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*Socio-technical solutions for the provision of safe WSS in vulnerable communities: a synthesis.*

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Socio-technical solutions for the provision of safe WSS in vulnerable communities: a synthesis

Work Package 6 Report
(Deliverable 6.1)

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Acronyms

D  Deliverables  
DESAFIO  Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovation  
EC  European Commission  
ECLAC  UN-Economic Commission for Latin America and the Caribbean  
IDB  Inter-American Development Bank  
IFIs  International Financial Institutions  
LA&C  Latin America and the Caribbean  
MDGs  Millennium Development Goals  
NGO  Non Governmental Organization  
RJMA  Rio de Janeiro Metropolitan Area  
SDGIs  Sustainable Development Goal Indicators  
UN  United Nations  
UNR  National University of Rosario, Argentina  
UNIVALLE  University of the Valley, Colombia  
WP  Work Packages  
WSS  Water and sanitation services
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Introduction

This report provides a summary of key project results, focusing on the findings that provided relevant evidence to respond the project’s research questions along the lines of the indicators of progress beyond the state of the art set in the original project proposal (see Table N° 2). Details of the studies, particularly for the techno-infrastructural dimension of the socio-technical innovations studied, are treated in more depth in the individual case-study reports (Britto et. al, 2014; Brown et. al., 2014; Castro and Ferreira, 2014a,b; de Pádua et al., 2015; Freitas et. al., 2014; Passos et. al., 2015; Peña et. al., 2014, a,b; Portapila et. al, 2015) and in the cross-comparative report (Pinto et. al., 2015). For a fuller picture of the results, this document should be read in conjunction with the two cross-comparative reports (Pinto et. al., 2015; Castro, 2015b).

The first section discusses the results in the light of the project’s research problem and provides the framework for the synthetic analysis of results organized around the project’s research questions. Section 2 presents an overview of the socio-technical innovations covered in the ten case study reports. In Section 3, we examine the political character of the socio-technical innovations, in line with the project’s main objective to study innovations aimed at the democratization of the politics of essential water and sanitation services (WSS) to solve the deficit of these services affecting vulnerable communities. Sections 4-6 present the key findings regarding how socio-technical innovations emerge, and about the factors and process that help to explain the success and failure in the long-term term sustainability and replicability of the innovations. The Conclusions provide a summary of the main findings in relation to the indicators of progress beyond the state of the art set in the original project proposal.
1. The research problem and questions

As explained in the original project proposal (DESAFIO, 2013: 3), DESAFIO literally means “challenge” in both Portuguese and Spanish, the two main working languages of the project owing to its focus on Argentina, Brazil, and Colombia. This was a fitting name for our project, as it concerns what still now after the end of the Millennium Development Goals (MDGs) in 2015, constitutes one of the most difficult challenges facing Latin America and the Caribbean (LA&C) and most other developing regions: eradicating structural social inequality in the access to essential WSS. In other words, as the full title states, our project was about the democratization process in the field of essential public services, with an empirical focus on WSS.

Effectively, despite the fact that in many regards the MDGs were a timid attempt to decrease inequality in the access to WSS, compared with the more radical goals of the 1980s, we failed to achieve the real target even if nominally the MDGs have been met. In the 1980s, the UN International Drinking Water and Sanitation Decade had the goal of bringing 40 litres of safe drinking water to every human being in the planet by 1990 (UN, 1980). This ambitious and universalistic goal was not achieved, as in 1990 there were 1.1 billion people, 17% of the world population, without safe drinking water, and 40% lacked basic sanitation facilities. Then, the MDGs set in 2000-2002 aimed at halving the proportion of the unserved population by 2015 (UN, 2000, 2002), a tacit admission that universalization of essential WSS was not to be achieved for at least two more decades. In this sense, the MDGs were timid, conservative, and even mean compared with the goals of the 1980s. Yet, we failed to achieve them too.

For some, admitting that we failed to achieve the MDGs may sound unacceptable, a too radical judgement some would say, and they may point to official figures showing that LA&C would have met the MDG targets. However, the official figures show that 11 LA&C countries did not meet the target of halving the proportion of the population without access to an “improved water source”, while 19 countries of the region failed to meet the target for sanitation consisting in halving the proportion of the population lacking access to “improved sanitation facilities” (ECLAC, 2015: 65). In rural areas, the situation is much direr, and in countries like Bolivia, Colombia, Ecuador, Haiti, Nicaragua, Peru, and Venezuela, 80% of the rural population continue to “lack sustainable access to drinking water” (ECLAC, 2015: 65). A recent report from the Inter-American Development Bank (IDB) suggests that between 30% and 40% of rural water systems in the LA&C are out of working order, while others suffer chronic problems of water quality, intermittence, and quantity of water delivered (Ducci, 2015). Although the situation for basic sanitation has improved since 1990, still only 64% of the LA&C population in rural areas has access to “improved sanitation facilities” in 2015. The figure is below between 60% and 80% in El Salvador, Guatemala, Nicaragua, Panama, Peru, Saint Vincent and the Grenadines, and Suriname, and less than 50% in Bolivia, Guatemala, and Haiti (ECLAC, 2015: 65). The IDB report cited above estimates that 12% of the LAC population still practices open defecation in 2015, ranging from 11% in
Honduras and Ecuador, 13% in Brazil, 14% in Colombia and Nicaragua, to 35% in Haiti and 46% in Bolivia (Ducci, 2015).

Even these figures must be read with caution, as we are not discussing here the implications of the indicators used for the MDGs, “improved water sources” and “improved sanitation facilities”, which have been the subject of long debates. The inadequacy of these indicators has been already accepted as the evidence shows that not all “improved” water sources actually provide drinking water that is safe for human consumption (WHO, 2010: 9), because “water from improved sources is not necessarily free from contamination” (WHO-UNICEF, 2014: 42). As a result, in the ongoing discussions about the post-2015 Sustainable Development Goal Indicators (SDGIs) a new definition has been put forward: “safely managed drinking water”, which means that “services reliably deliver water that is sufficient to meet domestic needs and does not represent a significant risk to health” (WHO-UNICEF, 2014: 41). In short, if we consider the quality of the water available to people, the official MDG figures would be much more modest and the reality that we have not truly achieved the real target becomes apparent.

Moreover, one of the latest reports about the MDGs argues that the advances made towards meeting the goals in 2015 have often reproduced or even generated new inequalities in the access to WSS:

[Int] It is usually the poor and otherwise excluded and marginalized populations who tend to have least access to improved drinking water supplies and sanitation. **Interventions that do not have an equity focus may exacerbate inequality by failing to reach the most disadvantaged subgroups.** Closing these gaps requires explicit consideration of those who are being left behind. […] there are multiple dimensions of inequality, which can overlap, combine or reinforce one another. Without specific attention to marginalized or vulnerable groups, **it is possible to see national averages improve while within-country inequality increases** (WHO-UNICEF, 2014: 38; our emphasis).

A very important point in this statement relates to evidence presented earlier by the authors in the same report showing that in some countries that met the MDGs **intra-national inequalities increased because the wealthier tend to benefit first.**

In this connection, unfortunately it can be said that in many ways the research problem that was the object of DESAFIO starting in early 2013, remains largely unchanged. As stated in our original proposal:

We argue that these deficiencies [in relation to WSS] are caused neither by unfortunate environmental constraints nor by a shortage of scientific and technical knowledge or by the unavailability of technological
solutions, even in the poorest countries. […] What we confront are protracted structural social inequalities historically developed and reproduced along the lines of age, class, ethnicity, gender, and other power-based social divisions. […] the main reasons for the predicted failure in meeting the MDGs are derived from the deficiencies in the exercise of democratic governance and substantive citizenship […] too often “citizen participation” in policy programmes means “willingness” to accept decisions already taken by power holders and technical experts with little or no consultation […] while the users themselves are often reduced to the role of passive beneficiaries, providers of labour and resources, or mere clients of profit-oriented WSS. For instance, decisions about how WSS should be financed and organized (e.g. should these be provided as a public good and a social right or should rather be considered to be commodities to be delivered commercially by profit-oriented private or public operators?) have been time and again imposed on the population, often with disregard for the fact that large citizen majorities oppose the initiatives, which has triggered endless conflicts in many countries, including those considered in this proposal (DESAFIO, 2013: 3, 11-12).

