate and report on the provision of a water service. Direct support expenditure includes all the expenditure made locally by the international agency to appoint international staff and hire local staff, to plan and operate water facilities, to monitor and report to headquarters and funders.
	ExIDS	Indirect support covers the expenditure made by international agencies and global WASH cluster to develop strategies and policies, and to coordinate humanitarian interventions in relation with the provision of water services to refugees.

Tool: a water service ladder to assess the level of service provided to refugees

LCCA is a cost / benefit approach where the level of service provided is regarded as the benefit or the output resulting from the financial resources invested (input). A framework is required to assess the level of service provided to refugees., What matters is not the service that is expected from the investment, but the service that is actually being provided to a given population in a given area.

A service is usually described by indicators such as the quantity of water per capita and per day for which a certain level is estimated for the system used to deliver the water. In Burkina Faso, for instance, a borehole equipped with a hand pump must provide 20 litres per capita per day to a maximum of 300 people. This is the service per design in terms of quantity. The service that is actually provided can be quite different: it is the real quantity each user collects per day and the total number of real users collecting water at a given water point.

In regular settlements, four indicators describe the water service provided at the water point: quantity of water per person per day, quality of water at the water point, accessibility of the water point and reliability of the water point. Each indicator must reach an agreed level to provide a standard or basic level of service to each water user. These levels are defined in each country in a sector policy and are used for planning purposes to invest in improved access to water.

IRC has developed a water 'ladder' to capture indicators and corresponding levels of service, and calculate the overall service level provided to the users of water points which correspond to internationally agreed indicators (Table 3).

Table 3 Water service ladder in regular settlement

	Quantity	Quality	Accessibility	Reliability
	Litres / capita / day		*Minutes / capita / day*	
High	Greater than 60	Good	Less than 10	Very reliable
Intermediate	Greater than 40	Acceptable	Less than 30	Reliable
Basic (normative)	Greater than 20			
Sub-standard	Greater than 5	Problematic	Less than 60	Problematic
No service	Less than 5	Unacceptable	Greater than 60	Unreliable

The basic principle is that the overall level of service provided to a user is set by the lowest individual indicator. If, for instance, a user collects water from a reliable water point located less than 10 minutes from his house and where the water quality is acceptable, but he only fetches 10 litres per day, then the overall service provided to this specific user ranks as sub-standard. Only users who meet a basic level for all indicators qualify as being served.

In the ladder, two indicators are household based (quantity and accessibility). Quality and reliability are water point based. It means that when a water point does not deliver water of acceptable quality or is not reliable, no user of this water point will qualify as being provided with a basic level of service. As soon as a water point delivers acceptable water quality and is reliable, users will be getting a service than can range from no to high service, depending on the quantity they fetch and how far they live from the water point.

The service provided to each user at each water point gives the overall level of service provided to a given population in a targeted area. The tables below show the example of a location where two water points are available, including one where the water quality is problematic.

Table 4 Combining water service levels in a given area

Table 4.1 Levels of service provided to users of water point 1 (number of real users)

<table>
<tr><th>Indicators
Levels</th><th>Quantity</th><th>Quality</th><th>Accessibility</th><th>Reliability</th><th>Overall</th></tr>
<tr><td>High</td><td>10</td><td>0</td><td>5</td><td>0</td><td>5</td></tr>
<tr><td>Intermediate</td><td>15</td><td rowspan="2">100</td><td rowspan="2">70</td><td rowspan="2">100</td><td>20</td></tr>
<tr><td>Basic</td><td>50</td><td>50</td></tr>
<tr><td>Sub-standard</td><td>20</td><td>0</td><td>15</td><td>0</td><td>15</td></tr>
<tr><td>No service</td><td>5</td><td>0</td><td>10</td><td>0</td><td>10</td></tr>
</table>

Table 4.2 Levels of service provided to users of water point 2 (number of real users)

<table>
<tr><th>Indicators
Levels</th><th>Quantity</th><th>Quality</th><th>Accessibility</th><th>Reliability</th><th>Overall</th></tr>
<tr><td>High</td><td>10</td><td>0</td><td>5</td><td>0</td><td>0</td></tr>
<tr><td>Intermediate</td><td>15</td><td rowspan="2">0</td><td rowspan="2">70</td><td rowspan="2">100</td><td>0</td></tr>
<tr><td>Basic</td><td>50</td><td>0</td></tr>
<tr><td>Sub-standard</td><td>20</td><td>100</td><td>15</td><td>0</td><td>90</td></tr>
<tr><td>No service</td><td>5</td><td>0</td><td>10</td><td>0</td><td>10</td></tr>
</table>

Table 4.3 Levels of service provided to users in the village (number of real users)

<table>
<tr><th>Indicators
Levels</th><th>Quantity</th><th>Quality</th><th>Accessibility</th><th>Reliability</th><th>Overall</th></tr>
<tr><td>High</td><td>20</td><td>0</td><td>10</td><td>0</td><td>5</td></tr>
<tr><td>Intermediate</td><td>30</td><td rowspan="2">100</td><td rowspan="2">140</td><td rowspan="2">200</td><td>20</td></tr>
<tr><td>Basic</td><td>100</td><td>50</td></tr>
<tr><td>Sub-standard</td><td>40</td><td>100</td><td>30</td><td>0</td><td>105</td></tr>
<tr><td>No service</td><td>10</td><td>0</td><td>20</td><td>0</td><td>20</td></tr>
</table>

The indicators and ladder have been adapted and developed for the refugee context, based on UNHCR indicators and to fit a post-emergency context. (Table 5).

