

AN APPLICATION OF SOFT SYSTEMS METHODOLOGY TO WATER AND SANITATION PROJECTS IN BARCELONA INFORMAL SETTLEMENT

S. Pan¹, N.P. Armitage^{1*}

¹Department of Civil Engineering, University of Cape Town
*Neil.Armitage@uct.ac.za; Tel: 021 650 2589; Fax: 021 689 7471

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ABSTRACT

The right of access to basic water supply and sanitation is a clear cornerstone of South Africa's national water laws, but how to ensure the right of access to these two services in informal settlements is less clear. The City of Cape Town has made significant progress in increasing emergency water and sanitation services to the majority of settlements but is struggling to establish a sustainable basic level of service. One of the main issues is how to engage with the social dynamics between different stakeholders to match appropriate technologies with management strategies. A holistic perspective of proposed water and sanitation improvements is required. Systems theory methodologies like Soft Systems Methodology (SSM) can be used to piece together the different dimensions (material, personal, and social) of problem situations encountered in service provision to informal settlements. A case study of Barcelona informal settlement in Cape Town is presented to illustrate the utility of SSM for deepening understanding of connections between different stakeholders, projects, and as a tool for generating debate and supporting decision making around proposed actions. A conceptual model or "rich picture" of the different water and sanitation projects in Barcelona, stakeholders, and their connections is included to illustrate the problem situation.

INTRODUCTION

An estimated 15% of South Africa's population, or roughly 7 million people, live in informal dwellings according to data from the 2007 Community Survey (1). Water and sanitation services in informal settlements have been identified as areas of particular concern given the negative health and hygiene implications (e.g. preventable waterborne illnesses such as diarrhoea, transmission of parasites such as helminths, and vulnerability of HIV/AIDS affected individuals) of inadequate access to either of the two services (2).

The *Water Services Act* recognises every person's "right of access to basic water supply and the right to basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being" (3). There is however, an observed gap between government policy and considerations for long-term sustainability of water and sanitation services (4). In particular, how to expand services to more residents whilst maintaining a "basic level" of service in already established areas has been a significant challenge given the rapid growth of informal settlements in South African cities over the past two decades. Basic service levels are defined by the South African national government within Free Basic Service policies targeted at poor households which require the government to provide a minimum of 25l of potable water per person per day (5) and sanitation facilities "of the least cost that is appropriate to the settlement conditions;

operational support necessary and appropriate for the safe removal of human waste and black and/or grey water from the premises...(6)

An emergency level of services (water, sanitation and refuse removal) was provided to over 90% of settlements in Cape Town through the Emergency Servicing of Informal Settlements Project in 2004 (7). Subsequent servicing projects have expanded coverage to new settlements and improved the levels of service in some areas, but problems with the “temporary” nature of the facilities contribute to the gap between the “*right to access*” (3) and long-term sustainability of services (4) noted previously. Some of the problem areas include:

- a) inadequate drainage of excess water from water supply points and handling of greywater, i.e. failure to manage urban water services holistically;
- b) difficulty transitioning from emergency servicing to longer term incremental upgrading approaches; and
- c) insufficient engagement with social dynamics to match appropriate water supply and sanitation technologies *and* manageable levels of service.

Progress in improving access to water and sanitation services in urban informal settlements has thus been halting and frustrating to stakeholders (residents, municipal officials, NGOs, etc.) involved in the provision of services for informal settlements. Although the first two problem areas mentioned are important, addressing them is often superseded or complicated by the third problem area i.e. how to integrate social and technical “systems”. An application of systems theory to assist in planning and understanding the social and technical systems required for water and sanitation services in informal settlements will be demonstrated through a case study presented in this paper. The objective of the case study research was to identify critical institutional relationships and how water and sanitation projects may affect different stakeholders.

