

THE ROLE OF URBAN WATER DISTRIBUTION NETWORKS IN THE PROCESS OF SUSTAINABLE URBANISATION IN DEVELOPING COUNTRIES CASE STUDY: WUKRO WATER SUPPLY, WUKRO TOWN, ETHIOPIA.

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ABSTRACT

The development of urban distribution networks in the South is often carried out by agents of the North and analyzed under the financial and operational indicators used also in the North. Using the results of a case study in a small urban centre in Ethiopia, we propose a different evaluation model to measure the efficiency of such implementations across the concepts of Sustainable Urbanization. GIS maps are used to analyze the evolution of urban basic services, the dynamics of population movements and economic changes. With those results we can address the social dimension of inequality and exclusion that should be considered in the design and planning of water networks. The aim is to reduce the risk of slums formation and to promote inclusive growth in services.

KEYWORDS

Water and Sustainable Urbanization. Water Distribution Management. Water Services in the South.

INTRODUCTION

This study is part of a research program on Water and Urban Services in Africa and Latin America conducted by the GRECDH, Research Group on Development Cooperation and Human Development, and focuses on the implementation of a development project in urban water supply in Wukro town (Ethiopia). It claims that sustainable human settlements should make efficient use of resources to supply all individuals, particularly those belonging to vulnerable groups, with equal opportunities for a healthy, safe and productive life (UN-Habitat 2002).

Sustainable Urbanization is a multidimensional dynamic process that integrates the social, economic, environmental and institutional dimensions of sustainability and must be addressed from the Dublin Principles: environmental protection, increased participation, relevance of gender equality and water as an economic good. The rapid unplanned urbanization has a negative impact that is magnified in the South since they lack adequate resources (DFID 2002). This process contributes to the formation of slums in inner-urban areas, and it is reflected mainly by the lack of basic services, poverty and social exclusion. Water systems must seek the social, technical, economic, financial, environmental, health and institutional sustainability. In this way every dimension will support each other, and the integration of them will provide an effective, equitable, durable over time, efficient, replicable and transparent response. Therefore, water supply systems may act as an agent of transformation that contributes significantly to the sustainable urbanization process. We have to take into account several challenges in achieving sustainable urbanization: the conflict between economic growth and environmental sustainability, the social changes that result in increased inequality and exclusion, the inadequate development of infrastructure aggravated by poverty and its effects on health and the living environment of the poor, and poor governance capabilities of the responsible agencies. But all these challenges could be effectively led by a proper implementation of basic services, establishing the necessary mechanisms to achieve them.

In order to formulate such mechanisms we will analyze here, in a first step, the implementation of the water distribution network, then, we will analyze the evolution of basic urban services associated with the provision of water, and will conclude with an analysis of changes in stakeholders interaction.

In this way we have been able to assess the development of appropriate technologies associated with urban

services in the town of Wukro in a time perspective, since 1985 until today, and from a spatial perspective, from the city center to peripheral areas. It is intended here to determine the key factors explaining the graduation thresholds of appropriate technologies for each of the basic urban services. This is influenced by several variables: the distance from the city center to the suburbs, land prices, the cost of services, the distance to the point of connection and the family purchase power. At the same time we try to define what is the appropriate level of priority in the implementation of networks, from both scales, village and suburb level. In parallel, we will analyze the different actors involved in the process, in order to identify best practices of the interactions among them. This means to identify those interactions that have had a major impact on the development of the neighborhood, and therefore, which can be used in a process of scaling up due to its role in economic sustainability. We have to keep always in mind that progress towards sustainable development will require the commitment of a large range of actors: local governments, local communities, civil society, private sector, national government and international agencies (UN Human Settlement Programme 2003).

METHODOLOGY

The main element of assessment in this study is the development of GIS maps, with overlapping indicators represented geographically. When drawing up these maps several sources of information and data collection have been used. First, we remark the interviews undertaken to relevant agencies in each of the institutions and dimensions studied, considered as qualitative data. Secondly, we have the questionnaires completed by a representative proportion of the different social groups and stakeholders, providing quantitative data. In addition, we count on mathematical modeling of the network, management reports, historical evolution of services and technical reports outsourced to public and private entities responsible in each field. As well as direct measurements, field observations and documentation in the files of local authorities for each of the dimensions evaluated.