Table 5 Water service ladder in refugee context

<table>
<tr><th rowspan="3"></th><th rowspan="2">Quantity</th><th colspan="2">Quality (at water point)</th><th rowspan="2">Distance</th><th colspan="2">Crowding</th></tr>
<tr><th>Unchlorinated water points</th><th>Chlorinated water points</th><th>Hand pump</th><th>Tap</th></tr>
<tr><td>Litres / capita / day</td><td>E.Coli CFU</td><td>FRC mg/Litres</td><td>Meters</td><td colspan="2">Persons</td></tr>
<tr><td>Above standard</td><td>Greater than 20</td><td rowspan="2">0</td><td>>= 0.5*</td><td rowspan="2">=<200</td><td rowspan="2">=<250</td><td rowspan="2">=<100</td></tr>
<tr><td>Acceptable</td><td>Greater than 15</td><td>Greater than 0.1*</td></tr>
<tr><td>Problematic</td><td>Greater than 10</td><td>>= 1</td><td>0</td><td rowspan="2">>200</td><td>Greater than 250</td><td>Greater than 100</td></tr>
<tr><td>Critical</td><td>Less than 10</td><td>No test</td><td>No test</td><td>Greater than 500</td><td>Greater than 250</td></tr>
<tr><td colspan="7">* With turbidity < 5 NTU</td></tr>
</table>

This ladder and its indicators will be used according to the same principle as the ladder developed for regular settlements. In order words, only users collecting greater than 15 litres per day from a water point distant less than 200 meters, visited by less than 250 or 100 people per day and distributing a water whose quality complies with UNHCR standards will be counted as properly served. The others will qualify as receiving a problematic or critical level of service, depending on the quantity collected per user and per day, the quality of water and the crowding at the water point.

The total volume of water and the total number of users (crowding) will be used to calculate two types of unit costs: the cost per m3 and the cost per capita.

2. Collecting cost and service data

LCCA is a cost / benefit approach where the true cost for delivering a water service is compared with the service actually delivered to a given population in a given area. The implementation of LCCA thus requires the collection of cost and service data.

Collecting cost related data

In a refugee context as in regular settlements, the life-cycle costs approach aims at investigating the real cost of a water provision as opposed to planned or budgeted expenditure. In practical terms, it means that all the expenditure made on water supply in a specific area – a camp or settlement – must be collected, no matter the funder, the international agency in charge, the type of water system and the functionality of water points. As in a regular settlement, the older the expenditure, the more difficult it is to capture it. It is of crucial importance to be able to reconcile expenditure on investment, operation and capital maintenance with a specific water system. It is equally important to know what year the expenditure was made and in what currency in order to further actualise and convert all expenditure in Euros or US dollars to allow for comparing costs across time and countries.

The basic document that provides financial information on water supply in camps is the annual financial report that each international agency delivers to UNHCR per zone of intervention. Ideally, the financial report comes with a narrative that identifies the water systems in place (built, operated, enhanced or rehabilitated).

The financial reports include planned and spent expenditure. It is thus possible to compare the real costs (the expenditure reported to UNHCR) to the budgeted or planned expenditure every year.

Collecting service related data

Two different sources of information will be used to assess the level of service provided to refugees: the information reported to UNHCR through Twine and the information collected by IRC through the water point survey.

Service levels as reported to UNHCR

The service provided to refugees is reported to UNHCR through TWINE on a monthly basis.

In terms of quantity, UNHCR WASH officers report on the quantity supplied per water system and the number of functional water points. An average quantity of water per refugee and per day is calculated, based on the total volume of water distributed in the camp per day, the number of functional water points and the number of refugees in the camp. In case other populations also benefit from the water systems (typically a host community), the average quantity per capita per day may take into account the total population (refugees and non-refugees).

In terms of quality, UNHCR WASH officers also report monthly on the parameters included in the ladder, for a randomly selected number of water points.

The average crowding at water points located in the camp is calculated by dividing the refugee population by the total number of functional water points in the camp.

Finally, estimation is given on the distance from a refugee's household to the closest water point.

The water point survey

Another way of assessing the levels of service provided is through a water point survey. The idea is to capture the real level of service by standing at water points for a few days, and collect data from all the users in order to estimate the level of service each user and her/his family actually receives.

