CASE STUDIES

The National Rural Water Supply and Sanitation Program in Tanzania

Paulo Milanesio and Alvar Garola

PHOTO: Queuing for water. Paulo Milanesio

GDEE GLOBAL DIMENSION IN ENGINEERING EDUCATION

CASE STUDIES

The National Rural Water Supply and Sanitation Program in Tanzania

EDITED BY
Global Dimension in Engineering Education

COORDINATED BY
Agustí Pérez-Foguet, Enric Velo, Pol Arranz, Ricard Giné and **Boris Lazzarini (***Universitat Politècnica de Catalunya)*
Manuel Sierra *(Universidad Politécnica de Madrid)*
Alejandra Boni and **Jordi Peris** *(Universitat Politècnica de València)*
Guido Zolezzi and **Gabriella Trombino** *(Università degli Studi di Trento)*
Rhoda Trimingham *(Loughborough University)*
Valentín Villarroel *(ONGAWA)*
Neil Nobles and Meadhbh Bolger *(Practical Action)*
Francesco Mongera *(Training Center for International Cooperation)*
Katie Cresswell-Maynard *(Engineering Without Border UK)*

DL B 10735-2015
ISBN 978-84-606-7546-4

Citation: Milanesio, P. and Garola, A. (2015) ' The National Rural Water Supply and Sanitation Program in Tanzania', in *Case studies for developing globally responsible engineers*, GDEE (eds.), Global Dimension in Engineering Education, Barcelona. Available from: http://gdee.eu/index.php/resources.html

Disclaimer: This document has been produced with the financial assistance of the European Union
The contents of this document are the sole responsibility of the authors and can under no circumstances be regarded as reflecting the position of the European Union

THE NATIONAL RURAL WATER SUPPLY AND SANITATION PROGRAMME IN TANZANIA: A CASE STUDY

Paulo Milanesio, Universitat Politècnica de Catalunya
Alvar Garola, Universitat Politècnica de Catalunya

INDEX

1. INTRODUCTION

The Tanzanian government, as many others in the Sub-Saharan region, has undertaken an ambitious plan to improve and increase access to water and sanitation services. In 2006, the National Rural Water Supply and Sanitation Program (NRWSSP) was launched as part of a bigger plan to improve and increase access to water. To implement this ambitious program and meet the corresponding objectives it was necessary to develop a comprehensive resources allocation strategy in order to set out what factors should be considered, and how they should be weighted and applied. With limited resources, adequate mechanisms are required to ensure that efforts and available resources are allocated to those water and sanitation activities that will produce the greatest impact for beneficiaries. Thus, evaluating the economic costs of interventions and the resulting benefits is critically important for effective resource allocation. While many criteria help to determine where resources should be targeted, such as social and environmental considerations, a sound economic cost-benefit analysis is a vital and useful tool for decision-makers (Sanctuary 2012).

In this case study, students will first analyse how the NRWSSP allocated available resources and how the decisions were made by the Ministry of Water in collaboration with the World Bank, the principal donor of the program. Second, an alternative case study is presented for analysis, based on the strategy followed by the well-known NGO WaterAid in Tanzania. A comparison between these two different alternatives will allow the students to draw corresponding conclusions on effective resource allocation for water and sanitation. The student will firstly receive a theoretical session about the fundamentals presented in this document: an analysis of the context including the national resources allocation in developing countries framework; a brief description of the context in The United Republic of Tanzania; the global and Tanzanian situation concerning the Water, Sanitation and Hygiene (WASH) sector; and a description of the NRWSSP. After that, the two activities will be presented: In the first activity (class activity) students will work on understanding how the NRWSSP select beneficiaries of the program and allocate corresponding resources. In the second activity (the homework) fieldwork of the organization WaterAid will be described. This field work consists of a water point mapping approach (WPM) that was designed as a procedure for measuring access to water. This new way of measuring population water needs allowed WaterAid to have a different perspective on improving water access. Thus, the case study will help the students to integrate all those information and to compare these two outlooks and conclude through their differences.

1.1. DISCIPLINES COVERED

The case study covers the allocation of national resources for the WASH field in a developing country, The United Republic of Tanzania. It is intended that students will understand the methodology implemented and criticize it through a cost-benefit analysis, that examines the results obtained and the way the funds have been allocated. This analysis will be possible after the students have completed a class activity and a complementary homework activity. Apart from the NRWSSP methodology and results, the case study also shows an alternative methodology executed by WaterAid, which is characterized fundamentally by fieldwork where data was obtained through a Water Point Mapping (WPM) approach. The presented case study promotes teamwork and encourages an atmosphere of constructive debate since the students will be organized in groups of 3 or 4 to carry out the activities.

1.2. LEARNING OUTCOMES

As a result of this case study, students are expected to be able to:

- Understand the problem of lack of access to drinking water and sanitation services and its consequences on human development.
- Know how national governments develop a National WASH Program and decide how to allocate national resources.
- Develop an economic cost-benefit analysis relevant to the WASH sector.
- Work with real data and process it in order to recognize how to allocate the funds of Tanzania's National Program.
- Understand how the WPM approach works and the differences that exist between using this and the Government of Tanzania's approach allocate funds.

1.3. ACTIVITIES

The following learning activities are proposed:

- Theoretical session: 2 hours class work on the economic analysis of water supply projects. The case study will be presented as a means to understand the way that the allocation of resources is conducted in developing countries, especially the WASH sector. Prior to this session, the students will have to read basic materials on economic cost-benefit analysis and queuing disciplines. It is also advisable for the students to read the context of this case study in advance.

- Problem resolution activity: the students will be organized into working groups and will be presented a communications problem based on the same context explained in the theory session. The problem will involve a cost-benefit analysis. Two activities are proposed (a class activity and a homework activity). Several solutions will be proposed during the class activity and each group will have to discuss the best way to solve the problem and define the details. Afterwards, students should develop this work through the homework activity, which is a decision-making exercise based on the class discussion and additional contributions of each group. The outcome will be a report produced by each group. It is important to consider that calculations in this case study will be conducted using the maximum amount of data available, which means that the lecturer can also reduce the exercise where necessary to meet class requirements.

2. DESCRIPTION OF THE CONTEXT

In this section a description of the context of the case study is provided. First, the framework of national resources allocation in developing countries is briefly explained. Secondly, the context of the case study of Tanzania is given, in relation to the WASH situation at global and national levels; the NRWSSP is then presented. Finally, the specific context of the proposed WaterAid case study is clarified and the methodology used for the funds allocation explained.

2.1 FRAMEWORK OF NATIONAL RESOURCES ALLOCATION IN DEVELOPING COUNTRIES

A resource allocation framework sets out what factors should be considered, and how they should be weighted and applied. Considering the case study analyzed in this report, the framework for national resources allocation will be applied to the rural water supply and sanitation sector.

As it is very important to conduct good resource allocation within any development sector, adequate mechanisms are required to ensure that resources are allocated to those water and sanitation activities that are likely to have the greatest impact on achieving sector objectives. Also, it is important to note that there are many factors to consider when assessing how best to allocate resources between and within water and sanitation sub-sectors, but there is never one ‘right’ answer. Thus, determination of the best way to allocate resources within a country is a key decision, whether targeted at centrally managed projects or (increasingly) as local decentralized funding. Considering that the division of rural resources is a particularly difficult issue to resolve, this case study will contribute to understanding these concepts. Finally, it should be highlighted that effective financial management requires good

monitoring, evaluation and audit procedures (Fisher, 2005).