RESULTS

Social Analysis

Social sustainability is reflected by fair and equitable access and provision of services. We evaluate here service coverage on different neighborhoods, and the reasons for the formation of slums as well as the current setting of them. We also study the growth of peri-urban settlements due to several factors.

In this dimension traces of inequality are observed in a number of parameters. The volume of water consumed per capita per day, ranges from 60 lpc / d for the highest income districts to 10 lpc / d among the most disadvantaged districts. In water quality, inequality is observed by the availability of filters and individual treatments in some homes while other areas show very low quality of supply. This happens in those locations with low pressure where intrusions occur through the openings of the leaks. Access can be classified as private connection, or it can come from public source. The later only available for three hours a day. The continuity of supply varies between those with storage tank, who are able to deal with interruptions, in comparison to those who are subjected to several days of interruption of supply for repair of pumps or pipes. The connection charge is fixed and high, therefore only accessible to social sectors with high purchasing power, but the fee for consumption varies according to the type of connection. The result is that the unit price per cubic meter is higher for public supply than for individual connection. The differences in sanitation vary from those with improved latrine at home or even low-flow toilet, to those who must rely on the limited public infrastructure or even wait till night for defecation outdoors. The time spent in water gathering is another clear example of inequality as it from those with immediate availability in some homes, to those who have to fetch water in the river, which means half an hour a day employed to this chore. We must emphasize as well that it is women who are in charge of collecting water and health burden. Therefore women collect water, wait in the queue, wake up early to go to the source, go to bed late for hygiene tasks, use water to clean the house and to wash babies. So women are more affected by inequality of services and the health burden associated with water quality problems.

Economic and Financial Analysis

It should be highlighted that slums have an economic function since they give shelter to the sectors that contribute as low labor cost. Besides, services are conducted informally. This enables an economic dynamics in the slums which is defined by casual work and informal economy. We will evaluate here the distribution of population according to income level to assess the relationship between service coverage and purchasing power for the users of those services (figure 1). On the other hand we will examine the budget allocation to water supply, and we will compare the balance sheets and financial statements from the office responsible for water

provision. We use financial indicators showing the relationship between profits and capital employed, debt divided by fixed assets and operating income divided by operating expenses. We will also analyze the level private sector participation as an indicator of economy generation.

Finally we will study the origin of investment sources in order determine the capability to ensure capital inflow despite weakness of bill collection and intermittency of public funds. We need to emphasize the lack of investment from multilateral cooperation programs for the provision of infrastructure in urban areas.