The added value of the water survey compared with the service as reported to UNHCR is getting additional information on the following points, given that most of the time:

- Average quantity per capita per day and average crowding per water point can hide very different situations due to family size, ethnical discrimination, etc.
- The number of users per water system is unknown as the average number of users is calculated per water point.
- The number of users served may not include the non-refugees, even when a water system also supplies a host community. When the number of users accounts for the refugee and the non-refugee populations, there is no census of non-refugees but estimation. In this case, the average number of users per water point is not reliable, introducing a bias in the calculation of the average quantity of water per capita per day.
- Water quantity is rarely metered at decentralized water systems such as hand dug wells or boreholes with hand pumps and sometimes even at tap stands. Hence the volume of water distributed is derived from the technical capacities in production and/or distribution, but not from what is de facto delivered. As a consequence, the volume of water distributed by each water system is unknown.

In order words, the service reported to UNHCR can give information on the average level of service provided to refugees under two conditions: 1) there is only one water system in the camp; 2) only refugees can access it. When two or more systems are in place and/or non-refugees benefit from it, the monitoring system does not capture the elements that are necessary to calculate the level of service provided nor the units that allow for the calculation of unit costs.

Through the water survey, the information captured is threefold:

- The identification of the users (status, name or identity number): each user can be a refugee or a non-refugee; refugees hold ID numbers that indicate the size of her/his family and the location in the camp (zone, block, community); all users are being asked the size of their families (even refugees for bi-angulation purpose).
- The location of the user: refugees can be located through their ID number, but they are asked, similarly as non-refugees, how far they live from the water point.

- The quantity of water taken: the number and size of containers each user fills up at the water point.

It happens that users don't fetch water every day; that is why a one-day survey is not enough. Besides, in most cultures, one day a week, water habits are affected by prayer time. In order to calculate accurate quantities of water per capita per day, the survey lasts for four days and includes either a Friday or a Sunday. A quantity of water per capita per day is then calculated based on the average quantity fetched over 4 days factoring in the special day as one day per week, and the number of members per family. The distance is calculated based on the geographical coordinates of the household location and the water point location. Crowding results from the average number of users per day over four days and the size of the family of each user. Finally water quality testing is conducted at each water point to provide input for the quality indicator.

Below is the questionnaire used in Bambasi refugee camp in Ethiopia on July 25-28, 2014.

Bambasi water point survey, July 25-28, 2014, Ethiopia

Date: ___________________________
D1 Camp: Bambasi
D2 Water point number: __________________
D3 Surveyor number: __________________

IDENTIFICATION

I1 Gender/Age of respondent:
(Single answer)

Boy ☐ Man ☐ Girl ☐ Woman ☐

I2 Do you have an ID?
(Single answer)
Yes ☐ No ☐

I3 If YES, what is UNHCR ID number? _______________
(enter the ID number)

I4 If NO, why you do not have ID?
(Single answer)
I forgot it ☐
A member of my family is registered but not me ☐
I live outside the camp / I am a visitor ☐
I am new and not registered yet ☐
Not relevant ☐

I5 Provide Survey ID: ________________________
(for person without ID, provide one code and enter number here)
(if person has ID, enter 0000)

From day 2 to 4
I6 Where you provided a survey ID any of previous days?
(Single answer)
- Yes
- No

I7 If yes, what is it: _________________ (enter the code)

LOCATION

L1 Do you know the code of the block you live in?
Yes ☐ No ☐

L2 In which block do you live? ______________________
(enter Block number, if person does not know enter 0000)

L3 In which zone do you live? (Single answer)
Zone A ☐ Zone B ☐ Zone C ☐

L4 In which community do you live? _________________
(enter Community number, if person does not know enter 0000)

L5 How long does it take you to come here? ___________________ minutes
(if person does not know enter 0000)

QUANTITY OF WATER

Q1 For how many family members is the water you collect? ___________ people

Q2 TOTAL NUMBER of jerricans that person fills up: ___________ pcs
(Input <u>Total number</u> of jerricans)
Q3 Enter number of jerricans of 5 litres: ___________ pcs
Q4 Enter number of jerricans of 10 litres: ___________ pcs
Q5 Enter number of jerricans of 15 litres: ___________ pcs
Q6 Enter number of jerricans of 20 litres: ___________ pcs
Q7 Enter number of jerricans of 25 litres: ___________ pcs
Q8 Enter number of jerricans of other size: ___________ pcs
Q9 Enter the size of the other jerricans: ___________ liters

Q10 TOTAL NUMBER of buckets that person fills up: ____________ pcs
Q11 Enter number of bucket of 5 litres ____________ pcs
Q12 Enter number of buckets of 12 litres ____________ pcs
Q13 Enter number of buckets of 15 litres ____________ pcs

Sampling strategy

Ideally, the water survey covers all functional water points in the camp. Otherwise, a sampling strategy is required to select the water points. Sampled water points must be representative of the water points available in the camp in terms of water systems and number of users per system.