As mentioned above, there is not only one method that can be used to make decisions on resources allocation. There are several different methods, like the sub-sector driven approach, or the sector objectives driven approach. The overall focus for the first of these is to allocate resources based on the importance of each sub-sector concerned Using the second method, resource allocation is based on the objectives and targets of the sector as a whole, investing where the gaps are greatest. The case study presented in this report uses the first methodology and a “Sector Investment Plan” (SIP) approach is completed. Using this method, several institutions take part in what is called Sector Wide Approach (SWAp), with key stakeholders meeting regularly to develop integrated sector policies, plans and budgets. This method is increasingly used and donors’ support is allocated across different institutions around the countryas funds are decentralised to local governments. Considering that geographical allocation is politically sensitive, the simplest method of allocation uses population levels, but this does not account for differing poverty levels, costs of providing services and access rates to them. Calculating and comparing these factors for different regions requires elaborate formulae and transparency is vital so that resource allocation decisions can be challenged (Fisher, 2005). However, cost-benefit analysis is rarely, if ever, the sole procedure used for making public investment and policy related decisions. Views differ on how desirable this current situation is, but political reality dictates that many other interests are embedded in decisions made (Brower R, etal. – 2005).

2.2 TANZANIA –CONTEXT OF THE CASE STUDY

The United Republic of Tanzania is located in Eastern Africa. It is bordered by Kenya and Uganda to the North, Rwanda, Burundi and the Democratic Republic of Congo to the West and Zambia, Malawi and Mozambique to the South, as shown in Figure 1. The country's eastern border lies in the Indian Ocean which has a coastline of 1,424 km. Tanzania has a total area of 945,087 km^2.

Figure 1: *The United Republic of Tanzania Location*
Source: https://www.countryreports.org/

Population

In 2005 the population of Tanzania stood at 36.2 million, with an annual growth rate of 2.9%. The population was estimated in 46,218 million by the end of 2011 (Tanzania Country Profile – 2014)

Economy

Tanzania is a developing country and its economy depends heavily on agriculture. The sector accounts for more than 40% of the Gross Domestic Product (GDP), provides 85% of the country's exports and employs 80% of the total workforce. Apart from the agricultural sector, tourism, mining and small scale industries are increasingly contributing to the national economic growth (Tanzania Country Profile – 2014). Figure 2 presents further information relating to resource availability and allocation in Tanzania, as provided in the last edition of the UNDP Human Development Report in 2014.

								DEBT			PRICES		
GDP	GDP per capita	Gross fixed capital formation	General government final consumption expenditure		Taxes on income, profit and capital gain	Research and development expenditure	Share of agriculture, hunting, forestry and fisheries	Domestic credit provided by the banking sector	External debt stock	Total debt service	Consumer price index	Domestic food price level	
(2011 PPP $ billions)	(2011 PPP $)	(% of GDP)	Total (% of GDP)	Average annual growth (%)	(% of total tax revenue)	(% of GDP)	(% of GDP)	(% of GDP)	(% of GNI)	(% of GNI)	(2005=100)	Index	Volatility index
2012	2012	2005–2012[a]	2005–2012[a]	2005–2012	2005–2012[a]	2005–2012[a]	2012	2012	2005–2012[a]	2012	2012	2013	2013
76,8	1654	36,1	16,4	14,2	..	0,4	28,3[c]	24,8	42,6	0,64	197	2,4	67,6

Figure 2: *Command over and allocation of resources - United Republic of Tanzania*
Source: UNDP, 2014.

History - Independence

Tanganika became independent on 9th December 1961, and Zanzibar received its independence from the United Kingdom on 10th December 1963. On 26th April 1964, Tanganyika was united with Zanzibar to form the United Republic of Tanganyika and Zanzibar. The country was renamed the United Republic of Tanzania on October 29 of the same year. The name Tanzania is a blend of Tanganyika and Zanzibar and previously had no significance.

Decentralization at Tanzania

The government structure, including local administration, existed in Tanzania before independence. The current government's decentralization policy was outlined in the 1998 Policy Paper on Local Government Reform (GoT 1998) and is characterized by the transfer of competencies from central to distinct legal entities, which have wide autonomy. The policy was expected to reduce poverty by improving service delivery thanks to effective and autonomous Local Government Authorities (LGAs).

2.3 WATER, SANITATION AND HYGIENE: THE WORLD REALITY AND TANZANIA`S SITUATION

Water, sanitation and hygiene (WASH) are essential for health, welfare and livelihoods. Research shows that increased access and better services lead to higher levels of school achievement and improved economic productivity. The linkages between improvements in WASH and the achievement of targets relating to poverty, health, nutrition, education, gender equality proposed targets and indicators for drinking-water, sanitation and hygiene and sustainable economic growth are well established (WSSCC, 2014). Yet, many people do not have their basic human rights to water fulfilled. **'Universal access to safe drinking water, sanitation and hygiene'** is a long-standing development goal.

Considering the global WASH situation, Figure 3 shows that Sub-Saharan African countries have the lowest proportions of population with access to improved drinking water supply. The same situation is true for access to sanitation facilities, as presented in Figure 4 below.

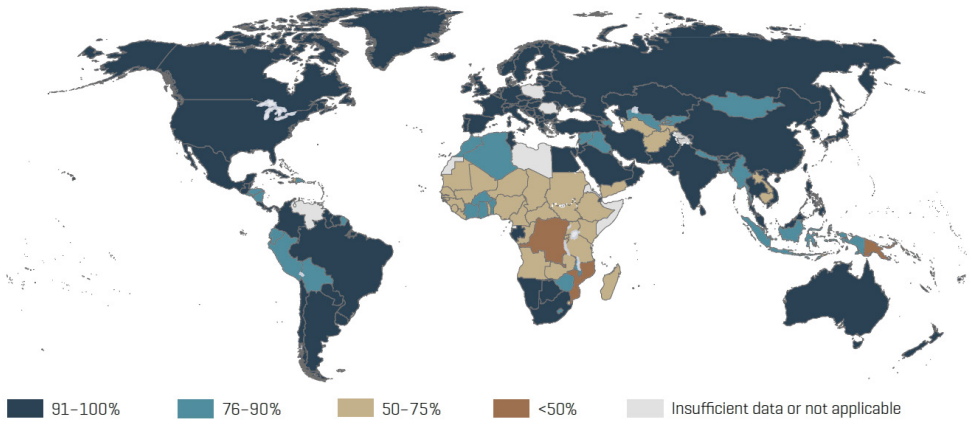

Figure 3: *Proportion of Population Using Improved Drinking Water Sources in 2012*
Source: WHO/UNICEF JMP, 2014

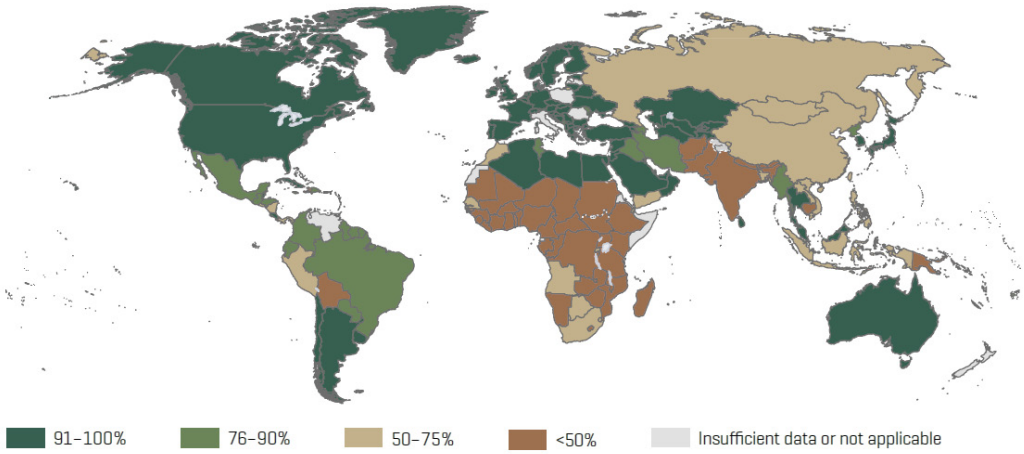

Figure 4 *Proportion of the Population Using Improved Sanitation in 2012.*
Source: WHO/UNICEF JMP, 2014

In Figure 3 and Figure 4 above, it can be seen that Tanzania is one of the countries in critical situation, both in terms of access to improved drinking water supply and sanitation services in the rural areas. Figure 5 presents the corresponding data for Tanzania. Figure 5a shows the total drinking water trends between 1990 and 2012, with 47% of the population remaining underserved by the end of the period. Regarding rural sanitation trend for the same period, Figure 5b shows that 89% of the population had undesirable sanitation practices.