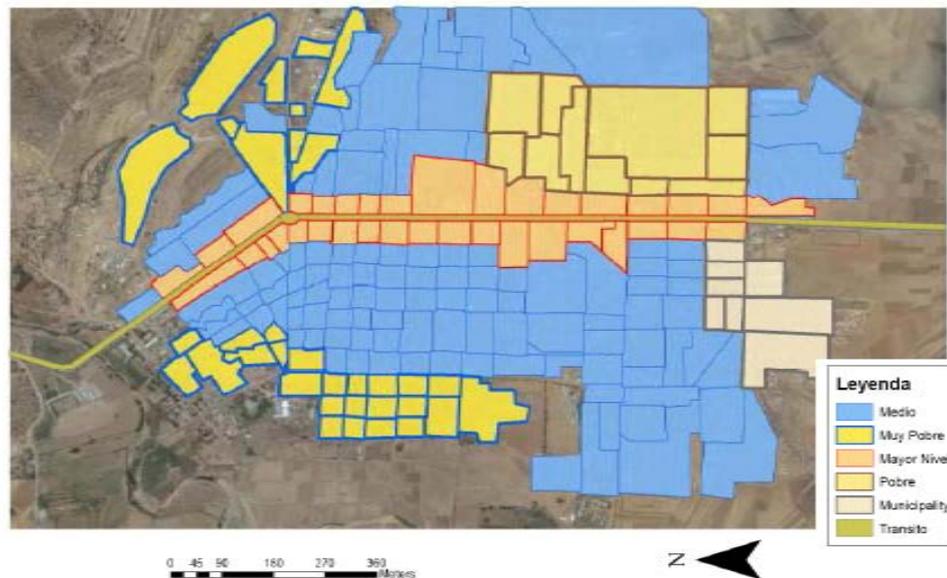


Figure 1 Economic levels distributed in urban center areas

Technical Analysis

In this section we will focus on engineering aspects, starting with a mathematical modeling of the network to assess pressure distribution (Almandoz, Cabrera et al. 2005) and possible supply constraints (Cabrera, Almandoz et al. 2001). We also analyze the growth of the water supply system in recent decades (figure 2). We study the evolution of basic services like sanitation and drainage. We assess the links between the growth of the city, in spatial perspective, and water services (Magrinya 2005). And finally we evaluate the evolution levels of appropriate technologies for each service. It concludes that average consumption is rated at 20 liters per capita per day and that 1 hour a day is employed for access to water. The quality level is less than 10 fecal coliforms but further treatment is recommended since there is no residual disinfection. When studying the continuity of supply (Hamilton, Charalambous et al. 2010), shortages are observed frequently, at least 1 per month. As for sanitation systems Wukro reaches up to 80% population coverage through private latrines. But treatment is not common; in fact there is actually only a random emptying of public latrines depending on the availability of municipal funds. Good hygiene practices focus on hand washing, proper treatment of child excreta and proper care of water storage conditions. Among the models of water supply services, 5 levels have been rated: Unimproved sources, which supply to a variable percentage of population depending on the weather and that includes the springs in the dry riverbed; Public taps distributed in several neighborhoods, close to the most disadvantaged areas, where queuing time has been reduced due to decreasing number of users; Communal taps distributed bunches of houses, shared by the neighbors who live in the same housing block and representing 50% of total water supply; Backyard tap, located on the exterior of the house without public access; and finally Interior domestic tap for beneficiaries with high purchasing power. Treatment in the storage tank consists on a minimum non-regular chlorination, but water abstraction is undertaken from deep groundwater. Non contaminated aquifers at 200 m depth are used as source through submersible water pumps. Sanitation systems can be classified in two categories: on site sanitation, including simple platform latrines and some ventilated improved pit latrines, and off site sanitation, including minimum flow systems with septic tank owned by private facilities like schools.



Figure 2 Evolution of water supply network for the years 1997-2007

Environmental and Health Analysis

We focus in this section on monitoring the achievement of two closely related Millennium Development Goals: Goal 1 eradicate poverty, Goal 7 environmental sustainability. There are strong links between poverty and environment. The poor are severely affected by inadequate urban environmental services, particularly by the lack of sanitation, drainage, waste collection and adequate drinking water supply (ACF 2005). The health impacts of such gaps in service provision contribute significantly to the burden of diseases of the poor, especially among women and children. The base of our study are the indicators established by WHO World Health Organization, which are split in three action areas. In the field of water: measuring quantity, quality, continuity of supply, distance to the well, the proportion of users who use the infrastructure and assessment of the uses where water is employed (Alegre, Hirner et al. 2000). With regard to sanitation: use of improved latrines, hygiene, failure of systems and proportion of people using the facilities (Franceys, Pickford et al. 1992) (figure 3). As for hygiene promotion: understanding the language of the devices for transmitting information, understand content, access to messages, face to face transmission, water storage habits and washing hands after defecation (Moe, Rheingans 2006). We pay special attention to the issue of human health and disease transmission in the slums because that gives us a reference of the standards achieved and the adequacy of water supply to reduce the burden for health. So we evaluate the number of cases of diseases transmitted by ingestion of water, poor hygiene or contact with contaminated water. From the point of environmental analysis is essential to remark that the supply of potable water, adequate sanitation and solid waste collection reduces land pollution, contaminated surface water and groundwater both within urban settlements and downstream of them (WSP 2005). In our case the depth of toilets pit is 6 meters above the water level in the wet period, which is why we have no cases of water pollution from household sanitation.