A stratified sample strategy is followed. First, a number of water points are selected based on water systems, and then according to crowding.

- Representativeness of water systems
  Sample water points must be proportionate to the number of water points per system available in the camp. For instance, if 2 types of water system exist with 80% of taps supplied by a piped scheme and 20% by hand dug wells, then 80% of sample water points will be composed of taps and 20% of hand dug wells.
- Representativeness in terms of crowding at water points
  Crowding is a crucial criterion in the sampling strategy because the level of service provided to all refugees is extrapolated from the level of service captured at sampled water points, and because the calculation of unit costs is determined by the number of capita and the quantity fetched at water points. At least three levels of crowding can be assessed at each water system: low density (below the average crowding reported to UNHCR); average density (around the average density reported) and high density (above the average density reported). For each water system the water points are selected in proportion with the density category. If for instance, 20% of the water points supplied by a piped scheme are often frequented, 20% poorly visited and 60% "normally" crowded, then the sample water points of the piped scheme will be similar.

3. Calculating unit costs

The life-cycle costs methodology consists in capturing real financial expenditure made on each cost component, and in converting them into unit costs that can be used for planning and budgeting purposes.

Cost components can be converted into three different unit costs, depending on the source of information:

- Unit cost per design: planned or budgeted expenditure is divided by the population per design (cost per capita) and by the volume per design (cost per m3).
- Unit cost based on the data reported to UNHCR: real expenditure is divided by the number of beneficiaries reported to UNHCR (refugees and non-refugees) and by the volume of water reported to UNHCR for each water system.
- Unit cost based on IRC survey: real expenditure is divided by the number of users counted at water points (extrapolated per water system) and the volume of water collected at water points (extrapolated per water system and triangulated with meters for metered water systems).

The interest of having these series of unit costs originates in the fact that a water system could be planned to supply a population which in the end is different from the effective number of people supplied once the water system is operational. With these series, it is possible to compare real costs and services against planned expenditure and service per design, and to provide insights into the accuracy of the monitoring system that informs UNHCR on the benefit of its interventions.

Investment costs

Unlike all other cost components, capital expenditure is a one-off expenditure, not a recurrent one. Thus unit costs are expressed per water point and per capita, but not per year nor per m3.

Table 6 lists the data required to calculate the unit cost related to capital expenditure for building and extending water systems.

The costs per design (cost per water point and cost per capita) are based on budgeted investment, 100% functionality of the water points and 100% use by the targeted population. If, for instance, a piped scheme has been built to supply 15 tapstands with 10 taps each and a targeted population of 150 people per tap, than the cost per water point per design is calculated for each of the 150 taps and the cost per capita per design based on a number of 150 users per tap or 1500 per tapstand or 22,500 per piped scheme.

Costs as reported to UNHCR consider the real expenditure on investment, but do not factor in the functionality rate. Hence, with a functionality rate below 100%, the cost per functioning water point is higher than the cost per water point per design, as a similar investment calculates a lower number of water points. However, the cost per reported user could be the same as the cost per capita per design if the targeted number of users (22,500 in total in our example) collects water from the functioning taps.

Finally, the costs are based on the IRC survey results looking at the functionality rate observed during the survey and the number of users counted at sample water points.

The analysis of the initial investment costs as well as the extension costs allows comparing the investment cost of a given system over time according to its functionality and use. Though it is clear that the investment in a system increases with extension, investment cost per capita may decrease due to economies of scale which helps in justifying, for instance, the extension of a system to the host community.

Table 6 Indicators, definitions and data required to calculate unit capital expenditure

		Indicators	Definitions	Data required			
Initial water system		Investment cost per system	Initial investment per water system	year	currency	Budgeted and real investment per system	Funder
	Unit cost per design	Unit Investment cost per water point per design	Planned investment per water point	Number of planned water points per water system		Budgeted investment per system	
		Unit investment cost per capita per design	Planned investment cost per capita per design per water point	Number of capita per design per water point			
	Unit cost reported to UNHCR	Unit investment cost per water point reported functional	Real investment per water point reported as functional to UNHCR	Number of functional water points per system		Real expenditure on investment per system	
		Unit investment cost per capita reported	Real investment cost per capita reported to UNHCR	Number of capita reported to UNHCR per water point			
	Unit cost observed	*Unit investment cost per water point*	*Real investment per water point in 2014*	*Number of functional water points per system*		*Real expenditure on investment per system*	
		Unit investment cost per capita surveyed	*Real investment cost per capita effectively serviced during the survey*	*Number of users surveyed per water point*		*Size of users' households*	
Extended system		Total Investment cost per water system	Initial planned investment plus investment planned to extend the water system (water points, network, treatment capacity, distribution capacity, etc)	year	currency	Budgeted and real inv to extend the PS	Funder
	Unit cost per design	Unit investment cost per water point per design	Planned initial and additional investment for extension per water point	Number of planned water points after the extension of the system		Budgeted investment per system	
		Unit investment cost per capita per design	Planned investment cost per capita per design per water point of the extended system	Number of capita per design per water point after extension			
	Unit cost reported to UNHCR	Unit investment cost per water point reported functional	Real investment cost per water point reported as functional to UNHCR	Number of functional water points per extended system		Expenditure on extension	
		Unit investment cost per capita reported	Real investment cost per capita reported to UNHCR for the extended system	Number of capita reported to UNHCR per water point for the extended system			
	Unit cost observed	*Unit investment cost per water point*	*Real investment per water point of the extended system in 2014*	*Number of functional water points per extended system*		*Expenditure on extension*	
		Unit investment cost per capita surveyed	*Real investment cost per capita effectively serviced during the survey*	*Number of users surveyed per water point of the*		*Size of users' households*	