It is important to note that data presented in the figures below follow the different categories that the WHO/JMP uses to classify water resources and quality, and sanitation facilities. According to WHO/JMP, an improved drinking water source is one that, by the nature of its construction, adequately protects the source from outside contamination, particularly faecal matter. Improved sources include, but are not limited to, protected dug wells, boreholes, rainwater collection and standpipes. Unimproved sources have been disaggregated into two categories: surface water and other unimproved sources. Surface water includes water collected directly from rivers, lakes, ponds, irrigation channels and other

surface sources. The latter includes unprotected dug wells, unprotected springs and water delivered by cart or tanker. For sanitation the same source is used to define the categories. An improved sanitation facility is one that hygienically separates human excreta from human contact.. Unimproved sanitation comprises facilities that fall short of being 'improved' and are unimproved, shared or public. An example of unimproved sanitation is open defecation, which is defined as defecation in fields, forests, bushes, bodies of water or other open spaces. All definitions relating to water and sanitation facilities are outlined in the Table below.

	Drinking Water	Sanitation
Improved	Use of: ▪ Piped water into dwelling, yard or plot ▪ Public tap or standpipe ▪ Tubewell or borehole ▪ Protected spring ▪ Protected dug well ▪ Rainwater collection	Use of: ▪ Flush or pour-flush to: – Piped sewer system – Septic tank – Pit latrine ▪ Ventilated improved pit (VIP) latrine ▪ Pit latrine with slab ▪ Composting toilet
Unimproved	Use of: ▪ Unprotected dug well ▪ Unprotected spring ▪ Cart with small tank or drum ▪ Tanker truck ▪ Surface water (river, dam, lake, pond, stream, canal, irrigation channel) ▪ Bottled water (considered to be improved only when the household uses drinking water from an improved source for cooking and personal hygiene)	Use of: ▪ Flush or pour-flush to elsewhere (that is, not to piped sewer system, septic tank or pit latrine) ▪ Pit latrine without slab, or open pit ▪ Bucket ▪ Hanging toilet or hanging latrine ▪ Shared or public facilities of any type ▪ No facilities, bush or field (open defecation)

Source：WHO/UNICEF JMP，2014

NZANIA RURAL DRINKING WATER TREND (b) TANZANIA RURAL SANITATION TREND

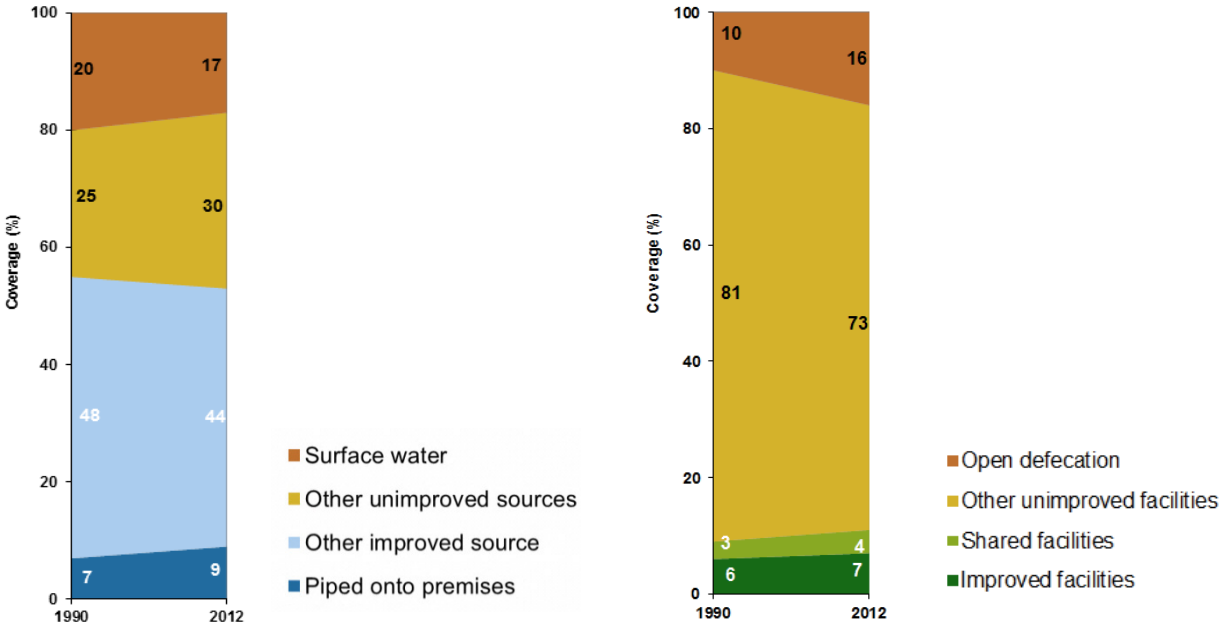

Figure 5: *(a) Proportion of the Population Trend Using Improved Drinking Water Sources and (b) Improved Sanitation. (1990 – 2012). Source: WHO/UNICEF JMP, 2014*

2.4 THE NATIONAL RURAL WATER SUPPLY AND SANITATION PROGRAM (NRWSSP) AT TANZANIA

The Tanzanian government, like many others in the Sub-Saharan region, has undertaken an ambitious plan to improve and increase access to water. This plan, known as the Water Sector Development Program (WSDP), includes three sub-programs: water resources management and development, the RWSSP, and urban water supply and sewerage. At the time of programme design, Tanzania had an estimated rural population of 25.9 million, and the reported rural water coverage was 53% (MoW, 2006a).The central government plays the role of coordinator and facilitator in the water sector, while the district level holds the main implementation responsibilities (World Bank, 1998).

Targets

The NRWSSP establishes targets for the percentage of rural population with sustainable and equitable access to safe water:

(1) At least 65% by 2010 (a goal set by the National Strategy for Growth and Reduction of Poverty, also known as MKUKUTA);

(2) At least 74% by mid-2015, as specified by the Millennium Development Goals; and

(3) At least 90% by 2025.

Population Growth estimation

The estimated population growth rate for the period at the national level is derived from the population growth estimated for the region in the 2002 household census. Overall, the fulfilment of the above targets will require extending water supply coverage to an additional 33.8 million people from 2005 to 2025.

Cost Estimation

The estimated costs for the rural component (i.e., excluding small towns) is US$1.61 billion, with US$1.46 billion for capital investment, including rehabilitation, US$51 million for management and operational support to districts, nearly US$17 million for institutional strengthening and development, and US$74 million for contingencies (Ministry of Water 2006a, “Table 3-4”).

General Planning Process

The process at district level combines approaches from two different directions: top-down and bottom up. Every year the LGA decides on their budget based on allocations to their districts, which is submitted to the Ministry of Funds (MoF). The MoF has the last decision and approves the national budget. At the ministry level the same system is used and the development grants are allocated only to qualified districts. However the mechanism is different, since the Ministry allocates funds to qualified districts according to formulae, and the LGA makes the final selection of beneficiaries discussing during the full council meeting.