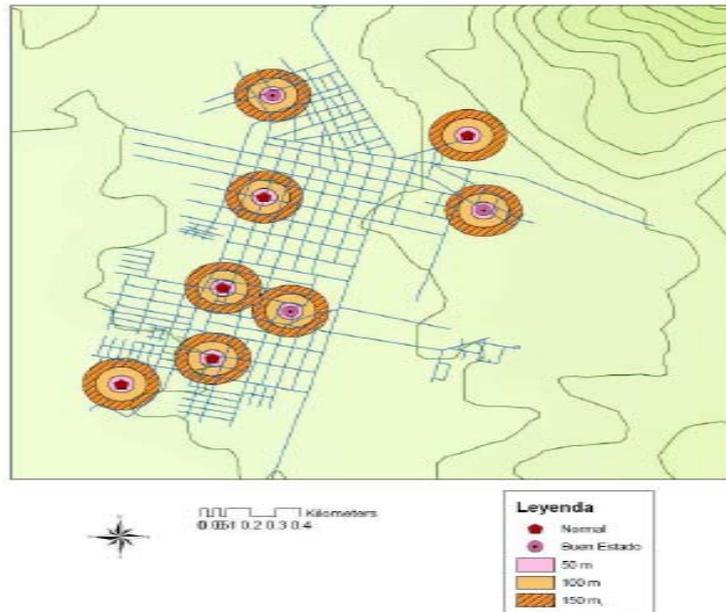


Figure 3 Distances from active public latrines

Institutional Analysis

The process towards Sustainable Urbanization requires the involvement and commitment of a wide range of actors: local government, community civil society, private sector, national government and international agencies (Elimelech 2006). In this sense, good governance is reflected if more equal access to decision-making processes, greater transparency in decision making and a high degree of civic engagement are achieved. Institutional responses are manifested at this level of participation through the adoption of policies that include programs for capacity building, community development, land management, poverty reduction and gender equity, paying special attention to vulnerable groups in each of these programs. We will measure it through the analysis of stakeholders interaction (figure 4), analyzing the process of systems ownership and comparing technology enhancement efforts with the efforts in improving the social dimension of it. Also measuring the degree of citizen participation and classifying according to level of autonomy. So we have some cases of passive participation in the selection of technologies, participation by consultation in defining priorities, participation incentives in cooperative use of infrastructure, and even interactive participation in the case of the proposed sanitation.

On the other hand we appreciate the functioning of the institution responsible for water management by calculating the number of jobs for maintenance of the system, the frequency of meetings hold by water committees, and effectiveness in the collection of fees. Likewise we assess the kind of support that the international donor agency has on the project, in order to establish if it is for temporary assistance or if it is a long-term program integrated within development dynamic process. Another important aspect is the collaboration between organizations, particularly with regard to the replicability of our strategies. This is measured as the ability of the community to extend services and to transfer the strategies used. Finally, a detailed study of the characteristics of the institution managing the system. It is important the organizational culture in terms of sense of mission, team spirit and commitment of its members. We also measure the autonomy in their roles, for example, independence in decision making, in recruitment, in adoption rates, wages and scheduling. The effective management is measured as the ability to organize resources and control of the operation. The commercial orientation and financial self-sufficiency when it comes to operating and managing revenues and costs. And we evaluate the user orientation and rate of interaction with them, providing equitable services and responses to the demand.