On this basis, we formulated our research problem taking into account a number of experiences that we identified in Brazil, Argentina and Colombia, which targeted the deficit of WSS in vulnerable communities through the design and implementation of socio-technical innovations. These experiences had in common an approach that articulated technological development with a clear concern for some aspects of the democratization process, for instance involving community members in one or more stages of the design, implementation, and long-term maintenance of the systems. Bolder initiatives extended the involvement of common citizens to the design of public policy and introducing mechanisms of radical democracy to empower citizens-users to monitor the performance of the government, the WSS providers, and other relevant power holders. LA&C has been an experimental field for this kind of developments, and we chose a range of experiences in order to cover a variety of socio-political, cultural, and policy-institutional contexts, in addition to a wide selection of settings including urban and rural communities in the three countries.

Therefore, we placed these experiences of socio-technical innovation at the heart of our project: “the main tenet of this proposal is that achieving the development goals set by the international community […] crucially depends on harnessing existing and developing new appropriate and innovative socio-technical solutions for the provision of safe WSS (DESAFIO, 2013: 3, our emphasis). This way of framing our research problem led us to formulate specific questions that guided our research work:

How can we harness existing and develop new socio-technical innovations in order to change policies, to develop strategies and practical interventions, and to enhance policy learning for tackling
unacceptable inequalities and injustice in the access to essential WSS? What **conditions, factors and processes facilitate the emergence** of socio-technical innovations in this sector? What are the **critical requirements** to make successful socio-technical innovations **sustainable and replicable**? What are the **obstacles to their sustainability and replication**? (DESAFIO, 2013: 3, our emphasis.)
2. DESAFIO’s case studies and the democratization of WSS

In total, we developed ten case study reports covering seven experiences of socio-technical innovation in the three countries involved in the research, Argentina, Brazil, and Colombia (Britto et al., 2014; Brown et al., 2014; Castro and Ferreira, 2014a,b; de Pádua et al., 2015; Freitas et al., 2014; Passos et al., 2015; Peña et al., 2014, a,b; Portapila et al. 2015). One of these experiences was covered by three research reports that addressed different angles of the innovation: the case of the Integrated Rural Sanitation System (SISAR) implemented in the state of Ceara, Brazil. We dedicated an individual page to each case study report in DESAFIO’s website. The experiences span over several decades and include a wide range of situations, from community-organized and managed spring water sources in the Rio de Janeiro Metropolitan Area (RJMA) dating back at least to the 1960s, to the diagnosis of water quality and the development of a water filtration system through participative activities jointly with members of a remote small rural community in the state of Minas Gerais, Brazil. We organized the case study work in three Work Packages (WP) to differentiate three categories reflecting different degrees of maturity of the experiences studied: WP2) “historical cases”, roughly with at least 20 years of existence, WP3) “current cases”, that had been implemented within the previous decade, and WP4) newly developed “interventions” that took place during the period of the research (2013-2015). Figure No 1 illustrates the temporal distribution of our ten case study reports or Project Deliverables (D).

Figure No 1. Temporal span of the case study reports

<table>
<thead>
<tr>
<th>Historical Cases:</th>
<th>Current Cases:</th>
<th>Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2.1 Rural Sanitation SISAR (Ceará, Brazil)</td>
<td>D3.2 Community-managed spring sources (São Paulo, Brazil)</td>
<td>D4.1 Water supply to indigenous community (Mazalahir, Iran)</td>
</tr>
<tr>
<td>D3.1 Condominium sanitation (Vila Madalena, Rio de Janeiro, Brazil)</td>
<td>D3.3 Community-managed water supply (Mondego, Coimbra, Portugal)</td>
<td>D4.2 Rural Sanitation SISAR (Cristais, Ceará, Brazil)</td>
</tr>
<tr>
<td>D3.2 Community-managed spring sources (Salvador, Bahia, Brazil)</td>
<td>D4.3 Restoring community awareness on water-related public health (Santa Fe, Argentina)</td>
<td>D4.3 Restoring community awareness on water-related public health (Santa Fe, Argentina)</td>
</tr>
</tbody>
</table>

Although the experiences studied go back at least to the 1960s, in practice our research was centred on the period beginning in the 1980s, when the bulk of our cases are concentrated. Table Nº 1 provides synthetic information about each of the case study reports, indicating Work Package and Deliverable number, and providing a link to the web page of each case study report.

Table Nº 1. The case study reports

<table>
<thead>
<tr>
<th>Work Package and Deliverable</th>
<th>Socio-technical innovation</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Historical Case Study Reports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WP2.1</td>
<td>Integrated Rural Sanitation System (SISAR)</td>
<td>State of Ceará, Brazil</td>
</tr>
<tr>
<td>WP2.2</td>
<td>Condominial Sanitation System</td>
<td>Mustardinha community, Recife, Brazil</td>
</tr>
<tr>
<td>WP2.3</td>
<td>Community-managed spring water sources <em>(minas de água)</em></td>
<td>Queimados Municipality, Rio de Janeiro Metropolitan Area, Brazil</td>
</tr>
<tr>
<td>WP2.4</td>
<td>Community-managed integrated WSS system with multi-stage filtration</td>
<td>La Vorágine community, Cali, Colombia</td>
</tr>
<tr>
<td><strong>Current Case Study Reports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WP3.1</td>
<td>Integrated Rural Sanitation System (SISAR)</td>
<td>Aratáca and Andreza communities, Fortaleza Metropolitan Region, Ceará, Brazil</td>
</tr>
<tr>
<td>WP3.2</td>
<td>Integrated Sanitation System</td>
<td>Mustardinha community, Recife, Brazil</td>
</tr>
<tr>
<td>WP3.3</td>
<td>Community-managed water supply system with ecological multi-stage filtration</td>
<td>Mondomo community, Santander de Quilichao, Cauca, Colombia</td>
</tr>
<tr>
<td><strong>Intervention Case Study Reports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WP4.1</td>
<td>Participative development of drinking water filtration system</td>
<td>Lagedo quilombola community, Sao Francisco, Minas Gerais, Brazil</td>
</tr>
<tr>
<td>WP4.2</td>
<td>Integrated Rural Sanitation System (SISAR)</td>
<td>Cristais community, Fortaleza Metropolitan Region, Ceará, Brazil</td>
</tr>
<tr>
<td>WP4.3</td>
<td>Participative assessment of water quality</td>
<td>Carcaráña, Coronda, La Chispa &amp; San Francisco, Cañada de Gomez, Santa Fe, Argentina</td>
</tr>
</tbody>
</table>
We have addressed elsewhere in detail different aspects of the ten case study reports, including the systematic comparison of results (Pinto et. al, 2015; Castro, 2015). Also, for a more detailed description of the innovations and their implementation the reader should check the individual case study reports (Britto et. al, 2014; Brown et. al., 2014; Castro and Ferreira, 2014a,b; de Pádua et al., 2015; Freitas et. al., 2014; Passos et. al., 2015; Peña et. al., 2014, a,b; Portapila et. al, 2015).

In the following sections, we present a synthesis of results focusing on DESAFIO’s original research questions. Next, we centre attention on the political character of the socio-technical innovations studied in the project, as the crucial objective of our research was to better understand how these innovations can contribute to democratize the politics of WSS.