Key Aspects at Ministry Level

For this case study we will concentrate in the Ministry’s mechanisms of decision making. The allocation of NRWSSP resources are affected by the following responsibilities: design of programme, allocation of resources and formulation of guidelines to help LGAs.

In reference to the **design of the programme**, it is important to notice that calculation of costs for each district was based on two general principles: i) current coverage rates – the program aims to increase coverage levels in those district showing lowest coverage -, and ii) technological options presented in each district.

Hence, the number of water points needed to attain the desired coverage for every district was calculated and the costs were assigned based on the foreseen technology mix. This technology mix

was the main driver for cost calculation, neither the total costs per district nor the budget per capita have any relationship with the initial water coverage per district. (Jimenez, etal. 2011)

With respect to the **allocation of resources,** allocation of NRWSSP funds from ministry to district level is driven by formulae. Three different water budgets are in place:

- The Development Budget (also named the Capital Development Grant: is used for implementing water infrastructure and constructing demonstration latrines. This represents 91.22% of the estimated budget of the programme. The proportion of unserved population living in one district compared with the total unserved population in the country is taken as the parameter for allocating funds. This represents a major shift between the intended goal and the implementation of the plan, since the largest groups of unserved people will be targeted there will not be territorial equity.
- The Recurrent Budget (also named the Rural Water Block Grant), it is the investment assigned for the annual supervision, monitoring and support of water services in rural communities. In this budget priority is given to unserved areas (90%).
- The Capacity Building Grant: for this grant, the same amount is allocated regardless of the district.

3. CLASS ACTIVITY

3.1 THE NRWSSP IMPLEMENTATION

The NRWSSP has a planning process that assigns the main responsibilities at different government levels, which affects the allocation of resources related to the programme. At the Ministry of Water, the main responsibility is the design of the RWSSP, which includes the allocation of funds to districts and preparation of guidelines for implementation. This allocation of funds, which is the main topic addressed in this case study, is analysed in the following paragraphs.

The forecasted allocation of resources is derived from three general principles (Ministry of Water 2006a):

- Districts with less coverage will receive more funds to bring their level of service closer to the national level. In 2004, the reported coverage by district ranged from 6.4 to 91.8%. The RWSSP aims for all districts to be in the range 80 to 95% by 2025.
- The proposed water supply technologies and related costs are derived from the existing mix of technologies in each district, combined with a demand assessment study performed in 18 districts and expert opinions.
- Government investment forecasts for 2005–2025 assume that only 25% of all rural systems in existence in 2004 will require major investments for rehabilitation during that period (MoW 2006a, “5.6.1.3. Rehabilitation of Existing Systems”). Additionally, capital investment for major system rehabilitation is assumed to account for 66% of the cost of new water supply services by technology. As a result of these two assumptions, only US$77 million of government funds has been set aside for rehabilitation (MoW 2006a, Annex B “Appendix 5”).

NRWSSP Implementation Manual Resume

The National Rural Water Supply and Sanitation Programme (NRWSSP) is the national plan to reduce poverty and improve the health and quality of life of the rural population. The Ministry of Water (MoW) has implemented several Rural Water Supply and Sanitation Projects over the past 30 years, with support from different donors, External Support Agencies (ESAs) and Non-Governmental Organisations (NGOs),which are putting the water policy into practice. The core problem addressed by these initiatives is the inadequate supply of clean and safe water and the low standard of sanitation that prevails in rural settlements.

Population and Growth Rates

Investment requirements are based on the rural district census population and growth rate figures as reported in the 2002 census. The rural census includes small towns with populations under 50,000 (discussed specifically in Section 4 of this report) but exclude regional and district centres with more than 50,000 residents. For the purposes of estimating investment requirements in this report, the total rural and small towns population is estimated at 30.0 million as of 2004, projected to grow to 56.0 million by 2025.

Current District RWSS Coverage Levels

Nationally, water supply coverage was estimated by MoW to be 53% in December 2003.Estimated levels of actual coverage in water supply in rural districts as of December 2003 were provided by MoW, while estimates of coverage in the small towns considered herein were provided by the towns themselves. These approximations of current coverage in rural water supply, together with projections for population growth forecasts, were used as a basis for determining investment needs for the future.

Using these information sources (national estimates, MoW and small towns), it is therefore estimated that approximately 15.9 million inhabitants of rural districts and small towns (or 53% of the total population of 30.0 million) currently have access to adequate water supplies (MoW, 2006a).

Funding Sources

Table 1 provides a summary of specific investments in the NRWSS sub-sector, during the 2005 – 2008 time period, for which GoT and/or external funding has been identified. In response to the resources that are planned to be allocated in the construction and rehabilitation of water systems, donors are provided by the World Bank, which is the principal investor in the NRWSSP.

Table 1 - *Summary of Funding Identified for NRWSS Sub-Projects (USD).*
Source: MoW - NRWSSP Implementation Manual.

SOURCE	2005/2006 [USD]	2006/2007 [USD]	2007/2008 [USD]	TOTAL [USD]
Government of Tanzania	1,968,000	5,672,000	6,239,200	13,879,200
Donors	11,570,000	14,013,000	15,414,300	40,997,300
Non-Governmental Organization	1,800,000	2,400,000	2,700,000	6,900,000
TOTAL	15,338,000	22,085,000	24,353,500	61,776,500

3.2 ECONOMIC COST – BENEFIT ANALYSIS IN THE WASH SECTOR

Economic principles that can inform water policy debates rest on the concepts of benefit and cost. That is why the cost–benefit framework, in general, can provide a comparison of total economic gains and losses resulting from a proposed water policy. For public water policy proposals, maximum beneficial use of water and its complementary resources requires that government formulate, implement and evaluate their water resource programmes using these economic principles. Using methods that are grounded in time-tested economic principles, the cost–benefit analysis can provide decision-makers with a comparison of the impacts of two or more water policy options. Using this methodology, it is possible to examine the growth of the social benefit derived from the water used and not just the quantity of water used itself. Economic efficiency, measured as the difference between added benefits and added costs, can inform water managers and the public of the economic impacts of water programmes to address peace, development, health, the environment, climate and poverty (Ward F. A., 2012). Improving water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication (Sanctuary M., 2012). A cost–benefit analysis is an analytical technique for measuring the economic efficiency of public actions by translating positive and negative effects to a common measure (normally money), in the WASH sector is possible to apply this and obtain important results that help decision-making on resource allocation.

DISCUSSION:

As outlined above, the NRWSSP is implemented through the construction of new water systems and technologies, or the rehabilitation of existing ones. These technologies are an obvious part of the costs list and generate specific benefits for associated sectors. Apart from those related to technologies, there are others factors that can be listed as costs and benefices.

Costs of water improvement vary principally with the infrastructure and implementing costs, depending on the technology adopted and the population covered. Furthermore, the benefits associated to the implementation of technologies have influence at a range of diverse levels. In groups of three or four students, list which other costs and benefits should be taken into account in order to make an economic analysis that allows for the correct resource allocation to be decided upon and implemented. After listing them, explain why they are important for the decision-making processes and the beneficiaries' selection. Discuss them with the other groups in the class with the aim of defining a final list that will be necessary for the homework activity. The first line of a solution table to help students create the list of factors required is given below.

BENEFICIARY	DIRECT ECONOMIC BENEFITS OF AVOIDING DIARRHEAL DISEASE	INDIRECT ECONOMIC BENEFITS RELATED TO HEALTH IMPROVEMENT	NON-HEALTH BENEFITS RELATED TO WATER AND SANITATION IMPROVEMENT

3.3 SOLUTION AND EVALUATION CRITERIA

The table that is expected to be created during the class activity is presented below, where the economic benefits arising from water and sanitation improvements are presented.