USING SOFT SYSTEMS METHODOLOGY TO ANALYSE WATER AND SANITATION IN INFORMAL SETTLEMENTS

Two characteristics of informal settlements are that they are complex and dynamic environments which are not easily understood by “reductionist viewpoints” but rather require a more “holistic perspective” (8). Given the interactions and intersections of social, political, environmental, and technical concerns, a systems approach offers a structured way to conceptualise relationships between the different areas of concern and how best to apply water and sanitation service improvements in informal settlements. Different dimensions that should be considered include: the material, personal, and social (9). The material dimension refers to aspects of problem situations that relate to “*physical space-time entities and objects*”; the personal dimension results from “*our individual history of choices, interactions and experiences*”; finally, the social dimension concerns “*shared languages, norms and practices*”, which are generally independent of any particular person (9). Many of the problems and issues identified through the case study show that the different dimensions (material, personal and social) often impact each other, and these points of interface can be identified as root causes for water and sanitation service dysfunction. These points of interface are where system theory approaches like Soft Systems Methodology (SSM) can be utilised most effectively during various phases of water and sanitation service delivery.

According to Cavana and Maani, systems methodology or the systems approach refers to a set of conceptual and analytical methods applied to systems thinking and methodology (10) which emphasises holistic approaches to looking at problems. When systems thinking

was first institutionalised, the development of a “*mathematically expressed general theory of systems*” (11) was the focus of systems thinking, which became the foundation for System Dynamics (SD) methodology developed by J.W. Forrester and other MIT researchers in the 1950s. Different applications and theories naturally emerged over time, one of the fundamental differences being the idea of “hard” and “soft” system methodologies. The fundamental differences in “hard” and “soft” system approaches can be attributed to philosophical differences in defining what a system is, the epistemology of what is objective and subjective, and how problems are defined, whether “structured” or “unstructured” (11). The problems related to providing water and sanitation services to informal settlements are best described as “unstructured” i.e. in the category of “wicked problems”, in which “*there is disagreement about what needs to be done and why*” (12). Thus applying a “soft” system methodology like SSM is appropriate for describing and analysing the problem situation.

The four main “activities” associated with SSM are:

1. Finding out about a problem situation, including cultural and political aspects;
2. Formulating some relevant purposeful activity models;
3. Debating the situation, using models, seeking from the debate both:
 - a. changes which would improve the situation and are regarded as both desirable and (culturally) feasible, and
 - b. the accommodations between conflicting interests which will enable action-to-improve to be taken;
4. Taking action in the situation to bring about improvement. (11)

Two of the main methods which support activities 2 and 3 are to formulate “root definitions” for problem situations and to use “rich pictures” (11). Root definitions incorporate six elements (Table 1):

Table 1: CATWOE pneumonic for root definitions (11)

C ‘customers’	The victims or beneficiaries of T
A ‘actors’	Those who would do T
T ‘transformation’	The conversion of input to output
W ‘Weltanschauung’	The worldview which makes T meaningful in this context
O ‘Owner(s)’	Those who could stop T
E ‘environmental constraints’	Elements outside the system which it takes as given constraints

Rich pictures are (pictorial) concept diagrams which include elements from the root definition and most importantly relationships between different elements of the problem situation described.

CASE STUDY OF BARCELONA INFORMAL SETTLEMENT

SSM methods were used to understand how different water and sanitation projects involving multiple institutions in Barcelona informal settlement, located in Cape Town, may affect each other. A general description of the settlement and the four projects that were implemented or proposed during the course of the research (2010-2011) follows.

Description of Barcelona Informal Settlement

Barcelona informal settlement is located between the N2 (Settlers Way) and Klipfontein Road near the township of Guguletu and within 3km from Cape Town International airport. Barcelona, along with six other informal settlements is part of the N2 Gateway Pilot Upgrading Project, although no significant upgrading has taken place in Barcelona to date.