3. Socio-technical innovations to democratize the politics of WSS

Drawing on our central research objective described above, DESAFIO’s first and more general research question asked

*How can we harness existing and develop new socio-technical innovations in order to change policies, to develop strategies and practical interventions, and to enhance policy learning for tackling unacceptable inequalities and injustice in the access to essential WSS?*

In this regard, the innovations studied are characterized by the articulation of mostly pre-existing technologies in new socio-political and policy-institutional arrangements and configurations. In all cases, the objective of the innovations was to contribute not only to tackle the deficit in the access to quality WSS in vulnerable communities, but to do so by involving members of these communities in the process. Implicitly, and often explicitly, all these innovations are political in character, as their introduction has the potential to transform existing structural inequalities in the activities of design, implementation, management, and monitoring of public policy and implementation in the field of essential WSS. Several of these innovations were explicitly developed as political instruments to transform the reality of vulnerable communities, such as in the cases of the Condominial and Integrated Sanitation systems implemented in Recife, Brazil (Castro and Ferreira, 2014a,b). All the innovations studied are also “political” in a more general sense, as their emergence did not happen in a social and political vacuum and were rather highly influenced by the social and political context (Castro, 2015b), as briefly discussed later. We summarize below some of the clearest examples of how the socio-technical innovations studied in DESAFIO contribute to the democratization of the politics of WSS.
Beyond the explicit or implicit political objectives of the innovations or the influence of the social and political context in their emergence, all the innovations have clear political effects on the communities where the systems were implemented. We found evidence of empowerment of local communities, which in some cases were able to develop sustainable levels of autonomy from power holders and gain access to dignified living conditions with safe and affordable WSS. A notorious example is the rural community of Mondomo in Colombia, the object of WP3.3 (Peña et. al, 2014b). In this case, after the local water system was destroyed by an earthquake in 1994, a new system was built with the leadership of the regional public university, DESAFIO’s partner UNIVALLE, mostly with public funding, additional financial and technical support from local private actors and international donors, and meaningful community involvement. The significant aspect of this experience is that the construction of the new system did not follow the conventional top-down approach characteristic of techno-centric interventions. The innovative character of this case is that it brought together a simple, affordable, locally-sensitive and effective water treatment eco-technology with participative activities that involved the local community in ways that allowed them to fully appropriate the technical knowledge to understand, operate, and maintain the system over time. There is no need to romanticise the experience, and in fact, the study also highlighted pitfalls, threats, and challenges facing community-managed WSS like Mondomo’s. However, the study showed the potential of these innovations to foster the democratization process in vulnerable rural communities, which as mentioned earlier are the most deprived and marginalized social sector in LA&C in relation to WSS and other essential services.

Another important example addressing the situation or unserved rural communities that we covered in our study is the Integrated Rural Sanitation System (SISAR) implemented in Ceará, Brazil (Brown et. al., 2014; Freitas et. al., 2014; Passos et. al., 2015; Cortez, 2015; Alves, 2015). SISAR was developed as an initiative to tackle the lack of drinking water in rural areas of Ceará, a Brazilian state located in the semi-arid region of the country where rural communities tend to be small and scattered over long distances. The initiative was triggered during the 1980s by a cooperation agreement between the state government of Ceará and international donors. SISAR is a not-for-profit non-governmental organization (NGO), which taps on a long tradition of associativism characterizing the local culture, and was designed to provide support to rural community associations that take charge of running their own WSS systems. Initially the objective was that SISAR would be financially self-sufficient, but over time it became clear that it needs strong public sector support to be sustainable, and the provincial public utility CAGECE, one of DESAFIO’s research partners, created a special management unit to support the operations. This has been a very successful experience, and currently there exist eight SISAR units in the state of Ceará, providing support to 759 local water supply systems in 137 municipalities, serving over 430 thousand people (Alves, 2015). Moreover, the system has been identified by international donors and financial institutions (IFIs) as a model to be replicated in other countries, a process that...
has already started. Like in the previous case, we do not romanticise the experience, and our case study reports highlight important pitfalls and potential dangers that need to be addressed in the functioning of SISAR. However, this is undoubtedly a socio-technical innovation that has already demonstrated the feasibility of solving the lack of access to drinking water affecting rural communities in LA&C, and its potential to make a material contribution to the democratization process in the WSS sector.

The community-managed multi-stage filtration system implemented in Mondomo or the SISAR system discussed above were not explicitly political projects, and often have been perceived and presented as “apolitical” by the community and other actors who strive to protect the project from the intervention of external political actors, and particularly from the influence of electoral politics. However, other experiences studied in DESAFIO were explicitly designed as political projects and its implementation was made possible by the determination of political actors, and their success in electoral politics. The clearest examples in our project are the cases of the Condominial Sanitation System studied by WP2.2, and the Integrated Sanitation System studied by WP3.2, both of them implemented in Recife, Brazil. In the case of Condominial Sanitation, the designer of the system, Eng. Jose Carlos Melo, explicitly defined it as a “political project” (Melo, 2014, 2015). It was political firstly because it tried to subvert the technological status quo in WSS based in large-scale, centralized infrastructures, by introducing low-cost, small-scale, interconnected decentralized sewerage systems. Secondly, it was a political decision to design a system to tackle the lack of sanitation services in vulnerable communities located in informal urban areas, which were left unserved by the conventional networked WSS that only provide services in regularized urban areas. Thirdly, the Condominial project involves the participation of the users, to the point that the infrastructure cannot be introduced in their neighbourhood without the explicit consent of the communities. Once the decision is taken, the participation is extended to the provision of materials, financial support, and labour during the construction and later for the management and long-term maintenance of the system. Fourthly, at least in Recife, the implementation was made possible because Eng. Melo became the Vice-Mayor of the city in the 1980s and the Condominial System was adopted as an official municipal public policy to tackle the deficit of sewerage collection and treatment in vulnerable areas. Like in the previous case, there is no need to romanticise the Condominial Sanitation System, and in fact the experience in Recife studied in our project was mostly a failure (however, the system has been highly successful and has been replicated in Brazil and in a large number of countries in several continents). The important point for our analysis here is that the experience illustrates the fundamentally political nature of socio-technical innovations aimed at solving the situation of vulnerable communities.

The other intervention introduced in Recife, the Integrated Sanitation System implemented since 2001 and studied by WP3.2, was perhaps the most explicitly political socio-technical innovation addressed in DESAFIO. In this case, the political character of the intervention included some of the elements highlighted in the experience of the
Condominial System, but went beyond it by introducing elements of radical democracy in all stages of the design and implementation of municipal public policy for the whole city, including the provision of WSS for vulnerable communities. The Integrated Sanitation system was also predicated on a critique of both the mainstream conventional WSS that excludes vulnerable communities located in irregular urban areas and of the Condominial Sanitation system as implemented in Recife. The premise was that there should be a single policy and a single system for the whole city, rich and poor alike. Why should poor vulnerable communities “participate” by providing funding, materials and labour, including the long-term maintenance of their domestic sewerage network, while the urban middle classes are served by the public utility and are not required to participate to have access to WSS? Integrated Sanitation focused on eliminating such inequalities and mobilizing the poor and vulnerable communities to actively participate in the elaboration of a municipal public policy for the whole city, which produced a roadmap that became adopted as a municipal public policy in 2002. The system, that in addition to water and sanitation coverage envisaged interventions of urban reform (paving, relocation of households located in dangerous or unsuitable places), provision of in-house sanitation facilities, environmental health including disease vector control, and environmental and health education, succeeded in entirely transforming some of the most deprived areas of the city into liveable, dignified neighbourhoods. This was not a top-down intervention, although it was implemented by the State with heavy funding, as the local authority implemented an effective training programme to facilitate the participation of the local communities in the close monitoring of the public works. Also, the local authority created mechanisms to ensure that both the municipality and the public utility were easily accessible and accountable to the local communities, including a physical local presence to ensure a rapid response to emerging problems with the provision of services. These and other radical measures were made possible because in the municipal elections of the year 2000, a political alliance led by the Workers’ Party won the contest on a platform that had placed the solution to the deficit of WSS in vulnerable communities as a top priority, and lived up to the campaign promises. Once again, in this case, the evidence from our research prevents us from romanticising this experience. As shown in our case study report for this experience, despite the significant achievements of the intervention, electoral politics eventually led first to the weakening of the model and later to its progressive dismantling from 2005 and onwards (Castro and Ferreira, 2014b). However, the main lessons emerging from this study remains very powerful and reinforce our argument about the fundamentally political nature of the factors and processes that explain the success, but also the failures, of socio-technical interventions designed to democratize WSS, especially in relation to vulnerable communities.

