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DESAFIO Project

Working Paper Vol. 2, N° 15

Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovation

Cross Comparative Analysis

Newcastle upon Tyne, UK, and Coimbra, Portugal
December 2015

Cover picture: Water carriers, Ceara, Brazil (field work for the case studies on the SISAR system)

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Backcover picture: Final International Conference, Project DESAFIO, Federal University of Rio de Janeiro, Brazil, 27-28 July 2015.

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WATERLAT-GOBACIT Research Network

5th Floor Claremont Bridge Building, NE1 7RU Newcastle upon Tyne, United Kingdom
E-mail: redwaterlat@gmail.com – Web page: www.waterlat.org

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José Esteban Castro (Ed.)
Newcastle University, United Kingdom

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WATERLAT-GOBACIT Working Papers General editor:

Jose Esteban Castro
5th Floor Claremont Bridge Building,
Newcastle University
NE1 7RU Newcastle upon Tyne,
United Kingdom
E-mail: esteban.castro@ncl.ac.uk

Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovation

Cross Comparative Analysis

Keywords
Water and sanitation, socio-technical innovations, inequality, vulnerability, democratization, rural sanitation, community participation, citizenship, water politics

Editor:

Jose Esteban Castro
5th Floor Claremont Bridge Building,
Newcastle University
NE1 7RU Newcastle upon Tyne,
United Kingdom
E-mail: esteban.castro@ncl.ac.uk

Corresponding authors:

For comments or queries about the contents of this Working Paper, contact the corresponding authors, whose contact details are provided in the individual articles.

Table of Contents

Castro, José Esteban (Ed.)

Presentation of the SPIDES Series and the Working Paper

SPIDES stands for Research Projects Series (SPI), DESAFIO Project, for its acronym in Portuguese and Spanish. WATERLAT-GOBACIT is a network dedicated to research, teaching and practical interventions connected with the politics and management of water and water-related activities. The DESAFIO Project (www.desafioglobal.org) was developed by researchers of WATERLAT-GOBACIT's Thematic Area 3, dedicated to the Urban Water Cycle and Essential Public Services, jointly with invited partners.

DESAFIO had a lifetime of 30 months, from 1 February 2013 to 31 July 2015. It was funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement N^{o} 320303. The information contained in the documents published in the SPIDES Series reflects only the views of the researchers, and the European Union is not liable for any use that may be made of the information contained therein.

DESAFIO is the acronym for "Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovations", the project's full title. 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 acronym for the project, as it concerned what still now after the end of the Millennium Development Goals in 2015, constitutes one of the most difficult challenges facing developing regions: eradicating structural social inequality in the access to essential water and sanitation services. In other words, as the full title states, the project was about the democratization of the politics, management, and access to essential public services, with an empirical focus on water and sanitation services.

The project focused on the study of eight experiences identified in Brazil, Argentina and Colombia, which targeted the deficit of essential services 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 service providers, and other relevant power holders. Latin America has been an experimental field for this kind of developments, and the project 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. DESAFIO placed these experiences of socio-technical innovation at the heart of the study: "the main tenet of [the project] 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 water and sanitation services" (Castro, 2013: 3).

This way of framing the research problem led to the formulation of specific questions that guided the study:

> 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 water and sanitation? 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? (Castro, 2013: 3).

In order to respond to these research questions, DESAFIO adopted a comparative, interdisciplinary approach grounded in the social sciences and involving the participation of technical disciplines, particularly sanitary engineering, epidemiology, health, and ecology. It was also transdisciplinary, as the research team included practitioners from public sector and civil society institutions, and was developed in close co-operation with community organizations and other relevant actors. We present a more detailed discussion of the methodological approach employed by the project in another Working Paper of the SPIDES Series (Castro, 2015).

This Working Paper presents an edited version of two research reports corresponding to the cross comparative analysis of the 10 case-study reports that composed the core of the project work. Article 1 presents a systematic comparative analysis of the case-study results elaborated by our researcher partner at Coimbra University in Portugal. The team was coordinated by Prof. Maria da Conceição Cunha, and the comparative work was led by Dr. Rute Pinto. Article 2 was developed by DESAFIO's Coordinator, Prof. Jose Esteban Castro. The nature of the articles is very different. Article 1 systematizes the analysis looking for common patterns, findings, and weaknesses across all 10 case study reports. Article 2 has the objective of identifying the key lessons learned from the studies that may contribute to the development and implementation of public policies that promote the democratization of water politics and management in Argentina, Brazil, and Colombia, the three countries covered in the research.