Operation and maintenance costs

Operation and maintenance are a recurrent expenditure; hence unit costs are all given per year. Depending on the detail in the financial reporting, this cost category will separate operation expenditure from maintenance expenditure in order to track the change in maintenance across time and relate the age of a given water system to spending on maintenance.

Reported and surveyed costs can be expressed per water point, per capita and per m3. Design costs are reported per water point only.

This difference comes from the fact that water systems can be under or overdesigned due to an unpredictable change in population. It can reasonably be assumed that expenditure on operation and maintenance is planned every year based on the population to be served and the volume to be supplied, not on the number of capita per design per water point, nor on the volume per design resulting from the number of users per design.

Let's take the example of a piped scheme. Per design, each tap should provide a minimum of 15 litres per day to a maximum of 100 people, to deliver an acceptable level of service. If the average number of refugees per tap is very different from the number of users per design, it considerably affects the operation and maintenance expenditure of the overall system (fuel, chemicals, etc.). As a consequence, measuring a unit cost based on the population per design (cost per capita per design) or the volume per design (cost per m3 per design) makes little sense for operation and maintenance: it cannot be compared to the real expenditure per capita (or m3) reported to UNHCR nor per capita (or m3) surveyed by IRC.

However, the expenditure planned on maintenance and operation will be compared to the real expenditure on operation and maintenance. Besides, the ratio operation and maintenance on investment will also be calculated and the planned ratio compared with the real situation.

Table 7 lists the data required to calculate operation and maintenance costs. They apply equally to initial and extended water systems.

Table 7 Indicators, definitions and data required for unit operation and maintenance costs

	Indicators	Definitions	Data required						
	Operation cost per water system per year	Planned and real expenditure on operational staff, preventive maintenance, water quality testing per water system per year	Year	Currency	Budgeted operation per water system per year		Expenditure on operation per water system per year		Funder
	Minor and major maintenance cost per water system per year	Planned and real expenditure on minor and major repairs per water system per year	Year	Currency	Budgeted repair per water system per year		Expenditure on repair per water system per year		Funder
	Operation and maintenance cost per water system per year	Planned and real expenditure on operation and maintenance per water system per year	Year	Currency	Budgeted operation and maintenance per water system per year		Expenditure on maintenance and operation per water system per year		Funder
Unit cost per design	Unit operation and maintenance cost per water point per design per year	Planned expenditure on operation and maintenance per water point established for each water system per year	Number of water points built per water system		Budgeted operation per water system per year				
Unit cost per design	Planned ratio Operation and maintenance on Investment per water system and per year	Planned expenditure on operation and maintenance compared to planned investment (year 1) or real investment (other year) per water system and per year	Budgeted operation and maintenance expenditure per year		Real expenditure on investment				
Unit cost reported to UNHCR	Unit operation and maintenance cost per water point reported funtional to UNHCR per system per year	Real expenditure on operation and maintenance per functional water point reported to UNHCR for each system	Number of functional water points per system		Expenditure on maintenance and operation per water system per year				
Unit cost reported to UNHCR	Real ratio Operation and maintenance on Investment per water system and per year	Real expenditure on operation and maintenance compared to real expenditure on investment per water system and per year	Real expenditure on operation and maintenance		Real expenditure on investment				
Unit cost reported to UNHCR	Unit operation and maintenance cost per capita reported to UNHCR per water system and per year	Real expenditure on operation and maintenance per capita reported as using a water system to UNHCR	Number of capita per water point reported to UNHCR						
Unit cost reported to UNHCR	Unit operation and maintenance cost per m3 distributed as reported to UNHCR per water system and per year	Real expenditure on operation and maintenance per m3 distributed per water system to UNHCR	Volume of water distributed reported per water system to UNHCR						
Unit cost observed	*Unit operation and maintenance cost per functional water point per system as observed by IRC*	*Real expenditure on operation and maintenance per functional water point as observed by IRC for each water system*	*Number of functional water points per water system during the survey*		*Expenditure on maintenance and operation per water system per year*				
Unit cost observed	*Unit operation and maintenance cost per capita surveyed by IRC per water system*	*Real expenditure on operation and maintenance per capita observed at water points by IRC*	*Number of users surveyed per water point and per water system*		*Size of users' households*	*Number of functional water points per water system*		*Number of water points surveyed per water system*	
Unit cost observed	*Unit operation and maintenance cost per m3 distributed to refugees per water system surveyed by IRC*	*Real expenditure on operation and maintenance per m3 counted at water points by IRC*	*Total volume of water distributed at surveyed water points per water system*		*Number of functional water points per water system*		*Number of water points surveyed per water system*		