All the examples of socio-technical innovations studied in DESAFIO provide important lessons that may contribute to the development of policies that help to consolidate and advance the democratization process. The cases discussed briefly in this section are probably the clearest to illustrate the potential of these innovations in this regard. In the
next section, we focus on the emergence of these innovations, which was the focus of DESAFIO’s second research question.

4. The emergence of socio-technical innovations

DESAFIO’s second research question addressed the emergence of the innovations, as another key objective in our project was to better understand:

What conditions, factors and processes facilitate the emergence of socio-technical innovations that seek to democratize the access, the politics, and the managerial-operational activities in relation to essential WSS?

This question led us to examine the context, including the historical processes within which the innovations studied first emerged. As explained before (see also Figure Nº 1), most of the innovations studied in DESAFIO emerged during the 1980s and 1990s, two decades that were marked by socio-economic and political transformations that had far-reaching implications for the provision of essential WSS worldwide. This was particularly the case in LA&C, a region that became an experimental field for policy reforms in the WSS sector, including the countries covered in the study. We examined in some detail these issues elsewhere in this project (Castro, 2015a,b; see also Castro, 2004), and therefore only provide here a summary of key elements:

- The return to democratic rule after the civic-military dictatorships in Argentina (1983) and Brazil (1985) fostered the democratization process and strengthened initiatives to decentralize the State and empower local authorities
  - in Brazil, a new Constitution passed in 1988 granted significant autonomy to municipalities in relation to essential public services
  - in Colombia, similar movements to decentralize and democratize the State gained momentum in the 1980s leading to the introduction of decentralization reforms in 1987 and a new Constitution in 1991.
- Another important development that played a central role in the transformations introduced in this period was related to the “appropriate technologies” debate, which was grounded on a critique of conventional development programmes and mainstream economic thinking. Appropriate technology meant technologies that
  - are small in scale and appropriate to local contexts
  - tap local sources of raw materials, energy, and labour
  - are simple enough and affordable to make them widely available
  - involve local communities directly in their management and maintenance
  - give the poor access to benefits that were before reserved to the rich and powerful.
- Counteracting the forces of democratization, neoliberal and neoconservative policies since the 1980s contributed to the weakening and dismantling of the
State’s capacity to regulate and directly provide essential public services, including WSS.
  
  o These policies found a fertile ground because there was much appetite for decentralization of powerful State monopolies, which for decades had been perceived as a source of inequality and injustice.
  
  o Neoliberal and neoconservative initiatives tapped and often co-opted long-standing traditions of solidarity and reciprocity characterizing Latin American and Caribbean cultures to promote the notion that the poor should help themselves rather than expecting State interventions to tackle structural inequalities.
  
  o Also, within the prevailing neoliberal and neoconservative framework of the 1980s and 1990s, the arguments for small, context-sensitive, locally appropriate, and especially low-cost technologies were often used to complement public policies seeking to free the State from the responsibility to provide essential services to the population. This particular understanding of the “appropriate technology” approach often contributed to reproduce rather than eradicate structural inequalities and injustice in relation to WSS, consolidating a division between technologies for the established social sectors and “technologies for the poor”.
  
  o These policies, in a context of extreme financial crises during the 1990s, contributed to further curtail citizenship rights by reducing the State’s capacity to provide for the most vulnerable sectors of the population. A major objective of these policies was to free the State from such responsibilities, and make the poor take responsibility for their own needs.

- The contextual conditions of the 1980s and 1990s also nurtured alternative innovations that resisted the neoliberal policy framework promoted in the WSS sector. These innovations were advanced by citizen organizations, social movements, community organizations, progressive sectors of the Catholic Church, committed academics and political actors, among others.
  
  o The alternative innovations that emerged as a result were informed by political objectives and principles grounded on the understanding that the democratization of WSS required establishing democratic social control of the State institutions by the citizenry.
  
  o Therefore, rather than freeing the State from responsibility for the provision of essential WSS, these forces sought to radically transform the role of the State to put an end to the protracted conditions of inequality characterizing the provision of public services. Eradicating these conditions of inequality required not only the universalization of access but also the creation of the relevant institutional mechanisms to make the State and the public institutions in charge of essential public services accountable and subject to democratic social control by citizens and users. It also required a strong role of the State in the direct provision of
services, including heavy public investment to reverse the situation of chronic deficit affecting vulnerable communities.

Therefore, the contextual conditions of the emergence of the socio-technical innovations studied in DESAFIO consisted in a very complex and evolving configuration of socio-economic, cultural, and political forces that was far from being monolithic and that adopted different forms and dynamics in the different territories, including the three countries involved in the project. In consequence, the different factors and processes summarized above evolved over time in diverse forms and with often diverging results. Although our project results do not allow us to ascertain with precision the influence of the contextual conditions, innovations like the Condominial Sanitation system (Castro and Ferreira, 2014a), the Integrated Rural Sanitation System (SISAR) (Freitas et al., 2014; Brown et al., 2014; Passos et al., 2015; Cortez, 2015; Alves, 2015; Melo [CVS], 2015; Sobreira, 2015), the community-managed rural water and sanitation systems in Colombia (Peña et al., 2014a,b), and the Integrated Sanitation system (Castro and Ferreira, 2014b), in different degrees, all borne characteristics inherited from the prevailing conditions of the period (for details, see Castro, 2015b). However, and although it is possible to establish clear differences between the innovations studied along the lines of the characteristics identified, the evidence does not allow us to pigeonhole these experiences mechanically. For example, despite the stated policy objectives of neoliberal policies that clearly influenced some of the innovations studied, the reality in the ground was much more complex and our case studies show that innovations that emerged under the influence of the neoliberal context did not necessarily deliver neoliberal outcomes. Once implemented, these innovations sometimes evolved into complex configurations because of the widespread social resistance to neoliberal and neoconservative policies, owing to the influence of the local context and the interplay between local actors in the ground, or because the success of the innovations led to significant re-adaptations of the innovations and the diversification of their original objectives.

In this regard, among the key project findings that have relevance to tackle the situation affecting vulnerable communities it is worth highlighting the interplay between structural determinations and social actions that underpin democratization processes. While some of the innovations were clearly triggered by conscious decision making grounded on well-planned political objectives, others emerged from the combination of unpredictable events. This the case in Mondomo, Colombia, addressed in our case study WP3.3. The destruction of the local water system by the 1994 earthquake triggered the articulation of several processes that had been maturing locally and a complex array of social actors, bringing together the adoption of inter- and transdisciplinary approaches for the development of technological interventions at the regional university UNIVALLE, our research partner in DESAFIO, with the active mobilization of the local population that sought to improve their living conditions after the disaster.
In this connection, although the socio-political and economic-financial structural conditions that provided the context and some of the triggers mentioned in the examples above contributed to the emergence of the innovations, this always happened in a dynamic process of interplay between these structural forces and conditions and social actions informed by a wide range of perspectives and objectives, often in contradiction with each other. In a similar way, the experiences of success or failure and the replicability of the innovations under the study must be examined as the result of this complex interplay between structural forces and conditions and the manifestations of individual and collective agency initiatives and projects, which we consider next.

5. Success and failure of the socio-technical innovations

Another key objective of our project was to understand the reasons that explain the long-term success of these innovations. Our main research question related to this objective was:

*What are the critical requirements to make successful socio-technical innovations sustainable and replicable?*

Many of the factors and processes discussed in Section 3 in relation to the emergence of the innovations also had a significant role in their success and replicability. We summarize these below.

**Local community involvement.** Our ten case-study reports provided substantial evidence of the significance of local community involvement for the success of the innovations studied.

- In some cases, the solution to the lack of drinking water in vulnerable communities was the exclusive result of local community action to organize and maintain a system to solve the problem, in the absence of external support, whether public, private or else. This is the situation that we found in Queimados municipality in the Rio de Janeiro Metropolitan region. However, as explained in the case study report for this experience, the conclusions of the research for this case do not allow us to promote this particular community-led solution as a viable innovation that we think should be maintained or replicated. It poses significant risks to the population and reflects the lack of responsibility showed by the public institutions responsible for the conditions of vulnerability affecting the local community (Britto et al., 2014).