BENEFICIARY	DIRECT ECONOMIC BENEFITS OF AVOIDING DIARRHEAL DISEASE	INDIRECT ECONOMIC BENEFITS RELATED TO HEALTH IMPROVEMENT	NON-HEALTH BENEFITS RELATED TO WATER AND SANITATION IMPROVEMENT
Health Sector	• Less expenditure on treatment of diarrheal disease	• Value of less health workers falling sick with diarrhoea.	• More carefully managed environment and effect on vectors.
Patients	• Less expenditure on treatment of diarrheal disease and related cost. • Less expenditure on transport in seeking treatment. • Less time loss due to treatment seeking.	• Value of avoided days lost at work or at school. • Value of avoided time loss of care for sick babies. • Value of loss of death avoided.	• More carefully managed environment and effect on vectors.
Consumers			• Time savings related to water collection or accessing sanitary facilities. WS give women more time for child care, domestic hygiene and food preparation, relaxation, organizing themselves; education, production. • Labour-savings devices in household. • Switch away from more

			expensive water sources. • Property value rise. • Leisure activities and non-use value. • Improved school attendance (if boys and girls are in charge of water collection duties) • See Benefits of Latrine Ownership as Perceived by 320 Households in Rural Benin in attached table (Jenkins (1999) PhD Thesis)
Agricultural and industrial sectors	• Less expenditure on treatment of employees with diarrhoea disease.	• Less productivity impact of workers being off sick.	• Benefits to agriculture and industry of improved water supply – time saving or income-generating technologies and land use changes.

Benefit	(Average importance rating, scale 1–4)
Avoid discomforts of the bush	3.98
Gain prestige from visitors	3.96
Avoid dangers at night	3.86
Avoid snakes	3.85
Reduce flies in compound	3.81
Avoid risk of smelling or seeing feces in bush	3.78
Protect my feces from enemies	3.71
Have more privacy to defecate	3.67
Keep my house or property clean	3.59
Feel safer	3.56
Save time	3.53
Make my house more comfortable	3.50
Reduce my family's health care expenses	**3.32**
Leave a legacy for my children	3.16
Have more privacy for household affairs	3.00
Make my life more modern	2.97
Feel royal	2.75
Make it easier to defecate because of age or sickness	2.62
Be able to increase my tenants' rent	1.17
For health (spontaneous mention)	**1.27**

Cost-Benefit Analysis in practice

The different criteria that could appear in the proposed table should be counted in some way. There are different ways to give value to these criteria and some examples are proposed below:

DALY; is short for Disability-Adjusted Life Year and was developed in the early 1990s to provide a broader measure of health than just deaths avoided. Thus DALYs go beyond a classification of individuals as either living or dead and incorporate standards of health on the basis of disability weights provided by the WHO. As a result "a DALY measures not only the additional years of life gained by an intervention but also the improved health that people enjoy as a consequence" (Jamison et al. 2006a).

Below is presented an example by **The Disease Control Priorities Project (DCPP):**
Both volumes of the DCCP are accessible on the internet. Go to http://www.dcp2.org/pubs/PIH and http://www.dcp2.org/pubs/DCP

Costs per DALYs averted in the DCPP Service or intervention	Cost per DALY ($US)	DALYs averted per one million $ US spent
Improved care of children under 28 days old including resuscitation of newborns)	10-400	2500-100,000
Expansion of immunization coverage with standard child vaccines	2-20	50,000-500,000
Adding vaccines to the standard child immunization programme	40-250	4,000-24,000
Switching to the use of combination drugs (ACTs) against malaria where there is resistance to current inexpensive drugs (Sub Saharan Africa)	8-20	50,000-125,000

Source: Jamison et al., (2006)

Another reference to calculate these values is presented by Malloy-Good S., et al.. (2008). WHO indicates numerous benefits to water and sanitation programmes. These benefits span to include both health and economic factors. Health benefits were a critical point in the study, as improved access to water and sanitation can greatly decrease the incidence of water-borne, water-washed, water-based, water-related, and vector-borne diseases and illnesses (Hutton et al, 2007a). Some examples are given below.

TIME SAVINGS VALUE

Determining Time Saved per Day

New Estimate of Time Saved – WHO Estimate = (3)-(0.05) = **2.5 Hours Saved**

Determining Time Saved per Year
Hours Saved per Day (New Value) x Days per Year = (2.5) x (365) = **912.5 Hours Saved per Year (per capita)**

Determining Hours per Year
Hours per Day x Days per Year = (24) x (365) = **8,760 Hours in a Year**

Determining Minimum Wage
GNI per capita / Hours per Year = (742.90) / (8,760) = **$0.0848 per Hour**

Determining Monetary Value to Total Hours Saved
Hours Saved per Year x Minimum Wage Rate = (912.5) x ($0.0848) = **$77.39 per Year (per capita)**

Determining Monetary Value for Female Population of Sub-Saharan Africa
Value of Time Saved x Female Population of Sub-Saharan Africa = ($77.39) x (377,052,600) = **$29,180,100,710 Value of Time Saved**

INCREASED LIFE EXPECTANCY VALUE

A 10% Increase in Literacy Rate leads to a 10% Increase In Life Expectancy for Future Generation:

Determining the Change in Life Expectancy
10% Increase x Current Life Expectancy in Sub-Saharan Africa = (.1) x (47. 2) = **4.72 Years Increase in Life Expectancy for Future Generation (per capita)**

Determining Number of Children in Next Generation
Current Population in Sub-Saharan Africa x Population Growth Rate in Sub-Saharan Africa = 752.6 million x 0.023 = **17,309,800 Children In Next Generation**

Determining the Total Number of Years Gained
Years Gained per capita x Children in Next Generation = (4.72) x (17,309,800) = **81,702,256 Total Years Gained**

Determining the Monetary Value of Total Years Gained

Total Years Gained x GNI per capita in Sub-Saharan Africa = (81,702,256) x ($742.90) =

$60,696,605,980 Value Gained From Increased Life Expectancy

4. HOMEWORK ACTIVITY

The home work activity expected to be done by students takes between 8 and 12 hours. Students will be organized in groups of 3-4 students per-group, as they were separated for the class activity. Most of the information needed for the activity is described in this section and additional material is attached as separate annexes. First, the principal ideas behind the NRWSSP allocation of funds are outlined and the way the allocation was planned for this programme planned is explained. Secondly, the WaterAid water point mapping methodology is presented. Finally, the homework activity is proposed, followed by the corresponding solution and evaluation criteria.

4.1 THE NRWSSP ALLOCATION OF FUNDS

In the above mentioned Manual of Implementation, the MoT provides all the information they used to make decisions regarding the allocation of their corresponding funds.

Water Supply Needs

Future needs in terms of RWSS services, which are to be met by the programme, are determined by attempting to satisfy (or exceed) three criteria at the programme and district level.

Based on 2002 census data and current coverage levels and satisfaction of these objectives, Table 2 shows examples of some districts and gives the yearly district-level targets for new coverage (numbers of people to be provided with service) for the first six years of the programme (2005 – 2010 inclusive). In Annex 01, this table is presented for all districts.