In addition to the reports presented in this Working Paper, the reader may benefit from complementary information that we have made available online, including video records of public presentations made by the researchers in a number of events organized by DESAFIO. These include the First Project Conference, which took place in Recife on 25 February 2013 (http://desafioglobal.org/meetings/open-meetings/conference/), the Final Project Conference that took place in Rio de Janeiro on 27-28 July 2015 (http://desafioglobal.org/meetings/open-meetings/second-international-conference/), and a special dissemination seminar that took place in the city of Brasilia on 9 September 2015 (http://desafioglobal.org/meetings/open-meetings/post-project-meetings/seminar-in-brasilia-9-10-september-2015/day-1-a-seminar-for-research-and-debate-desafio-project-9-september-2015/). The presentations of the First Conference were published in the SPIDES Series of Working Papers (CASTRO et. al, 2013, available at: http://waterlat.org/WPapers/WATERLAT%20Working%20Paper%20SPIDES%201.pdf).

The Working Paper constitutes work in progress that may be revised, and may be further developed and later published in journals or as book chapters. We are pleased to present this work to the interested public.

Jose Esteban Castro
Project Co-ordinator

Newcastle upon Tyne, December 2015

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List of Acronyms

ALBA	Bolivarian Alliance for the Peoples of our America
APLA	Planning Agency (Argentina)
ASSEMAE	National Association of Municipal Water and Sanitation Services
AySA	Argentinian Water and Sanitation (Argentina)
BAMA	Buenos Aires Metropolitan Area
BRL	Brazilian Real
CAF	Andean Decelopment Corporation
COP	Colombian Peso
CRA	Regulatory Commission for Drinking Water and Basic Sanitation (Colombia)
CoFAPyS	National Council for Potable Water and Sanitation (Argentina)
DESAFIO	Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovation
ECLAC	UN-Economic Commission for Latin America and the Caribbean
ENOHSA	National Entity of Sanitation Water Works (Argentina)
ERAS	Water and Sanitation Regulatory Entity (Argentina)
ETOSS	Tripartite Entity of Sanitary Works and Services
IBGE	Brazilian Institute of Geography and Statistics
IDB	Inter-American Development Bank
IFIs	International Financial Institutions
INAP	National Institute of Public Administration (Argentina)
INDEC	National Institute of Statistics and Censuses
ISGSD	International Society of Groundwater for Sustainable Development
KAF	Konrad Adenauer Foundation (Germany)
KfW	Reconstruction Credit Institute (Germany)
LA&C	Latin America and Caribbean
MDGs	Millennium Development Goals
MINPLAN	Ministry of Federal Planning, Public Investment, and Services (Argentina)
MPG	Participatory Management Model
NGA	Great North Region (Argentina)
NGOs	Non Governmental Organizations
OSN	National Sanitary Works (Argentina)
PAHO	Pan American Health Organization
PDA	Department Water Plan (Colombia)
PDS	Water Supply and Sanitation Master Plan 2006-2020 (Argentina)
PIA	Immediate Action Plan (Argentina)
PMSS	Project for the Modernization of the Water and Sanitation Sector (Brazil)
PBQ	Quilombola Brazil Programme
PRONAPAC	National Programme of Potable Water and Sewerage (Argentina)
RJMR	Rio de Janeiro Metropolitan Region
SDGs	Sustainable Development Goals
SDGIs	Sustainable Development Goal Indicators
SEPPIR	Secretariat of Policies to Promote Racial Equality (Brazil)

SISAR	Integrated Rural Sanitation System
SNAP	National Service of Rural Potable Water and Sanitation (Argentina)
SSPD	Superintendence Domestic Public Services (Colombia)
SSRH	Under-Secretariat of Water Resources (Argentina)
UFMG	Federal University of Minas Gerais, Brazil
UFRJ	Federal University of Rio de Janeiro, Brazil
UFPE	Federal University of Pernambuco, Brazil
UN	United Nations
UNDP	United Nations Development Programme
UNR	National University of Rosario, Argentina
UNIVALLE	University of the Valley, Colombia
WHO	World Health Organization
WSS	Water and sanitation services

List of Figures

Article 1

List of Tables

Article 1

Original report cover – Article 1

DESAFIO
Democratisation of Water and Sanitation Governance by Means of Socio-Technical Innovation

CROSS COMPARATIVE ANALYSIS OF CASE STUDIES REPORT

Work Package 5 Report
(Deliverable D5.1)

Authors

Rute Pinto, Zara Teixeira, and Maria da Conceição Cunha
Marine and Environmental Research Centre, Coimbra University (IMAR-UC),
Coimbra, Portugal

Consortium Partners

UFMG UFPE UFRJ Cagece Governo do Estado do Ceará Universidad del Valle Newcastle University

Coimbra, Portugal, 31 July 2015

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Coordinator's Address: 5th Floor Claremont Bridge Building, NE1 7RU Newcastle upon Tyne, United Kingdom
E-mail us here – DESAFIO'S Website