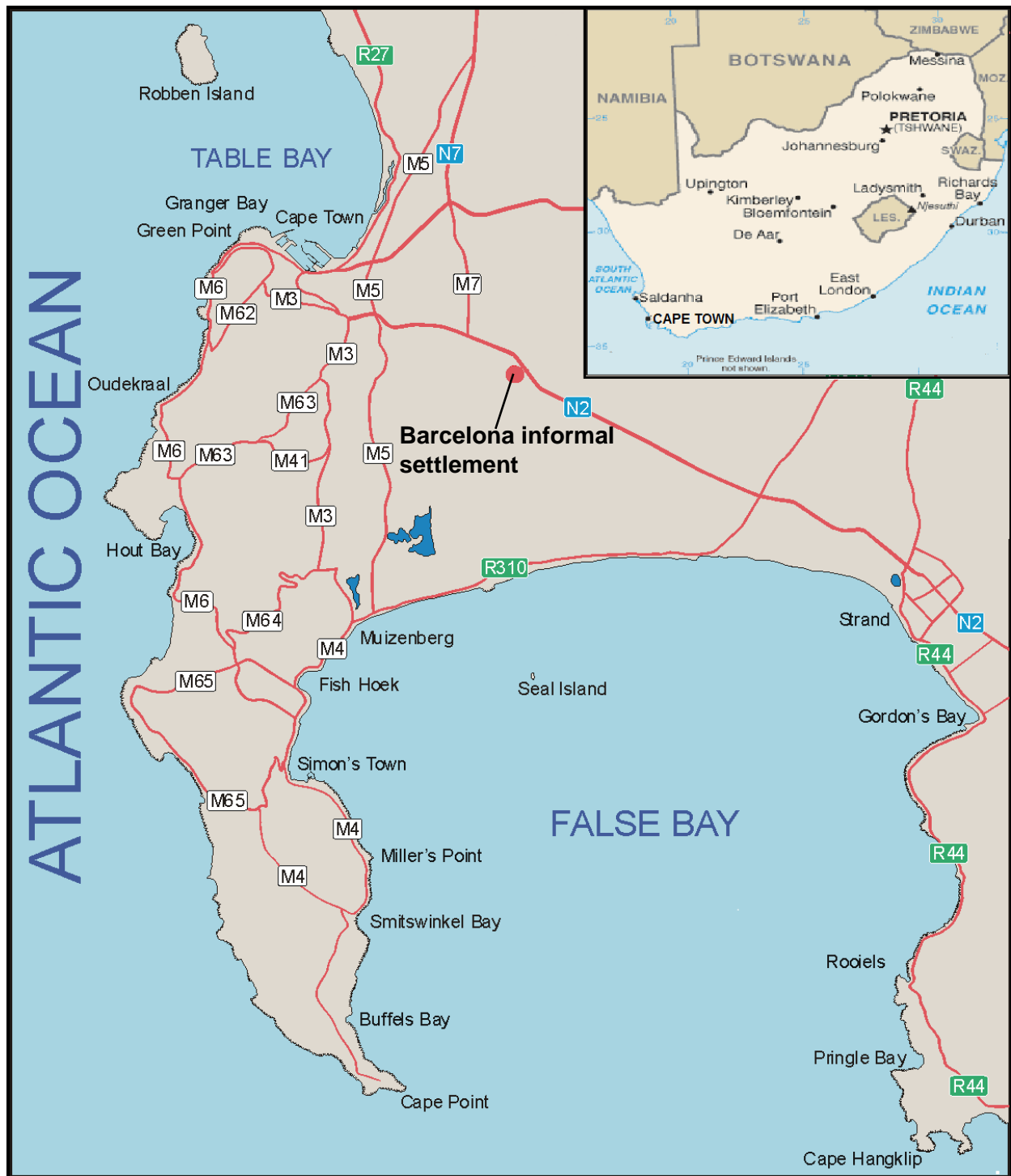


Figure 1: Map of Cape Town (after 13&14)

The settlement is built on top of a former landfill (closed c.1987), which presents significant service delivery challenges in the area because of the hazardous material under the fill layer. Given Barcelona's location, its zoning status is still undetermined according to officials in the city's Housing Informal Settlements department. Services to Barcelona are viewed as interim "emergency" levels of service since it is considered ineligible for upgrading because of the environmental and health hazards associated with landfill sites.