Table 2 - *Coverage levels and satisfaction of these objectives (Arameru, Iramba and Nzega Districts). Source: MoW - NRWSSP Implementation Manual.*

DISTRICT	2004			PROGRAMME PERIOD			2025		
	TOTAL POP.	TOTAL POP. COV.	% COV.	2005	2010	POP. COV. 2005 - 2025	TOTAL POP. COV.	TOTAL POP.	% COV.
Arumeru	368.8	222.1	60%	0.0	20.0	455.4	677.5	738.0	92%
Iramba	353.0	110.3	31%	31.9	17.5	319.0	429.3	500.2	86%
Nzega	390.5	134.3	34%	0.0	18.6	423.1	557.4	644.6	86%
PERIOD - all Districts	**25,930.7**	**13,900,3**	**54%**	**697.3**	**1,395.4**	**29,926.0**	**43,826.4**	**48,695.9**	**90%**
CUMULATIVE PROGRAMME				**697.3**	**7,434.3**				
TOTAL POPULATION - all Districts		**25,930.7**		**26,669.3**	**30,773.0**				
% COVERAGE		**54%**		**55%**	**69%**				

The Technology Mix

On the basis of the populations to be provided with new access to services, the water supply coverage is disaggregated by technology type throughout the NRWSSP period (2005-2025). The mix of technologies projected for 2025 closely resembles the estimated mix of technologies currently in use across the country. These technologies are: Handpump & Shallow Well, Handpump & Borehole, Single Pumped & Piped System, Multiple Pumped & Piped System, Single Community Gravity-Fed System (GFS), Multiple Community GFS, Protected Spring, Windmill, Rainwater Catchment and Charco Dam. An estimation of the number of facilities constructed by year and by technology type is presented in Table 3 below.

Table 3 - *Estimated number of facilities constructed by year and by technology type. Source: MoW - NRWSSP Implementation Manual.*

YEAR	HANDPUMP & SHALLOW WELL	HANDPUMP & BOREHOLE	SINGLE COMMUNITY GFS	MULTIPLE COMMUNITY GFS	SINGLE PUMPED & PIPED SYSTEM	MULTIPLE PUMPED & PIPED SYSTEM	PROTECTED SPRING	WINDMILL	RAINWATER CATCHMENT	CHARCO DAM	TOTAL
AVG. USERS PER SYSTEM	**250**	**250**	**1,500**	**2.500**	**1,500**	**2,500**	**250**	**250**	**500**	**1,500**	
ESTIMATED NUMBER OF FACILITIES CONSTRUCTED											
2005	1,045	503	12	7	72	44	29	67	39	8	1,827
2010	1,860	983	79	49	119	73	46	51	74	14	3,348
2011- 2015	9,235	4,825	370	231	596	364	240	285	367	71	16,585
2016- 2020	11,686	6,262	553	345	735	451	282	249	471	86	21,121
2021- 2025	8,632	4,711	460	286	533	328	200	120	352	62	15,684
TOTAL NO. OF FACILITIES	**39,630**	**21,.058**	**1,766**	**1,102**	**2,515**	**1,542**	**973**	**979**	**1,587**	**295**	**71,447**

Rehabilitation of Existing Systems

A proportion of RWSS systems that are currently functioning will, at some point during the programme's 21-year timeframe, require substantial re-investment in order to continue to provide adequate service to existing water users. Such cases will form part of the programme's work, and for the purposes of this report, it is assumed that 25% of all existing systems (those persons currently considered to have satisfactory service) will require major investment in rehabilitation supported by the

programme.

Table 4 estimates beneficiaries of rehabilitation work during the programme in the districts of Arameru, Iramba and Nzega. It is important to note that beneficiaries of rehabilitation work are not counted as new water users in the projection of future coverage.

Table 4- *Population covered by technology rehabilitated and number of facilities. Period 2005 – 2025. (Arameru, Iramba and Nzega Districts).*
Source: MoW - NRWSSP Implementation Manual.

DISTRICT	2005 - 2025 POPULATION COVERED BY TECHNOLOGY REHABILITATED										
	HANDPUMP & SHALLOW WELL	HANDPUMP & BOREHOLE	SINGLE COMMUNITY GFS	MULTIPLE COMMUNITY GFS	SINGLE PUMPED & PIPED SYSTEM	MULTIPLE PUMPED & PIPED SYSTEM	PROTECTED SPRING	WINDMILL	RAINWATER CATCHMENT	CHARCO DAM	TOTAL
	(Pop)	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*	*(Pop)*
Arumeru	5.6	2.8	16.7	16.7	6.9	6.9	0.0	0.0	0.0	0.0	55.5
Irambo	8.3	16.5	0.0	0.0	0.7	0.7	0.0	1.4	0.0	0.0	27.6
Nzega	13.4	8.4	0.0	0.0	5.0	5.0	0.0	0.0	1.7	0.0	33.6
TOTAL	1069.7	612.4	356.6	368.8	417.9	426.1	32.6	45.9	89.5	55.7	3475.1
AVG. USERS PER SYSTEM	250	250	1,500	2,500	1,500	2,500	250	250	500	1,500	
NUMBER OF FACILITIES REHABILITATED											
Period 2005 - 2025	4279	2450	238	148	279	170	130	183	179	37	

Capital Investment Costs

For new services to users currently without access, unit costs are used to calculate the yearly capital investment costs according to technology for each rural district and each small towns, by applying them to the projections of new water supply beneficiaries (by technology) provided in Annex 02.
The capital cost of investment requirements in new water supplies to meet national and district-level coverage targets in rural communities is estimated at USD 1,207.22 million not including sanitation promotions.

In Table 5, the unit costs for capital iInvestment in new water systems considered by the NRWSS are presented.

Table 5 - *Unit Costs for Capital Investment in New Water Systems (USD). Source: MoW - NRWSSP Implementation Manual.*

TECHNOLOGY	AVERAGE COST / SYSTEM (USD)	POPULATION SERVED	UNIT COST / CAP / YEAR (USD)
RURAL WATER SUPPLY			
Shallow Well and Hand Pump	2,100	250	8.40
Borehole & Hand Pump (25m – 40m depth)	6,150	250	24.60
Gravity Fed and Piped (Small)	76,300	1,500	50.90
Gravity Fed and Piped (Large)	84,800	2,500	33.90
Electric or Diesel Pumped and Piped (Small)	64,000	1,500	42.70
Electric or Diesel Pumped and Piped (Large)	71,300	2,500	28.50
Protected Spring	900	250	3.60
Windmill	8,000	250	32.00
Rainwater Catchment	4,335	500	8.67
Charco Dam	15,600	1,500	10.40

Total Capital Investment Water Supply Services

Capital investment in construction and rehabilitation of water systems is therefore estimated to total USD 1,284.48 million excluding sanitation promotion. Total expected capital costs for construction and rehabilitation of water systems are summarized by district and by technology. Values for construction are provided in Table 6 and for rehabilitation in Table 7 Table 7 – Capital cost of water systems by technology for rehabilitation - (Arameru, Iramba and Nzega Districts).. Where capital costs are high, this may be due to several factors, including: low initial levels of coverage; larger total population; and/or deeper groundwater sources.

Table 6 - *Capital cost of water systems by technology for construction - (Arameru, Iramba and Nzega Districts). Source: MoW - NRWSSP Implementation Manual.*

DISTRICT	2005 - 2025 CAPITAL BY TECHNOLOGY - CONSTRUCTION										
	HANDPUMP & SHALLOW WELL	HANDPUMP & BOREHOLE	SINGLE COMMUNITY GFS	MULTIPLE COMMUNITY GFS	SINGLE PUMPED & PIPED SYSTEM	MULTIPLE PUMPED & PIPED SYSTEM	PROTECTED SPRING	WINDMILL	RAINWATER CATCHMENT	CHARCO DAM	TOTAL
	(USD)	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*
Arumeru	0,57	0,83	10,36	6,90	3,62	2,42	0,00	0,00	0,00	0,00	0,68
Irambo	1,05	6,16	0,00	0,00	0,45	0,30	0,00	0,67	0,00	0,00	0,42
Nzega	2,12	3,88	0,00	0,00	4,04	2,70	0,00	0,00	0,27	0,00	0,63
TOTAL	120,01	187,35	199,16	137,89	231,56	158,01	1,26	10,69	9,94	6,61	43,32

Table 7 – *Capital cost of water systems by technology for rehabilitation - (Arameru, Iramba and Nzega Districts). Source: MoW - NRWSSP Implementation Manual.*

DISTRICT	2005 - 2025 CAPITAL BY TECHNOLOGY - REHABILITATION										
	HANDPUMP & SHALLOW WELL	HANDPUMP & BOREHOLE	SINGLE COMMUNITY GFS	MULTIPLE COMMUNITY GFS	SINGLE PUMPED & PIPED SYSTEM	MULTIPLE PUMPED & PIPED SYSTEM	PROTECTED SPRING	WINDMILL	RAINWATER CATCHMENT	CHARCO DAM	TOTAL
	(USD)	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*	*(USD)*
Arumeru	0,03	0,05	0,73	0,48	0,25	0,19	0,00	0,00	0,00	0,00	0,00
Irambo	0,03	0,32	0,00	0,00	0,02	0,00	0,00	0,02	0,00	0,00	0,00
Nzega	0,07	0,19	0,00	0,00	0,19	0,10	0,00	0,00	0,00	0,00	0,00
TOTAL	6,99	12,25	15,09	10,26	14,34	9,53	0,02	1,15	0,31	0,32	0,00

The tables with all the information relative to the capital of construction and rehabilitation costs in all districts are provided as Annex 03 and Annex 04, respectively.