Article 1

Cross Comparative Analysis of Case Studies Report

Rute Pinto[1]
Zara Teixeira
Maria da Conceição Cunha

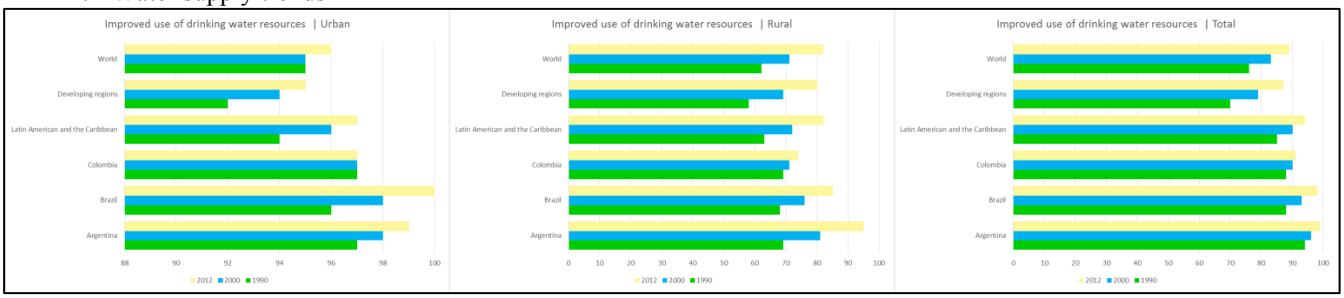
Marine and Environmental Research Centre, Coimbra University (IMAR-UC), Coimbra, Portugal

[1] E-mail: rutepinto@ci.uc.pt.

1. Introduction

Water supply and sanitation are key issues at the global scale. With the establishment of the Millennium Development Goals (MDG) an effort has been done to improve water supply (Figure 1A) and sanitation (Figure 1B) conditions worldwide to the most vulnerable communities, especially in rural areas. The MDGs have defined the targets that should be attained for water supply and sanitation issues worldwide: to decrease by half the proportion of world population living without proper access to drinking water and basic sanitation (WHO 2008; UN 2012). While, according to official reports, the target for water supply has been attained in 2010 (5 years before the targeted year), the same has not been verified for the sanitation target. Despite evidence confirming the cost-effectiveness of water and sanitation interventions (e.g. Walsh and Warren 1979; Hutton and Haller 2004; UNDP 2006; WHO 2011) additional efforts are needed to achieve the established targets for sanitation. Cost-effectiveness analysis might be a powerful tool since it relies on the comparison between the relative spending (costs) and physical benefits (effects) associated with the implementation of at least two management strategies (WHO 2011). According to World Bank data, for each US$1 spent on sanitation, a return of US$5.50 is attained by ensuring healthy and productive populations (World Bank 2015). On the other hand, poor sanitation facilities can cost countries between 0.5 to 7.2% of national GDP (e.g. 2.3% of Indonesia GDP is lost due to poor sanitation facilities, corresponding to a total amount of US$6.3 billion). In this context, some governments and NGO's are examining alternative ways of providing water and sanitation systems, especially to vulnerable communities.