Figure 2: View of Barcelona settlement

The reality is however that both cost and land availability limit the possibilities for relocating the estimated 6,600 residents residing in 2,161 shacks (15). Residents are currently using ~367 shared serviced container toilets, 157 self-made pit latrines (unimproved and not serviced by the City), and 15 standpipe facilities. The ratio of households to facilities is however too high given the City of Cape Town's (CCT) current basic level of service standards for informal settlements of at least 1 toilet per 5 households and 1 tap stand to every 25 households within a maximum walking distance of 100m. Barcelona was therefore identified by the CCT as an underserved site which needed increased access to water supply and sanitation facilities. The University of Cape Town Urban Water Management Group (UCT UWM) became involved with plans to upgrade the current sanitation system in Barcelona in March 2010 as part of a Water Research Commission (WRC) funded study on alternative sewerage in South Africa. The research group put forward an informal proposal to design a pilot settled sewerage system for Barcelona during a meeting on March 4th, 2010 with city officials from the Housing Informal Settlements Department (HIS) and the Water and Sanitation Informal Settlements Unit (WSISU).



Figure 3: Communal standpipe in Barcelona

From a social aspect, most city officials and residents interviewed mentioned residents' stated preference for flushing toilets, i.e. waterborne sewerage as opposed to dry sanitation alternatives as it helps to address greywater problems and reduce residents' exposure to urine and faeces which is visible in the containers until they are collected and replaced with clean containers. From anecdotal evidence, waterborne toilets are also perceived as "proper" toilets while container or pit toilets are regarded as inferior. Settled sewerage gets its name from the incorporation of interceptor tanks for settling solids before a connection to the main sewage pipe line. Settled sewerage was selected for technical reasons because sewer pipes can be laid at shallower gradients than conventional sewerage since theoretically only the liquid portion of wastewater is transported; additionally, interceptor tanks enable the system to handle bulky materials which may have otherwise blocked pipes or damaged the sewage pump.



Figure 4: Container toilet behind crèche



Figure 5: Self-constructed backyard pit latrine

During the course of the Barcelona settled sewerage pilot project (BSSPP) research, other water and sanitation service related projects by other departments within the CCT were initiated and incorporated into the discussion around the sanitation service upgrade, but clear communication of plans was often lacking. Miscommunications between different departments and other institutions involved with water and sanitation projects highlighted the need for more holistic planning and analysis of institutional relationships and potential impacts of projects.

Description of Water and Sanitation Projects in Barcelona Informal Settlement

Each of the four projects described involves multiple stakeholders with different roles. Without grasping how different stakeholders are involved, individual projects may run into or create potential conflict between the various stakeholder institutions that are active in Barcelona.

Lotus River Canal Upgrade

The Lotus River Canal upgrade (widening and bank stabilization) is not officially a project in Barcelona, but it is adjacent to the settlement and involves both employment opportunities and the relocation of households in Lawazi Park settlement across from Barcelona. The Street Committee of Barcelona was consulted prior to the start of construction, and the project's contractor hired a Community Liaison Officer (CLO) from Barcelona. However, this created tension between Lawazi Park residents and the Barcelona Street Committee as Lawazi Park residents questioned why Barcelona should be involved. While seemingly unrelated to activities in Barcelona, Lawazi Park is visible from the edge of Barcelona settlement across the Lotus River Canal that essentially forms the "border" between the two areas; thus, changes in either settlement can create tensions if one side perceives the other is receiving better services. Residents of Barcelona often cross the canal through Lawazi Park, which is another point of contention between Barcelona and Lawazi Park residents. The BSSPP research also was affected by the canal upgrading due to the proposed layout of the settled sewerage pipeline, which crosses over the canal before connecting to the main sewer line. The tensions between residents of different settlements and effects of the canal upgrade on the BSSPP demonstrate how both the social and material dimensions of seemingly unrelated projects can affect each other if plans are not examined and discussed holistically.

N2 Gateway Project

The impact that the N2 Gateway project plans may have on Barcelona are still unclear at the time of writing since the plans are still being debated by government officials. While the majority of the discussion has focused on the "local" scale (settlement and municipal specific), provincial or national level actions have the potential to shift the direction of water and sanitation projects significantly. Currently however, local projects take precedence and there is national support for more municipal level involvement with informal settlement upgrading in South Africa through the recently developed Urban Settlements Development Grant funding framework (16).