Operation and Maintenance Costs

The cost of operation and maintenance (O&M) is the responsibility of the beneficiary rural communities and small towns, and has therefore not been included in the overall NRWSSP investment budget. O&M costs have nevertheless been estimated here for purposes of information and comparison.

Unitary Rehabilitation Costs

Capital investment in major system rehabilitation is assumed to represent 66% of the cost of new water supply services. Considering the costs given in Table 7, the rehabilitation costs by technology are presented below in Table 8.

Table 8 - *Capital investment in major system rehabilitation.*
Source: MoW - NRWSSP Implementation Manual.

TECHNOLOGY	AVERAGE COST / SYSTEM (USD)	POPULATION SERVED	UNIT COST / CAP / YEAR (USD)
RURAL WATER SUPPLY			
Shallow Well and Hand Pump	2100	250	8.40
Borehole & Hand Pump (25m – 40m average depth)	6150	250	24.60
Gravity Fed and Piped (Small)	76300	1500	50.90
Gravity Fed and Piped (Large)	84800	2500	33.90
Electric or Diesel Pumped and Piped (Small)	64000	1500	42.70
Electric or Diesel Pumped and Piped (Large)	71300	2500	28.50
Protected Spring	900	250	3.60
Windmill	8000	250	32.00
Rainwater Catchment	4335	500	8.67
Charco Dam	15600	1500	10.40

4.2 THE WATERAID WATER POINT MAPPING

The water point mapping (WPM) approach was designed as a procedure for measuring access to water. WPM can be defined as “an exercise whereby the geographical positions of all improved water points (WPs) in an area are gathered in addition to management, technical, and demographical information. This information is collected using GPS and a questionnaire carried out at each WP. The data are entered into a geographical information system and then correlated with available demographic, administrative, and physical data. The information is displayed using digital maps (WaterAid, ODI, 2005). WPM has been applied extensively by Water Aid and other NGOs in various African countries for a number of years. WPM was first used in Tanzania in 2005. So far, 51 out of 132 districts have been mapped, and the Government plans to extend it across the whole country. WPM calculates coverage through density, which is equal to the number of improved WPs per 1,000 inhabitants (Stoupy and Sudgen, 2003).

Between 2005 and 2006, WaterAid collected data from 5921 improved water points in 15 Districts. This information allowed them to carry out a study that established the relationships between technology, functionality and durability of rural water points in Tanzania. The results have been arrived at through analysis of data collected from a water point survey. For this survey, every public water point in the areas covered was visited, and at each one a questionnaire was completed documenting a range of relevant characteristics including location, type and condition. A handheld Global Positioning

System (GPS) was used to record the precise location of all water points visited (Jimenez A., etal., 2011). The results are presented bellow in Figure 6 .and the corresponding references in Table 9.

Table 9 - *Category of Water points.[1] These categories are same as those used by MoW to allocate funds for recurrent costs at district level.[2] These symbols are same as those used in the study - Jimenez A., etal., 2011. Source: Own Elaboration.*

CATHEGORIES [1]	SYMBOL [2]	TECHNOLOGIES
ALL HAND PUMPS	■	Handpump & Shallow Well
		Handpump & Borehole
MOTORIZED	●	Single Pumped & Piped System
		Multiple Pumped & Piped System
GRAVITY	▲	Single Community GFS
		Multiple Community GFS
OTHERS	□	Protected Spring
		Windmill
		Rainwater Catchment
		Charco Dam

Table 10 - *% of Functional Water Points. Source: Jimenez A., etal., 2011.*

CATHEGORIES BY TECHNOLOGY	% of Functional Water Points					
	+25 years	25 – 20 years	20 – 15 years	15 – 10 years	10 – 5 years	5 – 0 years
ALL HAND PUMPS	8	13	29	41	51	61
MOTORIZED	25	14	36	44	66	77
GRAVITY	17	22	50	48	62	66
OTHERS	-	7	60	71	-	88

Figure 6 - *Figure: Rate of functionality by category of water point over time. Source: Jimenez A., etal., 2011.*

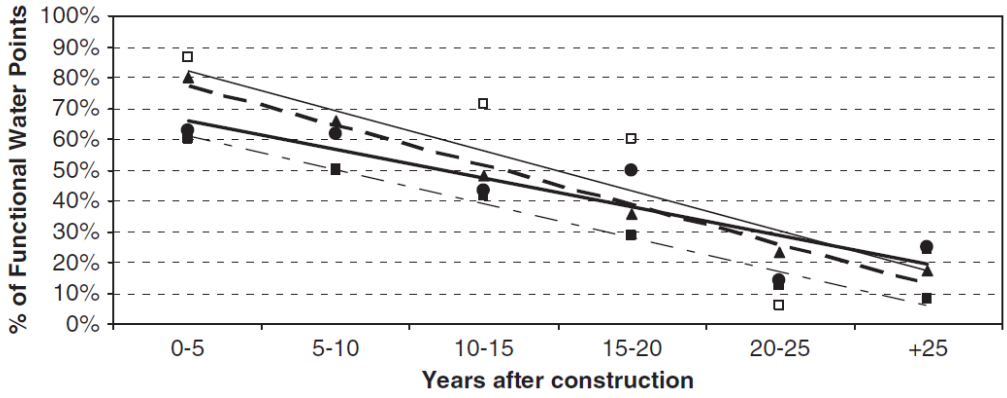

Figure 6 .presents simple linear regressions by category that yield interesting results (Jimenez A., etal., 2011). Hand pumps had the least favourable functionality–function over time dropped from 61% in the first five years to 6% in the 25-year period. Similarly, motorised systems started at 77% and dropped to 13% in the same period. Gravity-fed systems worked better in the long run than any other category of WP and dropped from 66% to 20%. In all three categories, just 35 to 47% of WPs were working 15 years after installation. WPs in the ‘‘other’’ category had better scores, but this category included very few WPs (just 152 out of 6,814) and, as explained above, grouped WPs of very different types.

EXERCISE PROPOSED:

As explained above, the NRWSSP considers the rehabilitation of systems that were constructed before its implementation. The WaterAid research and the results shown in Table 10 and Figure 5 allow improvement of the data and implementation criteria that NRWSSP uses. As homework it is expected that the students work in the same groups as for the class activity. The exercises proposed are, to:

- Create a list of districts, listed by cost of construction + rehabilitation (NRWSSP data).
- Create a new list with the additional criterion of rehabilitation of the new constructions.
- Create a matrix by districts that includes this new criterion of rehabilitation and compare the solutions with the one that includes only the NRWSSP data (above).
- Considering the resources tendency (Annex 05) and using the matrix created, find the differences between the two solutions (NRWSSP only and with WaterAid data). How many districts will it be possible to cover using the WaterAid WPM data? And without, as NRWSSP proposes?