A. Water supply trends



B. Sanitation trends

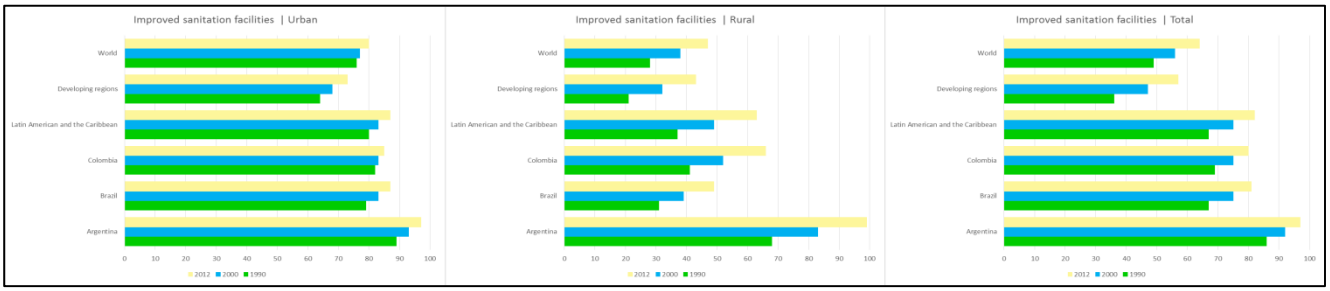


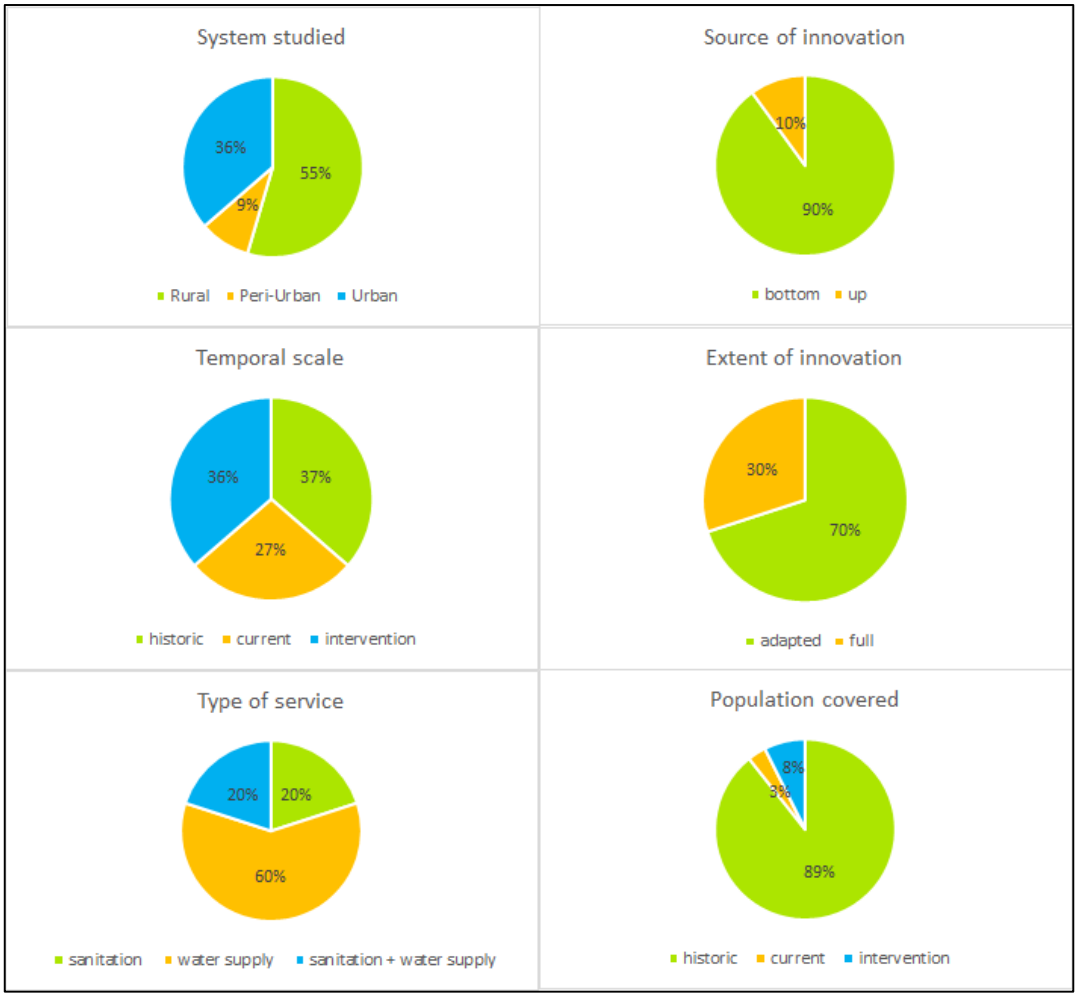
Figure 1. Worldwide, Developing countries, Latin America and the Caribbean, Colombia, Brazil, and Argentina trends for: A. Water supply, and B. sanitation (data source: WHO/UNICEF (2014) Progress on Drinking Water and Sanitation: 2014 Update).

It was in this context that the DESAFIO project has emerged. This project aimed to evaluate recent and current strategies, as well as innovative socio-technical interventions, for the design and implementation of sustainable, appropriate, and innovative socio-technical solutions for the provision of water and sanitation services (WSS) in conditions of social vulnerability and inequality. In this context, DESAFIO was structured around the following questions:

- *'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?'* (Castro 2012).

Trying to give some insights to these questions, DESAFIO considered several experiences and case studies, in urban, peri-urban, and rural areas, of South America, with a particular emphasis on Brazil. 10 case studies were selected that allowed to develop a holistic and comprehensive assessment of these processes. Figure 2 and Tables A1, A2 and A3, from the Appendix, summarise some of the features of these case studies.

Figure 2. Percentage of case studies per system studied; source of innovation; temporal scale; extent of innovation; type of service and population covered by the innovation.



The DESAFIO project characterised the selected case studies into historical, current or new intervention cases (Figure 2), allowing for a temporal (short- and long-term) comparison of water and sanitation services effects. Additionally, it also defined six analytical dimensions according to which each case study ought to be contextualised, analysed and discussed: policy-institutional, socio-political and cultural, economic-financial, techno-infrastructural/operational, health and ecological-environmental (Castro 2012).