Water Main Upgrade

The water main upgrade was proposed in January 2011 to augment the water supply to Barcelona and the adjacent settlement of Europe before the end of 2011. Increased standpipes are required to meet the basic service levels described earlier. As part of the overall water and sanitation service scheme in Barcelona, both employment opportunities during construction and increased access to water would likely have positive personal and social impacts. Nevertheless, it is likely that more greywater would be generated and given the absence of a drainage system the only alternative would be for greywater to infiltrate into the ground (which is complicated by Barcelona's location over a landfill site) or diverted into residents' yards (possible undesirable alternative). With respect to other projects, the water main upgrade would increase the water supply available to the BSSPP,

but regular communication between different stakeholders is required to ensure that both water supply and sanitation needs are addressed.

Barcelona Settled Sewerage Pilot Project

The proposed BSSPP initiated by the UCT UWM and CCT departments of WSISU and HIS went through multiple iterations during the design phase of the project. Many of the changes involved troubleshooting issues around Barcelona's situation on a landfill and how to prevent illegal connections, which would cause leakages or sewer blockages. Additionally, because residents expressed the desire for an equitable spatial distribution of the thirty toilets (three blocks of ten toilets), two of the three sites selected require a pump station to transport wastewater via a rising main along the road where the sewers will be laid, adding to the complexity of the original concept to use only gravity to transport wastewater. There are numerous technical issues to address in planning the settled sewage sanitation project on a former landfill site, but there is recognition that both technological solutions and institutional management capacity must be developed in conjunction (17) to create more sustainable services for people. Thus, in addition to planning the technical design for the settled sewerage, developing an operations and maintenance (O&M) strategy with the 'owners' of the system is critical. The responsibilities for who cleans and monitors the state of facilities, reports and fixes sewer blockages, leakages, etc. should be clearly defined and assigned based on the capabilities of the different project stakeholders or 'actors'. Any shortcomings should be identified and addressed as part of the implementation process. Another 'actor' that needs to be considered are service contractors who are utilised widely across in informal settlements for solid waste collection and sanitary waste disposal which indicates that if they are used for O&M strategies their role must be clearly defined and performance carefully monitored (by residents and responsible authorities). An example of the need for careful monitoring arose at Partnership meetings (organised by the HIS and the NGOs as a forum for CCT officials and informal settlement residents to meet and discuss service issues) when residents frequently complained of contractors who spill waste from container toilets without cleaning up or who come at inconvenient times.

As project implementers for the most immediately proposed water and sanitation service upgrades, the WSISU and HIS need to build strong relationships with all of the various stakeholders. The Partnership and initiative from individuals within the different institutions can assist with relationship building to make collaboration and communication between different stakeholders a priority. One of the potential problems with the current situation, identified through the SSM analysis, is that thus far the NGOs and UCT UWM have acted as the main facilitators for communication with the Street Committee and "ordinary" Barcelona residents. Third party facilitators can be very helpful for offering capacity support to residents who do not have many of the financial or professional resources that NGOs or an academic institution have. Nevertheless, overreliance on facilitators who are not ultimately responsible for maintaining a water and sanitation system or living with it (city officials or residents) makes projects vulnerable to collapse if facilitators leave during critical implementation stages or undue influence from facilitators' own agendas.

APPLICATION OF SSM TO BARCELONA INFORMAL SETTLEMENT

Figure 6 and Table 2 describe and summarise the main stakeholders and water and sanitation projects involved in Barcelona using an SSM rich picture and CATWOE analysis.

Developing the SSM rich picture and the CATWOE analysis address the first two activities associated with SSM, namely:

- 1) Finding out about a problem situation
- 2) Formulating relevant purposeful activity models.