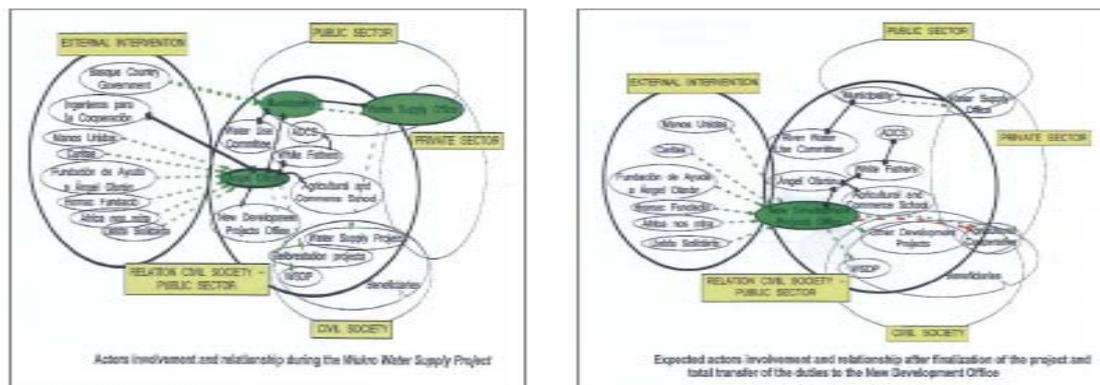


Figure 4: Evolution of the stakeholders interaction linked to the water supply network(Wessling, Magrinya 2008)

CONCLUSIONS

The reality of many African cities, and mainly the slums that are in them, is still nowadays an evidence of the lack of basic urban services. These areas have been neglected by the authorities and have been occupied massively, without any planning or service delivery. In this project we have established mechanisms to measure the sustainable development process, and we have observed that it is only through the integration of the various dimensions that an improvement in achieving sustainability goals will be possible. Priority should be given to capacity building, reducing environmental impact, strengthening public participation, enhancing social justice and inclusion by ensuring coverage of basic services. We have also concluded that there is an evolution of urban dynamics according to the growth of water distribution network as well as urban basic services. The benchmark to evaluate this link is the distance up to the service connection. In parallel, we have established the proper relationships between stakeholders in order to get the most adequate interaction for each service. And we have highlighted the need for suburb empowerment to meet these objectives. We conclude that water agencies must ensure an effective contribution to sustainable urbanization, to make cities a place for living and producing, from the foundation of an inclusive growth (UN DESA 2009)

REFERENCES

- ACF, 2005. Water, sanitation and hygiene for populations at risk. ACTION CONTRE LA FAIM edn. France: Hermann.
- ALEGRE, H., HIRNER, W., BAPTISTA, J. and PARENA, B., 2000. Performance Indicators for Water Supply Services. London: IWA Publishing.
- ALMANDOZ, J., CABRERA, E., ARREGUI, F. and COBACHO, R., 2005. Leakage assessment through Water Distribution Network Simulation. *J. Water Resour. Plan. Manag.*, **131**(6), 458.
- CABRERA, E., ALMANDOZ, J., GARCÍA – SERRA, J., ARREGUI, F., CABRERA, E.J. and COBACHO, R., 2001. A new approach to water network audits, *IWA Brno*, 2001 2001, .
- DFID, 2002. Sustainable Urbanisation. Achieving Agenda 21. UK: .
- ELIMELECH, M., 2006. The global challenge for adequate and safe water. *Journal of Water Supply, Research and Technology. AQUA*, **55**(1), 3.
- FRANCEYS, R., PICKFORD, J. and REED, R., 1992. A Guide to the Development of on-Site Sanitation. England: WHO.
- HAMILTON, S., CHARALAMBOUS, B. and FARLEY, M., 2010. Technology: an integral part of water loss reduction. *Water 21*, (February),.
- MAGRINYA, F., 2005. Access to urban services and urbanization in the South: the need for a perspective on space and time. *International Notebooks in technology for human development*,
- MOE, C.L. and RHEINGANS, R., 2006. Global challenges in water, sanitation and health. *Journal of Water and Health*, **1**(1), 41.
- UN DESA, 2009. Sustainable Urbanization in the Information Age.
- UN HUMAN SETTLEMENT PROGRAMME, ed, 2003. *The Challenge of Slums*.
- UN-HABITAT, 2002. An Urbanising World.
- WESSLING, U. and MAGRINYA, F., 2008. Comparison of urban upgrading projects on Development Cooperation in Ethiopia. Master Degree edn. Barcelona: UPC-ETSECCPB.
- WSP, 2005. Understanding Small Scale Providers of Sanitation Services: A Case Study of Kibera. *WSP Field Notes*, .