This report reviews and performs cross-comparisons of alternative socio-technical innovations of water and sanitation systems, focusing on the role that democratisation might have on these issues. It assesses the main lessons learned and main policy issues which have to be addressed before such alternative ways of providing water and sanitation services can be widely applied.

There are some debates about the advantages and drawbacks of water and sanitation socio-technical innovation systems, and about the contexts where they might be viable. This report aims to contribute to these debates, by comparing the results and experiences from these 10 case studies from 3 different countries. It identifies contexts where socio-

technical innovation water and sanitation systems might be considered as an option for governments and municipalities. It also identifies some precautionary principles that should be regarded before these innovations can be installed and contribute to tackling the main challenges in implementing it. This is a preliminary exploitation of results, and more work is needed to collect evidence and bring more light on these issues.

In this context, the objective of this report is to identify:
- the critical requirements to ensure the socio-technical innovations sustainability and reproducibility;
- the main disadvantages to its wide implementation; and
- the open issues that require further investigation and analysis.

This report is structured in six main sections. Section 1 (current one) sets the context, recalling the worldwide challenges regarding water and sanitation issues. Section 2 describes and characterises the innovations considered in the case studies. Section 3 explores the factors and processes that explain the emergence and need for innovations Section 4 analyses and assesses the results obtained from the case studies, comparing them within the DESAFIO context. Section 5 tries to explore the underlying causes, factors and conditions that determined the innovations success or failure, summarising the obstacles and critical requirements to the sustainability and replication of the socio-technical innovations under study. Finally, Section 6 addresses the main lessons learned and implications of the DESAFIO project to other similar contexts/situations.

2. The character of the innovations

Understanding the specific characteristics of the socio-technical innovations under study was the DESAFIO first step towards the more general goal of providing insights about the potential implementation of the socio-technical innovations to other systems. The following questions were address by the DESAFIO partners in their case studies to characterise the socio-technical innovations (between brackets is the reference to the section, in this manuscript, that summarises the information gathered in the field):

- What exactly is the innovation under study? (Section 2.1)
- What are its objectives and main characteristics? (Section 2.2)
- Who are the key agents/social actors in the different stages of design, implementation, etc. of the innovation? (Section 2.2.1)
- What is the temporal scale of design and implementation of the innovation? (Section 2.3)
- What is/are the temporal scale/scales of the impact sought through the innovation? (Section 2.3)
- What kinds of transformations are intended through the innovation? (Section 2.4)
- What mechanisms are used by the innovation to produce these transformations? (Section 2.4)
- In what sense/to what extent the innovation is "social"? (Section 2.4.1)
- In what sense/to what extent the innovation is "technical"? (Section 2.4.1)

- What is the relationship between the innovation and the process of democratisation of the access to and the management of water and sanitation services? (Section 2.5)
- What are the criteria used to define the "zero point", the baseline, to evaluate the functioning and results of the innovation? (Section 6.2)

Sections 2.1 and 2.2 aim at responding to the questions '*what exactly is the innovation under study?'* and '*what are its objectives and main characteristics?'* To achieve this goal, the key marker analytical dimensions of each innovation are highlighted (Table 1) and the main characteristics are identified (section 2.2). The case studies are separated by historical, current and intervention.

2.1. Describing the socio-technical innovations

Of the four (recent) historical case studies evaluated, two describe the implementation of a water supply system (D2.1 and D2.3), one describes the implementation of a sanitation system (D2.2), and a fourth describes a system for both water supply and sanitation (D2.4). Of the three case studies analysed to evaluate current experiences, two describe the implementation of a water supply system (D3.1 and D3.3) and a third one describes the implementation of a sanitation system (D3.2). Of the three case studies for which new interventions were developed, two describe the implementation of a water supply system (D4.1 and D4.3) and one describes the implementation of a water supply and sanitation system (D4.2) (Tables in the Annex A1, A2 and A3).

Six dimensions have been analysed under the umbrella of the DESAFIO project to characterise the socio-technical innovations selected to implement these water and sanitation services systems: policy-institutional, socio-political and cultural, economic-financial, techno-infrastructural/operational, health and ecological-environmental. However, each innovation water and sanitation system was characterised by only few key markers which differ between case studies (Table 1). For example, in some cases the operational dimension plays a central role in the definition of the innovation, as is the case for the SISAR model (D2.1, D3.1, D4.2). In other cases, the socio-political dimension, and particularly social participation throughout the process, is one of the key markers of the innovation. An example is the Echo-technological system (D2.4) whose process of selection of the best technological solution relies on strong community mobilization and awareness. Though some of the implementation processes took into account the health and the ecological-environmental dimensions, these dimensions were not key markers of any of the case studies evaluated. The innovation implemented in each case study is briefly explained next.

Table 1. Key marker dimension(s) of type of innovation.