- In the cases that we consider to provide the clearest examples of successful socio-technical innovation, a fundamental requirement for their success was community involvement.
In the cases of Mondomo, Colombia, and Recife, Brazil, we find probably the clearest examples among our cases of a strong record of pre-existing community organization and leadership that was a determining factor of success (Peña et. al., 2014b; Castro and Ferreira, 2014a,b). Also, the experience of the SISAR system in the Brazilian state of Ceará was made possible by the long standing tradition of community associations that facilitated the implementation of this innovation, which requires a high degree of community participation (Cortez, 2015; Alves, 2015).

Nevertheless, in all cases there was a need for external interventions to promote community involvement, either because it would not happen spontaneously (e.g. because the communities did not trust the external agents implementing the innovations) or because there was a need to target, restrict, or otherwise channel community participation in a certain direction to achieve success.

In some cases, there was a need to guide existing or externally promoted community participation to train local people and help them to appropriate the knowledge needed to take charge of the systems and become responsible for their long-term maintenance.

- This happened for instance in the two Colombian cases, where the university played a crucial role in training community members and developing participatory activities to raise awareness and facilitate the appropriation of the innovation by the users, keeping a permanent relationship to support the community in the long-term running of the systems.
- It is also the case of the SISAR in Brazil, where SISAR provides training to the local community associations to take charge of the system after its construction, with a strong technical support from the State public utility.
- Also the Condominial Sanitation system as implemented in Recife, Brazil, involved externally induced forms of participation to make sure that the local community agreed to the implementation of the system in their neighbourhood by signing a “Condominial Agreement” with the municipality or public provider. This formal agreement involved a commitment by the community to contribute with funds, labour, or materials for the construction and for maintenance of the system over time.
- Although the Integrated Sanitation system also implemented in Recife, Brazil, addressed community involvement with a more radical approach, it also required substantial external inducement to guide community participation.
  - There was a need to introduce significant institutional changes to make sure that community members were...
given a strong say in the design of a municipal public policy framework to tackle the situation of vulnerable communities for the whole city.

- Community members were also trained to monitor the implementation of the system by the municipality and were provided with specific institutional arrangements to facilitate the monitoring of the maintenance and running of the system over time.

  - The intervention implemented in the Quilombola community of Lagedo, Minas Gerais, Brazil was benefitted by existing mobilization of the local community over issues such as the regularization of land ownership. However, getting the local people effectively involved in developing a water filtration system suitable to their context required **strong external inducement from the researchers**. This included **training and participatory activities** to raise awareness among community members about the quality of local water sources and to help them to take charge of the management of the system after its implementation (de Pádua et. al., 2015).

  - In the intervention implemented in Santa Fe, Argentina community involvement was fully induced by our partner UNR working with local secondary school teachers and students with the objective of raising awareness about the quality of local water sources and **fostering the empowerment of the community** to monitor provincial and municipal public policies in the sector of WSS (Portapila et. al., 2015).

Another important finding is that, independently of the degree of success of the innovation or the specific weight that community involvement might have in explaining such success, there exist **different, event rival understandings of what exactly “community participation” should involve**. These different and rival understandings are rooted in different principles and objectives, including **diverging understandings of the democratization process and about the very meaning and extent of “democracy”**. We have discussed this in more detail elsewhere in this project (Castro, 2015a). In some cases, like the Condominial Sanitation system, explicitly the **participation is restricted to the formality of the Condominial Agreement** that must be signed by each local neighbourhood, which is basically a commitment to the co-management of the sewerage system. This has been the subject of much criticism of this innovation, which we have discussed in some length in the relevant case study report (Castro and Ferreira, 2014a). Similar criticisms have been directed at the SISAR system implemented in Ceará, pointing at the fact that **community participation is mainly restricted to the co-management** of the system and does not involve more meaningful engagement (Freitas et. al., 2014; Brown et. l., 2014). In the case of other innovations covered in the study, the notion of participation in principle goes beyond the more instrumental aspects, such as the construction and management of the systems, and includes the social and political appropriation of the innovations. This is particularly
the case in the Integrated Sanitation system implemented in Recife Brazil, and in the two Colombian cases of community-managed WSS (Peña et. al., 2014a,b; Castro and Ferreira, 2014b). In the last analysis, the crucial difference is between innovations that understand participation as a potential vehicle to tackle structural social inequality and injustice, and those that limit participation to the more instrumental aspects of the implementation of the innovations, such as persuading the population to accept the introduction of the intervention in their locality and the responsibility to co-manage the system over time.

Meaningful and sustained external support. Although community involvement is clearly a crucial factor of success that we identified in the socio-technical innovations studied, our research confirms a well-known fact that has been widely addressed in the existing international literature on the topic: community participation has severe limitations, and it could even become an obstacle rather than a vehicle for substantive democratization. Our findings show clearly that sustained and meaningful external support, particularly from the State, is a deciding factor in the sustainability of the innovations. This is the case even in situations where the implementation of innovations inspired by the appropriate technology approach provided for systems that are relatively inexpensive and simple to run by the users, as in the two Colombian cases of community-managed WSS (Peña et. al., 2014a,b).

An important point that must be highlighted here is that there exist important, deep-rooted contradictions in the understanding of key concepts related to these processes, particularly “autonomy”, “emancipation”, “independence”, and their opposites, such as “heteronomy”, “subordination”, and “dependence”. We do not have room in this brief summary to deal with these and other relevant conceptual debates, which we will address in the publications emerging from DESAFIO. However, it is important to point here some key, relevant points. Several of the innovations studied in DESAFIO were influenced by a strand of thinking in public policy, with deep roots in intellectual and political traditions, that argues for the self-sustenance of, particularly, small rural communities. Much emphasis is placed on helping these communities to achieve independence from external actors, in particular the State. In the extreme, it is expected that the communities will become fully self-sufficient. A pitfall of this approach is that although the conceptual dichotomies (e.g. autonomy-heteronomy) are a fundamental step in the development of thinking about these processes, if we remain trapped in dichotomic argumentation we fail to make observable the complex relational processes at stake. In practice, the implementation of the innovations studied in DESAFIO, as most other complex processes, are in a permanent flux and evolving into interdependent configurations that are difficult to foresee, let alone control, by any single actor. There is a high risk if the innovations implemented to solve the problem of poor, vulnerable communities have complete independence from outside actors as the final goal, for instance by becoming financially self-sustaining. We found evidence in our research showing that even when the innovations are successful, their long-term sustainability is always dependent on some degree, often a very strong degree, of external support, especially in financial
and technical matters. Why should it be otherwise, if even in well-off urban centres the provision of essential public services, including WSS, are heavily subsidised and supported by the State? The idealization of “full-cost recovery” policies may remain strong in some sectors of the public policy community, but it is more a political, even ideological project than a reality empirically verifiable. Why asking it from poor, vulnerable communities, whether rural or marginal urban, if full-cost recovery is not achieved even in wealthy urban centres?

In this regard, greater autonomy in the search for political emancipation cannot be achieved in isolation, as the democratization process is fundamentally interdependent. The social and political interdependence characterizing democratization processes, up to this historical stage, tends to crystalize in institutional configurations of coordination, where autonomy and heteronomy are in permanent tension. Full community self-sufficiency, even if it were achievable, is not necessarily a path to democratization, and may be on the contrary the result of increasing social polarization and inequality.

**Successful innovations and interdependence.** The lessons emerging from our project indicate that community involvement and self-determination are as important as external intervention and support, and successful experiences are clearly made possible by a combination of these two factors, whereby external support tends to be critical for the long-term sustainability of the experiences.

- In the two Colombian cases, the university, our partner UNIVALLE, has provided continued support to the community to facilitate the running of the systems over time. This has been necessary owing to the lack of State support for rural WSS in the country. In addition, there is a clear tendency to a decline in community participation over time, which the university has identified. One initiative to counter these negative trends has been to support the creation of regional organizations to bring together community-managed rural WSS in order to support each other. These organizations are meant not only to strengthen existing community-managed rural WSS but also help replicating the model based on the innovation implemented in the two cases studied by DESAFIO (Peña et al., 2014a,b). The success of these two cases suggests that the model has significant potential for replication.