Capital maintenance costs

Unlike operation and maintenance expenditure, spending on capital maintenance does not occur every year. However, it matters to have annualised capital maintenance for planning purposes, in order to ensure budget is available when a major component of a system must be replaced. Hence the expenditure on capital maintenance is annualised based on the real duration of the part of the system that is renewed, and unit cost for capital maintenance is given per year (Table 8).

Similarly to operation and maintenance expenditure, the unit cost per design is limited to the cost per water point. There is no design cost per capita or per m3. However, a ratio dividing the expenditure on capital maintenance by the investment on the water system is calculated, and the planned ratio is compared to the real one.

Table 8 Indicators, definitions and data required for unit capital maintenance costs

	Indicators	Definitions	Data required						
	Capital maintenance cost per water system per year	Average expenditure on rehabilitation and renewal of major components of a water system per year	year	currency	Budgeted expenditure on capital maintenance per water system	Expenditure on Capital maintenance per water system	Age of renewed component	Funder	
Unit cost per design	Unit capital maintenance cost per water point per design per year	Average planned expenditure on capital maintenance per water point established per system and per year	Number of water points planned per water system		Budgeted expenditure on capital maintenance per water system				
	Ratio planned expenditure on capital maintenance on total investment	Planned expenditure on capital maintenance compared to the total investment on the water system (initial + extension)	Budgeted expenditure on capital maintenance per water system		Real investment on (extended) water system				
Unit cost reported to UNHCR	Unit capital maintenance cost per water point reported funtional to UNHCR per system and per year	Average real expenditure on capital maintenance per water point reported functional to UNHCR per system and per year	Number of functional water points per water system reported to UNHCR		Expenditure on Capital maintenance per water system				
	Ratio Real expenditure on capital maintenance on total investment	Real expenditure on capital maintenance compared to the total investment on the water system (initial + extension)	Expenditure on capital maintenancne per water system		Real investment on (extended) water system				
	Unit capital maintenance cost per capita reported to UNHCR per water system and per year	Average real expenditure on capital maintenance per capita reported as using a water system to UNHCR	Number of capita per water point reported to UNHCR		Number of functional water points per water system		Expenditure on Capital maintenance per water system		
	Unit capital maintenance cost per m3 per design per system and per year	Average real expenditure on capital maintenance per m3 per design per system	Volume of water distributed by design per water system		Expenditure on Capital maintenance per water system				
Unit cost observed	*Unit capital maintenance cost per functional water point per system as observed by IRC*	*Average real expenditure on capital maintenance per functional water point as observed by IRC for each water system*	*Number of functional water points per water system during the survey*		*Expenditure on Capital maintenance per water system*				
	Unit capital maintenance cost per capita surveyed by IRC per water system	*Average real expenditure on capital maintenance per capita observed at water points by IRC*	*Number of users surveyed per water point and per water system*		*Size of users' households*	*Number of functional water points per water system*		*Number of water points surveyed per water system*	
	Unit capital maintenance cost per m3 distributed to refugees per water system surveyed by IRC	*Average real expenditure on capital maintenance per m3 counted at water points by IRC*	*Total volume of water distributed at surveyed water points per water system*		*Number of functional water points per water system*		*Number of water points surveyed per water system*		

Direct support costs

Direct support is the last recurrent component: the three types of unit costs are calculated per year, and will be given per capita (Table 9).

Ideally, with the correct amount of information, data allows disaggregating direct support into expenditure to operate the water facilities (service provision functions) and the expenditure required to administrate the water service (service authority functions). Though it may be difficult in practise to differentiate these expenditures in an emergency phase, it is of increasing importance to be able to do so in the recovery phase and *a fortiori* when transitioning towards development.

Indeed, an exit strategy would benefit from a good understanding of the financial resources required to fulfil functions initially carried out by international agencies before transferring them to local authorities and service providers.

If financial reporting allows it, IRC will separate the expenditure on water authority's functions from the expenditure on water provider's functions.

Depending on the context, IRC will try to isolate the support provided to refugees from the support provided to non-refugees, and to compare planned with real expenditure on direct support for both populations.