DESAFIO Dimensions	Case study									
	Historical				Current			Intervention		
	SISAR - Policy-Institucional Evaluation	Condominial Sanitation System	Communal Springs	Echo-technological System	SISAR- Ethnographic Assessment	Integrated Sanitation System	Community Management	Participative Generation of a Water Treatment	SISAR - Community oriented water and sanitation services	Capacity Building for Monitoring Water Quality in Vulnerable Communities
	D2.1	**D2.2**	**D2.3**	**D2.4**	**D3.1**	**D3.2**	**D3.3**	**D4.1.**	**D4.2**	**D4.3**
policy-institutional		X				X	X			
socio-political and cultural	X	X		X	X	X	X	X	X	X
economic-financial	X				X				X	
techno-infrastructural / operational	X	X	X	X	X				X	
health										
ecological-environmental										

2.1.A. Historical case studies

The SISAR/CE model (D2.1) is a shared management and operational model for water supply: the public authorities provide the physical infrastructure for water supply and treatment systems, while the local community takes responsibility for the systems' maintenance and operation in an attempt to make them more efficient and sustainable. Its economic-financial structure and the mechanisms it deploys are innovative in the sense that they had never been applied to rural areas.

The Condominial Sanitation System (CS) (D2.2) implements a sanitation system based on simplified, flexible and low-cost technical solutions, which entail a very active participation of the beneficiary population in some aspects of the implementation and maintenance of the system. The innovation did not require the introduction of new infrastructural elements, as the system relied on existing elements and mechanisms. The innovative element in the techno-infrastructural and operational dimension was, firstly, the decentralizing reordering of the elements of the infrastructure, making the block of houses (the condominium) the modullar centre of the system. Secondly, the innovation was also in the simplification of the system's structure, reducing the dimensions both of the network as a whole as well as of its individual components, pipes, connectors, etc.

The Communal Springs' model (D2.3) has no underlying planning and no interference from public entities. It relies on physical infrastructures (wells and springs) built by residents, without any planning and with informal or absent management, to guarantee water supply to low-income populations in peri-urban areas.

The Eco-technological model (D2.4) is a community-led model for the implementation of eco-technologies to improve the water supply and sanitation services. The model is based on a water treatment infrastructure, with two parallel processing lines, and a simplified sewerage system that allows a flexible design associated with lower costs

and a higher number of connected households. Its main goal is therefore to develop and provide technologies adapted to local social and cultural realms, as well as to municipal and national policies, to solve problems of water contamination in peri-urban areas, reducing associated problems of water supply and sanitation.

2.1.B. Current case studies

The SISAR/CE model has evolved throughout the years and was adapted to other regions. Currently, new communities wishing to enrol the SISAR's services have to be equipped with a water distribution network (D3.1). This modified model implements only specific measures, adapted to the local reality, regarding the operational and economic-financial dimensions of the water supply system. The Integrated Sanitation System (D3.2) implements an adapted model for effective sanitation provision that does not introduce new designs or technologies. Instead it proposes the integration of sectors and institutions to assure the long-term sustainability of the system based on three main principles: establishing inter-sector coordination, inter-federative collaboration, and qualified citizen-user participation at all stages of the process, from design and implementation to monitoring. The overall goal of the Community Management model (D3.3) is to promote, in a concerted and methodical way, inter-institutional and interdisciplinary coordination to enable the identification of problems and their causes in the water supply system and in its institutional component and community participation, enabling the search for solutions through teamwork with the beneficiary community, while guaranteeing their effectiveness and permanence. It proposes a structure to assist the community and partners on finding technological alternatives to solve water quality related problems, based on a participative process involving the community at all stages, from problem identification to operation, monitoring and maintenance.

2.1.C. Intervention case studies

The objective of the Participative Generation of a Water Treatment System (D4.1) is the discussion, selection, installation and operation of a potable water supply system in a rural community. It proposes a participatory process to select water treatment technological alternative solutions. The implemented participatory techniques include both students and professionals from public institutions, stimulating the community to actively participate in the research process as well as in the process of selection of the alternative that best suits the cultural specificities of the community.

The SISAR/CE model was initially designed and implemented to guarantee the provision of water to low-income populations in rural areas. More recently, the SISAR/CE model has also been dedicated to the implementation of dwelling-specific sanitary units (D4.2). The example presented is the first approach of SISAR/CE to the implementation of essential sanitary units. The case study presented shows that the model still relies on the implementation of a specific operational and economic-financial model for the management of a water supply system, but additionally it provides sanitation infrastructure.

The Capacity Building model (D4.3) proposes a method of capacity building of students and teachers, from secondary schools, to guarantee the engagement of the community on the solution of water quality related problems. The model is based on knowledge transfer from researchers to students and from them to the entire community

as a mean to build public autonomy. Four main goals were established: a) define and build a new methodological framework on the base of linking social actors trained with research/technical teams; b) build a new set of links between individuals in order to know, understand and solve immediate necessities, using technology and social networking; c) test empirical instruments to create knowledge transfer networks between academic researchers and civil society organisations; and d) develop learning mechanisms to encourage people for the engagement on social control of water and sanitation provision, based on existing standards.