- In the case of SISAR, although the original goal was community self-sufficiency, eventually the provincial public authority CAGECE, our partner in DESAFIO, had to step in to provide sustained strong support to ensure the survival of the systems. CAGECE has created a special management unit to support all SISAR units (Cortez, 2015; Alves, 2015. This model has been successfully replicated across the state of Ceara and is now promoted by the IFIs and some donors as a system that can be replicated in other countries. Also, the Brazilian government is considering the possibility of adopting SISAR as one of the policy options for rural sanitation in the country.
• Although the experience of the Condominial Sanitation system in Recife was a failure, the innovation has been highly successful elsewhere (Castro and Ferreira, 2014a). For example, it was adopted in the 1990s by the public WSS utility of Brasilia, the country’s capital, where it became the preferred option for the whole city, serving rich and poor alike very successfully. A major reason for this success is that the public utility has created a special management unit dedicated to Condominial Sanitation, and provides full support to the users (Montenegro, 2015b; Rissoli, 2013, 2015). There is little community involvement here, and the system operates like a conventional sanitation system. The innovation has been replicated in Brazil and worldwide and has been promoted by the World Bank, the Inter-American Development Bank, and other international agencies.

• The Integrated Sanitation system also implemented in Recife, Brazil, is a successful example of how to tackle holistically the different dimensions of vulnerability: lack of safe drinking water, sanitation, in-house facilities (toilets, showers), drainage, urbanization including housing and pavement, solid waste collection and disposal, disease vector control, and other related aspects. Although community involvement is fundamental in this innovation, this involvement takes place in the design and monitoring of public policy, implementation, and long-term management of the system. It is not expected that poor communities should take charge of the systems themselves, whether by investing financially or in kind for the construction of the infrastructure or in the long-term activities of maintenance and operation. Owing to its holistic approach, this is an expensive system, and it is grounded on the assumption of a strong State leadership and commitment to make the necessary investments and maintain the infrastructure and operation over time (Castro and Ferreira, 2014b; Miranda Neto, 2014, 2015).

To close this section, the lessons emerging from the research clearly show that although the requirement of sound techno-infrastructural and operational design and performance is critical, the evidence indicates that the crucial success factors for the long-term sustainability and replication of socio-technical innovations are socio-economic, cultural, policy-institutional, and, fundamentally political. This conclusion has been emphasised by the technical experts that we consulted during the research, many of whom were designers or implementers of some of the innovations studied (e.g. Melo, 2014, 2015; Miranda Neto, 2013, 2014; 2015; Montenegro, 2013, 2014a,b). Summarizing, we identify three main success factors for socio-technical innovations oriented to solve the deficit of WSS in vulnerable communities: firstly, the fundamental role of the State support in the funding of the infrastructure and in guaranteeing the long-term sustainability of the systems. Secondly, meaningful social participation that is not restricted to the tokenistic or instrumental involvement of the user communities is a crucial factor when the running of the system relies heavily on co-management. Thirdly, the significance of other forms of external support, for instance technical advice and training provided by universities and State agencies, to empower and facilitate the
appropriation of the innovations by the user communities and enhance their levels of autonomy and wellbeing.

6. Obstacles facing socio-technical innovations

DESAFIO’s other important objective was to understand concerned the factors and processes that help to explain the failure of innovations:

*What are the key obstacles to the sustainability and replication of the innovations?*

Our findings here confirmed our overall assessment that the main reasons for both success and failure are not related to the techno-infrastructural and operational dimension, as we anticipated in our original project proposal:

We argue that these deficiencies [in the provision of safe WSS to vulnerable communities] are neither caused by unfortunate environmental constraints nor by a shortage of scientific and technical knowledge or by the unavailability of technological solutions, even in the poorest countries (DESAFIO, 2013: 3).

In most cases, the innovations studied relied on existing techno-infrastructural and operational knowledge and practice that has been in use for decades. As discussed above, the key to the innovations has been the *assemblage of existing techno-infrastructural and operational knowledge and practice in new configurations* that challenge the status quo based on top-down policy and management and large-scale, centralized WSS. For sure, techno-infrastructural and operational factors play a role in the failure of some innovations, and among the experiences studied in the project perhaps the best example was the implementation of the Condominial Sanitation system in Recife, Brazil, covered by case study WP2.2. As explained in our report for this case, the CS system is an intervention exclusively focused on providing sewerage, disconnected from other infrastructure services. In the case of Recife, this became a major problem given the low level of coverage of these services, especially urban drainage, given that Recife is a city built on low-lying lands in a river mouth, much of it on soil reclaimed from mangroves. The high water table, combined with the impact of the tidal cycle on river levels, is a major problem for the provision of essential WSS in the city, which demands holistic interventions that tackle simultaneously the introduction of WSS networks with the provision of adequate drainage and other infrastructures. The exclusive focus on sewerage, disconnected from other infrastructure services, characterizing the original model of the Condominial Sanitation system implemented in Recife became a major obstacle for the project’s success and a key reason of failure. Nevertheless, even in this case techno-infrastructural and operational factors were not the key reason of failure, as the system could have worked if all the necessary requirements, including
complementary infrastructure services, had been in place, as suggested by the successful implementation of the system in many other locations.

In this regard, our findings suggest that the factors and processes that constitute the main obstacles are similar to those explaining the success of the innovations. These are mostly socio-cultural, policy-institutional, and political issues, which was confirmed in our interviews and exchanges with technical experts, that included the designers of the Condominial and Integrated Sanitation systems implemented in Recife (e.g. Melo, 2014, 2015; Miranda Neto, 2013, 2014; 2015; Montenegro, 2013, 2014a,b). Even the failures identified in the techno-infrastructural and operational aspects, for instance the inadequate infrastructural performance of the Condominial Sanitation system in Recife or the partial failure to fully comply with drinking water parameters in some of the SISAR systems (Passos et. al., 2015) can be mainly explained as failures in the public policy and institutional domain. In addition, socio-cultural and political aspects also play a fundamental role in the explanation.

The limits of community participation. The implementation of the Condominial Sanitation system in Recife contains important lessons in this regard. In particular, the reliance on users for much of the construction, maintenance, and operation activities led to critical problems

- The scale and intensity of the participation diminished over time, in part owing to the normal attrition of the participative processes, but also owing to the frustrations of the community provoked by failures in the implementation, management, operation, and maintenance of the system.
- The part of the condominial network that was completed only worked partially, because the construction of the domestic connections (the connections between the households and the network) was a responsibility of the users, and a large majority never built them for different reasons. This led to the rapid deterioration of the condominial network. Later, the Municipality built part of the missing domestic connections, but then many users decided to disconnect their homes from the network owing to serious operational and management problems. Most of them connected their domestic sewers to the drainage network or just emptied the sewage into nearby water bodies or even the streets.
- The urban dynamics typical of poor areas, characterized by spontaneous and unplanned construction, created serious problems for the system. Specially the building of new facilities inside the homes often led to the construction of rooms, paving, or other items on top of the networks that had been constructed inside the properties, in the back or front gardens, which turned impossible the operation and maintenance of the system. Also, the “Condominial Agreement” was too often broken by the users, for example by closing access to the sewers inside the property, often covering them with cement of other hard surfaces, for a number of reasons, including to avoid the bad smell inside the property, because of quarrels between neighbours, or because new tenants or homeowners that came
after the implementation of the system often were not alerted of the existence of the “Condominial Agreement” or did not feel obliged to stick to it, as they had not been part of the original process.

However, the limits of community participation became apparent in other cases too, particularly in those innovations that are highly reliant on it. For instance, in the case of the community-managed WSS in La Vorágine, Colombia, covered by case study WP2.4.