For this exercise the students should be provided with the data included in the Annexes. Using these and obtaining the results asked, an interpretation of them should be made.

Apart from calculating the matrix (see above), each group should discuss the following points and give their corresponding conclusions:

- Importance of rehabilitation during the programme.
- The best option between covering the entire population with construction of water systems, and covering part of the population with construction of systems considering rehabilitation of these during the programme implementation process.
- Calculated resources and viability of them.

Finally, consider all the previous conclusions to provide a list comprising all the necessary elements that should be considered during the decision-making process for a national water supply programme

resources allocation plan.

4.3 SOLUTION AND EVALUATION CRITERIA THE PROGRAM

The solution for the first part is provided in the document “Solution_Case Study_NRWSSP.xls”, where it is possible to find different folders following the necessary procedure to arrive at the final conclusions. These principal conclusions are in the last folder of the “.xls” document.

The rehabilitation during the execution of the programme is important due to the necessity of people to conserve their water resources. It is not fully beneficial if the water system will just be working for a few years.

The best option is to cover less of the population and ensure the rehabilitation of these new systems. This is the best way to ensure the sustainability of these systems and the whole programme into the long-term future. Also, this consideration will allow the population covered to develop their economic activities, which would have a positive influence on the rest of the country.

The list, required in the last part of the exercise, comprising elements that should be considered during the decision-making process for a National Water Supply Program resources allocation, should include those that appear in the table that presents the solution of the Class Activity (see Section 3.3), plus any additions. This will allow the students to have a general understanding of the whole case study. The listed elements are:

- Expenditure on treatment of diarrheal disease
- Value of less health workers falling sick with diarrhoea.
- Environment management and effect on vectors.
- Expenditure on treatment of diarrheal disease and related cost.
- Expenditure on transport in seeking treatment.
- Time loss due to treatment seeking.
- Value of avoided days lost at work or at school.
- Value of avoided time loss of care for sick babies.
- Value of loss of death avoided.
- Environment management and effect on vectors.
- Time savings related to water collection or accessing sanitary facilities.
- Labour-savings devices in household.
- Switch away from more expensive water sources.

- Property value rise.
- Leisure activities and non-use value.
- Expenditure on treatment of employees with diarrhoea disease.
- Productivity impact of workers being off sick.
- Impacts to agriculture and industry of improved water supply – time saving or income-generating technologies and land use changes.

5. BIBLIOGRAPHY

- Brouwer R.; Pearce David. “Cost–Benefit Analysis and Water Resources Management”. G MPG Books Ltd, Bodmin, Cornwall - Great Britain 2005.
- Fisher Julie - WEDC - Water, Engineering and Development Centre, Loughborough University, UK – 2005
- Giné Garriga, R., & Pérez Foguet, A. (2008). Sustainability assessment of national rural water supply program in Tanzania. Natural Resources Forum, 32, 327–342.
- Government of United Republic of Tanzania, 2002. National Water Policy. Ministry of Water and Livestock Development, Dar es Salaam.
- Hutton, G., Haller, L., & Bartram, J. (2007a). Economic and health effects of increasing coverage of low cost household drinking-water supply and sanitation intervention to countries off-track to meet MDG target 10. Geneva: World Health Organization.
- Jamison et al 2006a; Priorities in Health, World Bank, Washington.
- Jiménez, A., & Pérez Foguet, A. (2011). Implementing pro-poor policies in a decentralized context: the case of the Rural Water Supply and Sanitation Program in Tanzania. Sustainability Science, 6(1), 37–49. doi:10.1007/s11625-010-0121-1
- Jiménez, A., & Perez-Foguet, A. (2011). The relationship between technology and functionality of rural water points: evidence from Tanzania. Water Science and Technology, 63(5), 948–955. doi:10.2166/wst.2011.274
- Jiménez, A., & Perez-Foguet, A. (2011). Water Point Mapping for the Analysis of Rural Water Supply Plans: Case Study from Tanzania. Journal of Water Resources Planning and Management-Asce, 137(5), 439–447. doi:10.1061/(asce)wr.1943-5452.0000135
- Jamison et al 2006b; Disease Control Priorities in Developing Countries, World Bank, Washington.
- JMP – WHO/UNICEF (Joint Monitoring Programme for Water Supply and Sanitation. http://www.wssinfo.org/data-estimates/graphs/ . Last accessed at September 2014.
- Malloy-Good S., Smith K., 2008. Cost-Benefit Analysis of Improved Water and Sanitation for Women and Girls in Sub-Saharan Africa. Columbia University School of Social Work Economics for International Affairs.
- MINISTRY OF FOREIGN AFFAIRS AND INTERNATIONAL COOPERATION, The United Republic of Tanzania - "Tanzania Country Profile". http://www.foreign.go.tz/tanzania/category/country-profile. Last accessed August 2014.
- Ministry of Water. (2006a). “National rural water supply and sanitation program (NRWSSP).”

United Republic of Tanzania, Dodoma, Tanzania.

- Ministry of Water. (2006b). “Water sector development program: Implementation manual.” United Republic of Tanzania, Dodoma, Tanzania.
- Prime Minister’s Office Regional Administration and Local Government (PMO-RALG). (2002). “Population and housing census 2002.” National Bureau of Statistics, Dar es Salaam, Tanzania.
- Sanctuary M.; Tropp H. (SIWI); Haller L. (WHO). “Making Water a Part of Economic Development: The Economic Benefits of Improved Water Management and Services” - November, 2012. Available in: http://www.siwi.org/publication/making-water-a-part-of-economic-development-the-economic-benefits-of-improved-water-management-and-services/
- Stoupy, O., Sudgen, S., 2003. Halving the Number of People without Access to SafeWater by 2015 —A Malawian Perspective. Part 2: New indicators for the millennium development goal. WaterAid.
- UN Data, A world of information. “United Republic of Tanzania”. Available at: https://data.un.org/CountryProfile.aspx?crName=United%20Republic%20of%20Tanzania . Last Accessed at September 2014.
- UNDP - Human Development Report 2014. Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience, 2014. United Nations Development Programme - New York, USA.
- Ward F. A., 2012. “Cost–benefit and water resources policy: a survey”. Water Policy Vol. 14 - pp 250–280.
- Wateraid/ODI, 2005. Learning for advocacy and good practice. WaterAid water point mapping. Prepared by Katharina Welle, Overseas Development Institute. Available at http://www.wateraid.org/international/what_we_do/policy_and_research/ . Last accessed August 2014.
- WHO, 2004. “Water, Sanitation and Hygiene links to health: Facts and Figures.”
- World Bank - "Community water supply and sanitation conference. Water and sanitation program", 1998. http://www-wds.worldbank.org
- World Health Organization, UNICEF, 2000. Global Water Supply and Sanitation Assessment 2000 Report, Geneva: WHO.
- WSSCC (Water Supply and Sanitation Collaborative Council) – “Wash targets and indicators post-2015: Recommendations from international consultations comprehensive recommendations”- April 2014).

6. FURTHER/SUGGESTED MATERIAL

ANNEX 01: Population Estimation<Annex01_Case Study_NRWSSP.xls>

ANNEX 02: New water supply beneficiaries<Annex02_Case Study_NRWSSP.xls>

ANNEX 03: Construction Capital Cost<Annex03_Case Study_NRWSSP.xls>

ANNEX 04: Rehabilitation Capital Costs<Annex04_Case Study_NRWSSP.xls>

ANNEX 05: Resources Tendency <Annex 05_Case Study_NRWSSP.xls>

GDEE
GLOBAL DIMENSION IN ENGINEERING EDUCATION

http://www.gdee.eu

This project is funded by