2.2. Characteristics of the innovation per dimension

Despite being characterised by key marker dimensions (Table 1), as identified in the previous section, the case studies selected have features that can be described in light of the six analytical dimensions defined by the DESAFIO project. Notice, however, that not all dimensions were covered by all case studies and different sets of dimensions were covered for contextualization purposes, for description of the socio-technical innovations and for the analysis and discussion of the results.

2.2.1. Policy-institutional dimension

The water governance regimes adopted in the case studies analysed emerged under an historical framework of changes between regimes that saw water as a commodity, limiting the service coverage to those areas considered profitable by the private companies, and regimes with management models centred on the control and direct intervention of the state, seeking for the universalization of water and sanitation services (D1.1). Currently, in some countries of Latin America, like Argentina, though privatist regimes have been in reverse, the notion that the access to water and sanitation services is a social right and a public good has been almost eradicated and public companies run their services on a similar basis that private utilities. As a consequence the state tends to limits its role to that of enabler and guarantor of "privatised" public services". This profit-oriented approach left poor urban and rural communities out of target, but social pressure led to the arrangement of alternative political-institutional systems to guarantee the provision of water and sanitation services to unserved areas. Such approaches involved the participation of both public (i.e., the state) and private actors, which include the participation of private companies, not-for profit organizations and other social actors, such as the end-users. With exception from the Communal Springs' model (D2.3), which has been implemented without any institutional framework, all case studies analysed have implemented a political-institutional system with contributions from the state and from some other profit and/or non-profit entity (Figure 3). D2.4, D3.3 and D4.1 have implemented political-institutional systems involving partnerships between the state, private companies, a not-for-profit organization and end-users. D2.1, D2.2, D3.1 and D4.2 have implemented political-institutional systems involving collaborations between the state, private companies and end users. D3.2 had contributions only from the state and the community.

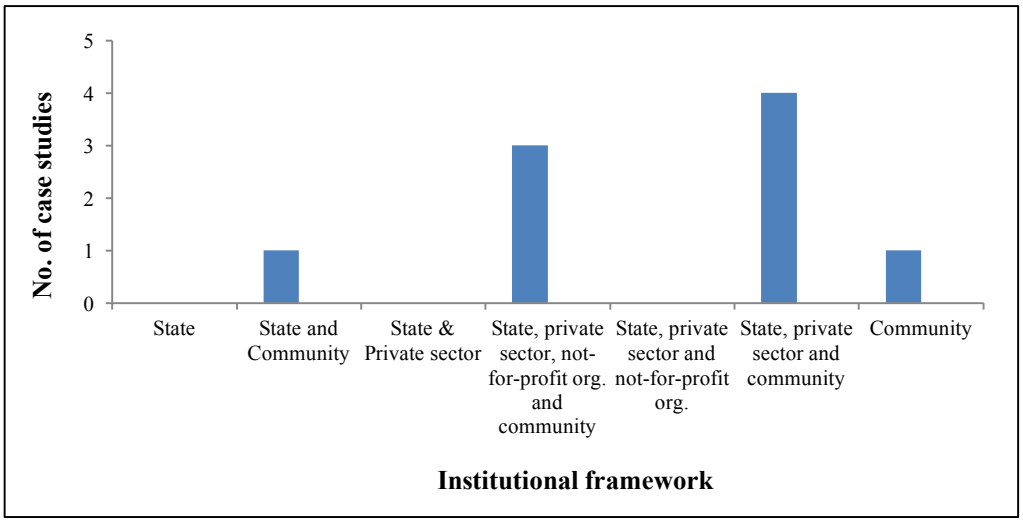


Figure 3. Policy-institutional dimension: Number of case studies per political-institutional system.

This section summarises the characteristics of the innovations regarding the policy-institutional dimension and tries to respond to the question '*who are the key agents/social actors in the different stages of design, implementation, etc. of the innovation?'*