Table 9 Indicators, definitions and data required for direct support costs

	Indicators	Definitions	Data required							
	Support cost for the provision of service by International agency(ies)	Expenditure on support to run the water systems and develop local capacities for each agency	Year	Currency	Budgeted Support to service provider functions	Expenditure to support service provider functions	Refugee population	Non refugee population	Agency	Funder
	Support cost for the administration of a water service by International agency(ies)	Expenditure on support to administrate the water service managed by each agency	Year	Currency	Budgeted Support to service authority functions	Expenditure to support service authority functions	Refugee population	Non refugee population	Agency	Funder
Unit cost per design	Unit direct support cost planned per refugee and per year	Planned expenditure on support to water provision and authority functions per refugee and per year	Number of refugees each agency plans to supply with water		Budgeted support to administrate and provide a service to refugees by each agency					
	Unit direct support cost planned per non-refugee and per year	Planned expenditure on support to water provision and authority functions per non-refugee and per year	Number of non-refugees each agency plans to supply with water		Budgeted support to administrate and provide a service to non-refugees by each agency					
Unit cost reported	Unit direct support cost spent per refugee and per year	Real expenditure on support to water provision and authority functions per non-refugee reported to UNHCR and per year	Number of refugees reported by each agency to UNHCR		Expenditure to support the administration and the provision of a service to non-refugees by each agency					
	Unit direct support cost spent per non-refugee and per year	Real expenditure on support to water provision and authority functions per refugee reported to UNHCR and per year	Number of non-refugees reported by each agency to UNHCR		Expenditure to support the administration and the provision of a service to refugees by each agency					
Unit cost observed	*Unit direct support cost spent per refugee surveyed*	*Real expenditure on support to water provision and authority functions per non-refugee surveyed*	*Number of refugees surveyed per water point operated by each agency*		*Number of functional water points observed per water system operated by each agency*		*Expenditure to support the administration and the provision of a service to refugees by each agency*			
	Unit direct support cost spent per non-refugee surveyed	*Real expenditure on support to water provision and authority functions per non-refugee surveyed*	*Number of non-refugees surveyed per water point operated by each agency*		*Number of functional water points observed per water system operated by each agency*		*Expenditure to support the administration and the provision of a service to refugees by each agency*			

After replicating these calculations for a sufficient number of systems and services, it is possible to compare the life-cycle costs of water systems and water services. Water systems can be compared across time and countries using cost per water point, m3 or capita, while water services can be compared across time and countries using cost per capita (table 10).

Table 10 Unit costs for comparing systems and services

<table>
<tr><th></th><th></th><th></th><th colspan="5">Unit cost</th></tr>
<tr><th colspan="2"></th><th>Cost component</th><th>Annual</th><th>Per water system</th><th>Per m3</th><th>Per water point</th><th>Per capita</th></tr>
<tr><td rowspan="4">Water service</td><td rowspan="3">Water system</td><td>Investment</td><td></td><td>X</td><td></td><td>X</td><td>X</td></tr>
<tr><td>Operation and maintenance</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Capital maintenance</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td></td><td>Direct support</td><td>X</td><td></td><td></td><td></td><td>X</td></tr>
</table>

4. Costing levels of service: how does it work?

The last step of the life-cycle costing methodology is to bring costs and service levels together. Unit costs must be compared with the level of service delivered. A specific system can have low unit costs, but provides a problematic service to most users. The opposite would be a service that is relatively expensive, but supplies the expected number of users above standard. LCCA always compares cost against service level in order to either try to lower the cost for a given level of service or limit the increase in cost for improving the level of service.

Costing of service levels will be calculated in the three following situations:

- where only one water point exists
- when a single water system exists with several water points
- where a mix of technologies supplies water in the camp or settlement.

Single water point

This first situation is not met in the context of humanitarian interventions, but it helps to understand the principle of costing service levels.

Let's take the example of a village of 200 people with one borehole equipped with a hand pump. The investment is 20,000 US$ and the recurrent expenditure is 500 US$ per year. Table 11 reports on the cost and service as designed and the cost and service based on observation. For the sake of simplicity, only 2 levels of service are retained: complying with standard and below standard.

Table 11 Unit costs and levels of service per design and as observed for a single water point

	Per design	As observed
Number of villagers with service complying with standards	200	60
Number of villagers with service below standards		100
Investment cost per capita (US$)	100	125
Recurrent cost per capita (US$)	2.5	3.1

Per design or as planned, all villagers are receiving a basic service that costs 100 US$ per capita and 2.5 US$ per capita per year. Based on the observed number of users and level of service, each user costs 125 US$ in capital and 3.1 US$ per capita per year in recurrent expenditure. There are fewer users using the water point than expected (160 instead of 200), and only 60 receive a basic service. In the case of a single water point, the unit costs of both levels are the same: per capita, the provision of a below standard service to 100 users and the provision of a basic service to 60 users. The analysis concludes that for a 20,000 US$ investment and an annual spending of 500 US$, 60 people receive a service complying with standards versus the 200 planned.