The rich picture in Figure 6 focuses on Barcelona informal settlement and the various institutions that are involved with planning, implementing, monitoring and communicating about the ongoing water and sanitation projects which affect Barcelona:

- The Lotus River Canal upgrade
- The N2 Gateway Project sanitation service upgrade
- A water main supply upgrade for Barcelona and the adjacent settlement of Europe
- A settled sewerage pilot project involving collaboration between CCT departments, the University of Cape Town (UCT) and Barcelona residents

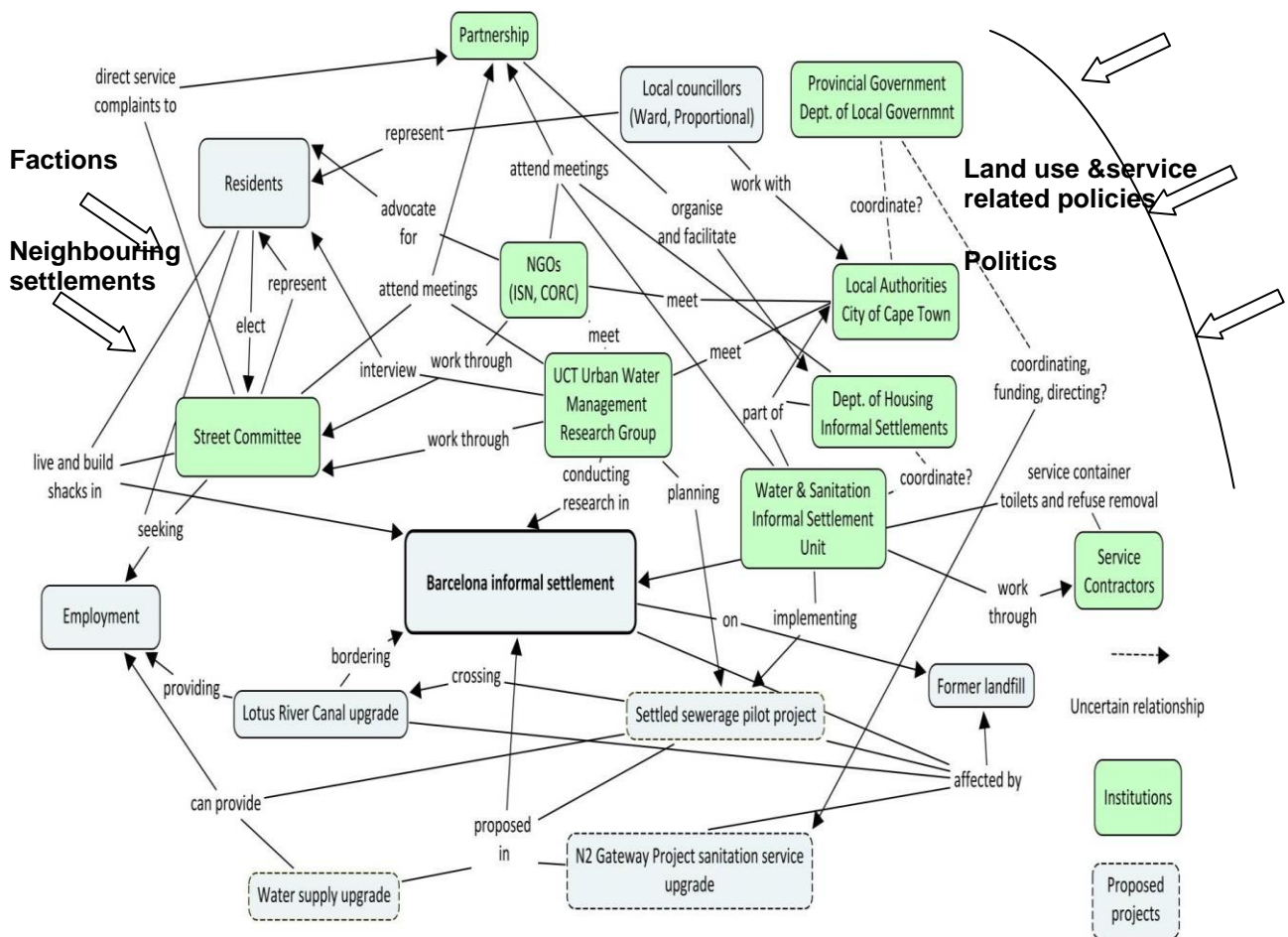


Figure 6: SSM Rich picture of stakeholders involved with water sanitation projects in Barcelona