- The very success of the innovation is reducing the vitality of community participation, as the local population considers that the system is properly managed by the current board of the community association, which is composed of a very few members who are burdened with most tasks. The findings of this study suggest that “the collective capacity to tackle disrupting factors related to the management of WSS services has been gradually declining” (Peña et. al., 2014a: VI).
  - This has created a vulnerability in the system, as one single person is currently responsible for most operational and administrative tasks, and there is no obvious replacement for this person.
- The study identified a number of additional causes that may explain the fall in community engagement threatening the long-term sustainability of the system, including
  - Recently arrived or younger members of the community lack the historical memory of the innovation, as they were not part of the participative process of design and implementation
  - There has been an exodus of young community members who had the potential to become community leaders, who leave in search for better work opportunities in the provincial capital Cali. As a result, the community board in charge of the WSS is finding hard to fill several vacant posts.
  - There are now women involved in the management of the WSS, which reinforces the gender imbalance detected in the process of community participation.

Similarly, the case of SISAR in Ceara, Brazil, provides further example of the limits of community participation as an obstacle for success and replication of the innovations. Despite that system is organized around the requirement of continued community engagement in the co-management of the system, our study found that “perhaps the major weakness [of SISAR] is that of social participation” (Freitas et. al., 2014: 49). The study found several indicators of this weakness, including

- Low or declining frequency of participation in the meetings of the community associations in charge of the systems, caused by
  - lack of engagement with community life at large
but also because after the successful implementation of the water supply system many people lose the incentive to participate and prefer to use their time in other activities perceived as more rewarding

- as SISAR is limited to the provision of water supply, the impact of the external inducement of social participation is greatly restricted
- the exodus of young people to urban centres in search for better opportunities is creating problems for the eventual replacement of current community leaders, which is perceived as a major risk for the long-term sustainability of the model.

These examples illustrate a common pattern across our case studies confirming that the limits of community participation constitute a major obstacle for success and replication of the innovations, to the extent that co-management and other forms of intensive community involvement are key requirements for their functioning.

**Poor or lack of State support.** This factor is intimately connected with the previous one. As seen before, strong and sustained external support, particularly from the State, is a major factor of success in the cases studied, and the weakness or absence of this support is conversely a key obstacle for the long-term success and replication of the innovations.

For instance, in the case of SISAR, the fact that the intervention is restricted to the provision of water supply in the absence of a more holistic approach is a fundamental weakness. Although this is not a weakness of SISAR as an innovation, in the absence of State policies to enhance the quality of life of vulnerable rural communities, the potential impact of SISAR is severely diminished and this in turn may limit the capacity and willingness of the population to engage more fully in the co-management of the system. Our study found that despite the fact that SISAR’s introduction of water supply is a major advance, the rural communities where the studies were carried out point at the lack of State support for the provision of a range of essential services, including cultural facilities, public health, basic education, local transportation, pavement, solid waste collection and disposal, etc. (Freitas et al., 2014: 49).

Another example is provided by the study on the Condominial Sanitation system implemented in Recife (Castro and Ferreira, 2014a). The major reasons of failure identified in this case were:

- Lack of long-term inter-sector collaboration between the relevant actors in the public sector. This included,
  - Lack of political decision, both at provincial and municipal level, to design an institutional framework to guarantee the continuity of management, operation, and maintenance activities of the system in the long term;
  - Particularly lack of involvement of the public utility COMPESA, which had a strong preference for conventional sanitation infrastructure and refused to take responsibility for the management of the alternative
Condominial Sanitation systems that had been introduced by the municipality

- Lack of continuity and prioritization in the implementation of the system, expressed in the poor allocation of financial resources allocated to the implementation in its early stages and later in the outright abandonment of the project.
- Absence of a campaign to raise awareness and keep the population alert in relation to their duties in co-managing the system, which requires a permanent domestic operation to keep the system working (avoiding and clearing blockages, solidary collaboration between neighbours, etc.).
- The lack of valorisation of water, WSS, and the environment at large by the authorities and the service providers, and by the users more generally.

Summing up the lessons from this case, the reliance on users for much of the construction, maintenance, and operation activities, in the absence of sustained support from the State (e.g. in environmental and hygiene education), led to critical problems. This problem was compounded by increasing conflicts between members of the “condominiums”, the neighbours, arising from system blockages caused by misuse and other issues leading to the break of the “condominial pact” that eventually provoked the abandonment of the systems by the community. However, the lack of continued State support for the system was a major factor of failure, particularly the non-compliance with investment commitments to complete the construction of the infrastructure and the lack of support for maintenance and operational activities in the long term.

The experience of the Integrated Sanitation system, also implemented in Recife, Brazil, further confirms the weakness or lack of strong and sustained State support as a crucial obstacle for success and replication (Castro and Ferreira, 2014b). Although this was a successful experience given that it achieved the specific objectives of the intervention in relation to the techno-infrastructural dimension, the long-term sustainability and replicability of the system became seriously compromised owing to changes in political priorities that led to the abandonment of the original strategy. The most important institutional reforms foreseen by the original project to empower common citizens to participate in the approval and monitoring of municipal public policies were never implemented and were eventually abandoned. Likewise, the mechanisms created by the local authority to make the municipal and provincial authorities and the public utility more accountable to the citizens and users were progressively scrapped. The abandonment of the commitment to introduce substantive political and institutional reforms led to the failure of the original project in Recife. In our interviews with the designers of the innovation, we also learned that a similar experience of failure caused by abandonment of State support for the system as a result of changing political priorities and electoral politics had also been a major factor of failure in previous experiences with Integrated Sanitation (Miranda Neto, 2013, 2014; 2015; Montenegro, 2013, 2014a,b).
The study of SISAR also provides evidence of the significance of poor or lack of State support as an obstacle for success. Despite its success, SISAR has not yet achieved institutional stability and has been under threat of political decisions that could seriously affect its continuity, at least in its present form. The lack of a national policy for rural WSS in Brazil may be a constraint for SISAR’s potential development, although a new national framework for rural WSS could also become a threat to SISAR as it could favour other alternative systems as the preferred choice of government policy for rural WSS. In any case, the lack of a national policy framework is a source of uncertainty for the future of rural sanitation, and this has potential consequences for the SISAR system. At the local level, the implementation of SISAR units is often marred by a political context characterized by a strong culture of clientelism within which the system has to operate (Alves, 2015). There is much room and need for concerted State action to improve the living conditions in rural communities in Brazil, which requires policies where drinking water supply interventions as SISAR form part of an integrated approach to eliminate structural inequality and injustice. However, there is a lack of integrated approaches for rural WSS in the country (Freitas et. al., 2014).

The case studies on community-managed WSS systems in Colombia also reinforce the findings that a major obstacle for the success of socio-technical innovations to democratize WSS to tackle the situation of vulnerable communities is poor or lack of State support. Like in the case of Brazil, Colombia still lacks a national framework for rural sanitation, which is a source of uncertainty for the long-term sustainability and replicability of the innovations studied in WP2.4 and WP3.3. Also, there is a pattern of lack of technical and financial support for the tens of thousands of rural WSS existing in the country, which is major impediment to the expansion and consolidation of community-managed WSS in a context where there are few if any alternatives for the rural population. In addition, the introduction of new regulatory arrangements for WSS in the country generated a homogenous regulatory framework that fails to take into account the specificities of rural WSS managed by communities or small local authorities, which are subject to similar bureaucratic burdens as public utilities in large urban centres (Peña et. al., 2014b: V). These problems are compounded by the fact that, at least officially as a result of joining the Pacific Alliance jointly with Chile, Mexico, and Peru, Colombia has adopted the neoliberal framework for WSS that promotes privatization and mercantilization of these services and the retreat of the State from the activities of provision and funding of these services. This approach to the provision of WSS is a major threat to the process of democratization of the politics and management of these essential services (Castro, 2015b). For example, the current regulatory system for WSS was designed for large, commercialized WSS utilities but apply to all WSS providers, including small community associations like those studied in DESAFIO, which are now regulated by private law. That is, their status as not-for profit entities organized on the basis of solidarity, cooperation, and community engagement is not recognized in the legal and regulatory frameworks, which were designed to promote market-oriented WSS wholesale. This, combined with the lack of a national policy for rural WSS constitute a major threat to the long-term success of the innovations (Peña et. al., 2014b).
Summing up this section, we just summarized relevant examples from our findings showing a pattern of common factors that constitute significant obstacles for the long-term sustainability and replication of the socio-technical innovations studied. We emphasised particularly two main factors: the limits of community participation, and poor or lack of external support, particularly State support for solutions oriented at tackling the deficit of WSS affecting vulnerable communities. Our research also found evidence of additional obstacles facing the replication of the innovations when exported to other regions and countries. Although our project did not include an in-depth study of such experiences, in our interviews and exchanges with experts in the field we learned about failures in the replication of innovations in other settings caused by cultural, institutional, and political differences (e.g. causes of failure in the implementation of the Condominial Sanitation system developed in Brazil when introduced in Bolivia and Peru). We also found evidence that the innovations have been often adapted to suit different conditions, even introducing radical modifications to the original model, as has been the case of the implementation of the Condominial Sanitation system in Brasilia or Salvador in Brazil, where community participation has been almost entirely replaced by conventional management by the relevant public utility. These and other aspects are worthy subjects for future research.