Single water system – multiple water points

A water system with multiple water points can be for example a piped scheme supplying a number of taps or a group of decentralised water points such as hand dug wells or boreholes equipped with hand pumps. It can be found in the first emergency phase when water is being trucked in and distributed through emergency water points, but also in a later recovery phase when a piped scheme is built to meet a more permanent demand.

Observed cost per capita may differ from planned cost per capita, but cost per capita (whether observed or planned) remains the same whatever the type of water point. What changes from one water point to the other are the levels of service provided. The difference with situation 1 is that the levels of service of all the water points must be consolidated to be compared against unit costs.

Let's take the example of a system with 2 water points. The investment for the whole system is 40,000 US$ and the budgeted recurrent costs are 1,000 US$ per year. Each water point is designed to supply 200 people every day. At the end of the year, it turns out that the expenditure on investment equals the budget (40,000 US$), but recurrent costs are 1,200 US$. The water points have served 450 people.

Table 12 Planned vs observed unit costs and service levels for a single system with two water points

	Per design	As Observed		
	WP 1 & 2	WP 1	WP 2	WP 1 & 2
Number of users with service above standard	400	50	0	50
Number of users with service below standard	0	100	300	400
Investment per capita (US$)	100	88.9		
Recurrent expenditure per capita (US$)	2.5	2.7		

It means that the provision of water can be compared in terms of cost and benefit across camps where a single system is in place. It allows comparing the cost and benefit of single systems that have been installed at different periods or in different locations, either similar systems (emergency systems for instance) or different systems (decentralised vs centralised system for instance). This type of analysis is required to identify the factors (notably population size) that justify a technology shift, because a similar level of service can be provided at lower cost or similar expenditure can generate higher levels of service.

System mix – extension and development

This third situation can be seen in camps or settlements where different systems co-exist to supply water to refugees: it can be a mix of decentralised water points initially built and still available after a piped scheme has been later deployed to cope with population increase. In this case, the question can be: should we extend the latter and close the former or are decentralised water points competitive in terms of cost and service levels?

The analysis has been done in 2 steps:

- For each system, the cost per capita is calculated in a similar way as in situation 2 (single system).
- For each service level, the cost per capita aggregates the unit costs of the different systems in proportion with the population each system supplies at this level.

Let's take the example of a camp where two systems co-exist: the initial system has 2 water points (the same as in the previous example) and the second 3 water points with a budget of 50,000 US$ in investment and 3,000 US$ per year in recurrent costs to supply 600 refugees per year. In reality, the investment for system 2 turns out to be 55,000 US$, recurrent costs are 2,000 US$ per year and only 300 refugees are served instead of the 100 according to the standard.

Table 13 Unit costs and service levels per design vs observed for a system with three water points

	Per design		As Observed	
	System 1	System 2	System 1	System 2
Number of users with service above standard	400	600	50	100
Number of users with service below standard	0	0	400	200
Investment per capita (US$)	100	83.3	88.9	183.3
Recurrent expenditure per capita (US$)	2.5	5	2.7	6.7

The unit costs per service level in the camp are given in table 14. As observed, 50 users are served according to standards for an investment of 88.9 US$ each and 100 for an investment of 183.3 US$ each: the service above standard costs on average 152 US$ per capita in investment (50 X 88.9 + 100 X 183.3 / 150).

Table 14 Unit costs per design vs observed for two levels of service provided by two water systems

	Per design	As observed	
	Service above standard	Service above standard	Service below standard
Investment cost per capita US$	90	152	120
Recurrent cost per capita per year US$	4	5.3	4

5. Conclusion

This report makes clear that both in a refugee context and in a regular settlement, similar components make up the life-cycle costs of a water provision: systems must be built, operated and maintained, and, at some point, rehabilitated, and that support is required to plan, organise and monitor the service itself. It also makes clear that the ladder that was initially developed to assess the service delivered to a certain population in a regular settlement can be adapted to a refugee context, based on UNHCR indicators.

LCCA is about investigating the real costs of providing a service for a given population in a given area not only for a few years but forever. It entails collecting financial expenditure for each cost component and calculating unit costs that can be used for planning and budgeting. It also entails collecting data related to the service that is actually being delivered to a targeted population in order to compare unit costs with the service provided.

Implemented in a sufficient number of camps and settlements, from first emergency to late recovery, with a large number of water systems of various sizes and age, LCCA could help in addressing questions such as:

- How much does it cost to operate and maintain a given water system that provides enough and safe water to populations of different sizes? How do these costs compare to those of other systems? What is the most cost-effective system after capital maintenance is taken into account?
- How much does it cost to support the provision of a given water service from first emergency to late recovery, by various international agencies? How much needs to be invested in developing local capacities to transfer the organisation and provision of the service to local authorities and service providers?

Testing the methodology in 2 camps will give IRC and UNHCR the opportunity to identify and cope with possible limitations. Specific attention will be given to the replicability of the approach at larger scale, building on the financial and technical monitoring and reporting tools used by UNHCR.

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