Table 2: Root definition for water and sanitation problem situation in Barcelona

Customers	Barcelona residents
Actors	Residents, UCT UWM, Local authorities, Service contractors, NGOs
Transformation process	Residents with inadequate water and sanitation access and service level → Residents get improved water and sanitation services
Weltanschauung	The government has a responsibility to provide people with access to basic levels of water and sanitation services as defined by local and/or national standards.
Owners	Residents, Local authorities
Environmental constraints	Settlement is established on a former landfill, Zoning regulations, Land for relocation, Financial resources, Management capacity

While there are many ‘actors’ involved in Barcelona, the main ‘owners’ (see Table 2) or people who could stop the ‘transformation’ process (improved water and sanitation services) are the local authorities and the residents themselves; thus the main power and responsibility for ensuring successful water and sanitation projects and ‘transformation’ lies in their hands.

The material dimensions for Barcelona informal settlement relate to the physical entities and objects such as the location of shacks, actual water and sanitation infrastructure and other service facility structures as well as the environmental conditions of being located on a landfill, drainage issues, etc. The personal dimensions relate to the individual experiences and history that different ‘actors’ bring to the table, e.g. one of the residents expressed her desire for a closer toilet facility because of her fear of rape or other physical assault as an older woman which is why many residents do not use toilet facilities after dark. The social dimensions relate to the shared norms and practices of the ‘actors’ in the problem situation. In Barcelona, the majority of residents are Xhosa speaking and come from the Eastern Cape but some residents moved from other parts of Cape Town to Barcelona which can create divisions within the settlement. Factions are not always immediately apparent, but they can result in tension for who appear to get better access to services between those with connections to the Eastern Cape and those without (18). Many of the other ‘actors’ in the situation including some of the CCT employees, UCT researchers, service contractors, and NGO leaders come from different socioeconomic, cultural and linguistic backgrounds to residents. While these differences are not necessarily detrimental to the ‘transformation’ from inadequate to improved water and sanitation services, these differences do affect communication between different groups and likely the *Weltanschauung* (worldviews) people hold, such as which are the most appropriate technologies or management models to use. Adding to the worldviews each individual brings is the complexity added by the fact that an individual can be part of multiple institutions, e.g. Street Committee members are also residents, a Street Committee member is also part of ISN, a partnership organiser is under contract to both the City of Cape Town and CORC, etc. Therefore, the multiplicity of an individual’s own worldviews as well as shared institutional practices must also be acknowledged.

While models cannot represent the full complexity of reality, SSM style conceptual models or “rich pictures” and “root definitions” of problem situations are useful for planning water and sanitation projects to assist decision makers (who can be any of the ‘actors’ but particularly ‘owners’) with understanding the connections between different institutions and

processes involved. SSM can also support 'multi-dimensional' analysis (strengths, weaknesses and challenges of material, personal and social dimensions). The intention of modelling in this case is not to predict outcomes but rather to spur meaningful debate about what actions should be taken and how to effectively proceed with actions. At its core, SSM is an action oriented methodology. The methodology is thus well-suited for building a deeper understanding of dynamic problem situations such as how to provide adequate water and sanitation services to informal settlements given shifting political, environmental, economic and social constraints.

CONCLUSIONS

Utilising SSM can help generate debate and discussion around proposed changes to the material aspects of water and sanitation which may affect personal and social dimensions. Underlying or fundamental social issues which are hindering progress or causing the material system to fail can be more easily identified than using a purely technically focused analysis. Furthermore, if nothing else, going through the process of a systematic analysis of both the material as well as social and personal dimensions encourages collaboration between different stakeholders and recognition that finding the most appropriate water supply and/or sanitation technology requires the incorporation of multiple perspectives.

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