Conclusions

DESAFIO was a study about the democratization process in the field of essential public services, with an empirical focus on the situation of WSS affecting vulnerable communities in Brazil, Colombia, and Argentina. We studied a range of socio-technical innovations developed and implemented in these countries, concentrating our focus on the period started in the 1980s. We studied these socio-technical innovations in their character of vehicles of the process of democratization of politics and management in the WSS. Our main interest was to ascertain the capacity of these innovations to transform the prevailing status quo in the sector of WSS, which is a major reason for the unacceptable conditions affecting vulnerable communities in LA&C. As discussed in the first section, despite official claims to the contrary, the evidence shows that strictly speaking the MDGs set in the year 2000 have not been achieved, and vulnerable communities continue to suffer the worst effects of this failure. In this regard, the socio-technical innovations studied in DESAFIO contain significant lessons and ample evidence of the potential to overcome the current crisis of WSS in the region. We learned about the factors and processes that contributed to the emergence of these innovations, as well as about those that help to better understand the successes and failures affecting the long-term sustainability and replicability of the innovations.

In our original proposal, we had identified a range of indicators to guide our project in the attempt to contribute towards advancing the state of the art in this field. Table N° 2 reminds us of these indicators.
Table № 2. Synthesis of key indicators of progress beyond state of the art

<table>
<thead>
<tr>
<th>Status Quo</th>
<th>Progress Expected</th>
</tr>
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<tbody>
<tr>
<td>Prevalence of technology-centred solutions (technological fixes, etc.)</td>
<td>Evidence-supported, people-centred socio-technical innovations</td>
</tr>
<tr>
<td>Dominance of North-South flows in technological transfer</td>
<td>Re-balance of the relationship through bi-directional North-South flows and renewed emphasis on South-South interactions</td>
</tr>
<tr>
<td>Persistence of disciplinary entrenchment; split between “hard/soft” scientific disciplines and similar divides (i.e. between natural, technical, and social sciences, humanities, etc.)</td>
<td>Interdisciplinary and holistic approach grounded on sound methodological basis</td>
</tr>
<tr>
<td>Protracted poor (or lack of) communication between policy sectors (i.e. environment, WSS, public health, etc.)</td>
<td>Strategically oriented inter-sectoral coordination to foster effectiveness, efficacy and efficiency</td>
</tr>
<tr>
<td>Weak or non-existent civil society engagement, poor governance; instrumentalization of community involvement and participation; top-down, paternalistic solutions; emphasis on users’ acceptance of decisions taken by politicians and technical experts</td>
<td>Transdisciplinarity; involvement of communities, citizens, and users in all stages of the production of knowledge, and the implementation, monitoring and validation of socio-technical solutions; empowerment and appropriation of socio-technical solutions by local communities</td>
</tr>
<tr>
<td>Failure to meet basic needs of vulnerable populations due to political priorities of short-term interests over human wellbeing and sustainability</td>
<td>Re-orientation of policy priorities placing the satisfaction of basic human needs at the top of the political agenda; public policy and technological development in the WSS must be geared to this purpose</td>
</tr>
<tr>
<td>Popularization of “success stories” about people-centred approaches to WSS (e.g. Brazil’s condominial system; small scale “water vendors”, etc.) but failure to change the structural conditions that favour the overall reproduction of the status quo</td>
<td>Strong evidence to replicate and upscale existing projects and develop new successful socio-technical innovations by making them a political priority and a driver for structural social change</td>
</tr>
</tbody>
</table>


We have oriented our project work using these indicators as a guide both in the design of our research questions and in the methodological approach implemented to produce our
results. The synthesis of main results presented in the previous pages presented evidence that DESAFIO makes a contribution towards advancing the state of the art along the lines of the indicators originally chosen.

1) The socio-technical innovations studied are clearly oriented towards transforming, in some cases radically, the prevailing techno-centric status quo and developing people-centred interventions to solve the problems affecting vulnerable communities. This is an area where DESAFIO makes a clear contribution.

2) DESAFIO certainly makes a contribution towards re-balancing historically prevailing North-South flows of technology and innovation with South-South and even South-North collaboration and cross-fertilization. Several socio-technical innovations studied in DESAFIO are clear examples of this re-balancing.

3) DESAFIO sought to transcend the prevailing approach in research and practice connected with WSS (and infrastructure services more generally), which is characterized by a protracted entrenchment into “hard” and “soft” disciplinary approaches. We made good progress in this regard. However, we also found that the entrenchment is so deeply rooted in academic and professional practice that not always our work was able to transcend the existing divides. Still, our results clearly show a commitment towards achieving the goal of meaningful inter-disciplinarity, which is characterized by the production of knowledge as a synthesis integrating the contributions of individual disciplinary contributions. Much more is needed though to achieve the level of inter-disciplinary coordination required to advance beyond the state of the art. This is also a worthy matter for future research efforts.

4) The research results also present evidence of successful inter-sectoral collaboration, and provide clear insights into the critical requirements, factors, and processes that help to explain their success and failure. Although meaningful and long-term inter-sector collaboration within State institutions remains an elusive goal globally, some of the socio-technical innovations covered in DESAFIO are excellent examples of the way forward.

5) DESAFIO has also provided an example of what we called in our original proposal “transdisciplinarity in practice” (DESAFIO, 2013: 46). On the one hand, most of the socio-technical innovations studied are examples of transdisciplinarity, some of them taking the principle well beyond conventional practice. In particular, the involvement of local communities in the production of knowledge and in the practical implementation of the innovations is the hallmark of several experiences studied in the project, most notably the community-managed rural WSS in Colombia (Peña et. al., 2014a,b), and the Integrated Sanitation system in Recife, Brazil (Castro and Ferreira, 2014b). On the other hand, our own research work involved relevant non-academic actors in all stages of the project. These included CAGECE, the provincial public utility in charge of SISAR, in Ceara, Brazil (WP2.1; WP3.1; WP4.2), public sector specialists and local community members working as researchers or research assistants at Partner
UFPE in Recife, Brazil (WP2.2; WP3.2), local community members engaged in research activities in the study of community-managed WSS in Colombia (WP2.4; WP3.3), and similar involvement of community members if the interventions implemented in Minas Gerais, Brazil (WP4.1) and Santa Fe, Argentina (WP4.3). The actual level of engagement in the research process and in the production of final project results varied significantly across the cases. In the same way that we found obstacles to fully develop an inter-disciplinary approach, as commented in point three above, we identified significant obstacles to practice transdisciplinary research, again largely owing to deeply entrenched academic cultures that resist the principle that the production of knowledge is not restricted to the academic sphere. Still, our project also makes an important contribution towards advancing the principle of transdisciplinarity.

6) Our findings from most case studies presented evidence both a) confirming the crucial significance of giving policy priority to the satisfaction of human needs over other objectives, such as profit making, and b) providing excellent examples of how this can be done with successful results. Our clearest example to this end is the experience of Integrated Sanitation implemented in Recife, Brazil (WP3.2).

7) The project findings, as summarized in Sections 1-6 above, provide substantial evidence of the conditions, factors and processes that helps us to better understand the emergence, success, failure and potential replicability of sociotechnical innovations aimed at the democratization of the politics and management of WSS.
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