2.2.1.A. Policy-institutional: Historical case studies

Within the SISAR/CE model (D2.1) the public Water and Sewerage Company of Ceará (CAGECE) offices provide technical and social assistance in the creation of community associations. Its Rural Water and Sanitation Management Department (GESAR) is responsible for the systems' management which is shared with local community associations. Executive representatives of local associations commit to a partnership with the SISAR/CE in which they assume the responsibility of playing an essential role as mediators between the SISAR managers and local water users. Initially, funding was provided by the German KfW Bank. The systems require a resident operator in the community who is chosen with the objective of insuring rapid response to operational problems and maintaining adequate communication with the population and the SISAR/CAGECE's offices, striving to solve more complex technical operations. The implementation of the Condominial Sanitation System (D2.2) was a political experience based on intense mobilization of the population in the initial stages of the project. This model proposes a redefinition of the institutional role in the provision of basic services, promoting decentralization and community engagement. As such, municipal authorities, and more precisely its social and technical departments, were responsible for the design, implementation, and community accompaniment. The community was responsible for the implementation, management, operation, and maintenance of the system. The model introduced the Condominial Agreement as a formal partnership between the user community and the local authority, which represented a potentially transforming change in the institutional dimension, mainly because it assumed the necessary negotiation between local authority and user community. The implementation of the Echo-technological model (D2.4) in the municipal area of Cali benefited from a previous

interdisciplinary and inter-institutional cooperation within the TRANSCOL Program (Technology Transfer Program in Water Supply Systems in the Republic of Colombia). A partnership was established between regional and municipal public entities (Public services municipal entity; regional environmental entity; Public Health entity; municipal government), the Cinara Research Institute, Private companies (for infrastructure construction) and the community to select priority areas and implement the best alternative solution. The development and selection of the optimal solution has into account the social and cultural conditions of local communities, as well as national and local policies. The model promotes community participation in the processes of planning, execution and evaluation of projects.

2.2.1.B. Policy-institutional: Current case studies

The current case study assessed to evaluate the SISAR/CE model (D3.1) follows the same policy-institutional framework as the case study assessed in the D2.1. The Integrated Sanitation System (D3.2), implemented after the lack of success of the Condominial Sanitation System, relies on inter-sector coordination, assuming that sanitation is not just about water and sewerage infrastructure, but it is rather a full-scale process of urbanisation. The Integrated Sanitation System assumes urbanisation of irregular areas as a fundamental component of its interventions. The Integrated Sanitation System model also relies on inter-federative collaboration, assuming that the financial and institutional efforts require the involvement of all levels of government, municipal, provincial and federal, including the participation of the water and sanitation service provider (the Pernambuco's Water and Sanitation Company, COMPESA). To enable the effective participation of the community, the municipality introduced deliberative mechanisms for the design of an Integrated Sanitation policy programme (debates and workshops) and created the Local Integrated Sanitation Desks in the neighbourhoods where the Integrated Sanitation System was implemented. This model also included the creation of Monitoring Commissions for the Works of Integrated Sanitation, composed by members of the community, professionals, members of civil organizations, and representatives of the local and provincial governments. The Community Management model (D3.3) shares responsibilities between the community and a public-private partnership. This model includes private companies responsible for project management and infrastructure building; national and international NGOs; international cooperation organisms; national, regional and municipal governments, which are responsible for funding, logistic support, work labour, material and monitoring. The Cinara Institute from the University of Valle is also involved in the project acting as a facilitator. From the community, the model has the support of the Aqueduct board Administration, of community leaders, of an educational institution and also community support groups and the users themselves. Research on the best pre-treatments was developed by local research teams, together with field social-technical teams and the community.

2.2.1.C. Policy-institutional: Intervention case studies

The Participative Generation of a Water Treatment System (D4.1) relies in an inter-institutional collaboration at the national and state level with parties that have some relation with the local Quilombola context: social movements and NGOs, which act as facilitators, and federal government institutions, responsible for infrastructure installation, distribution and storage and water treatment. The laboratory tests are carried out in the Department of Sanitary and Environmental Engineering (DESA) at the UFMG and in the Minas Gerais Sanitation Company's (COPASA) Water Treatment Station. The community is responsible for the system's maintenance and has an active role in the selection of the best alternative. The intervention case study assessed to evaluate the SISAR/CE model (D4.2) follows the same policy-institutional framework as the case studies assessed in the D2.1 and D3.1 The Capacity Building model (D4.3.) evaluated the provision of water supply services in 5 communities' located in Argentina, Santa Fé. Three different schemes of water provision were evaluated: through Cooperatives, through public water and sanitation services Company and water supply without formal network. The model proposes linking local wisdom with academic knowledge promoting collective knowledge. The political-institutional system has not been described.

2.2.2. Social-political and cultural dimension

In the perspective of the DESAFIO project one of the main obstacles for meeting the Millennium Development Goals is the protracted exclusion of substantive citizen involvement and democratic governance in the relevant processes. The pressure on governments from social actors, demanding greater transparency and accountability from the authorities and service providers, has led to the increasing popularity of "social participation" mechanisms, which in turn have been seen by governments as the ideal tool to control social conflicts. Several forms of social participation can be identified in Latin America (D1.1) and others can be envisioned for the future, but effective social participation can only be expected if citizens and service-users are informed and provided with organizational capabilities. In peripheral urban and rural communities this is less expected unless mechanisms of community empowerment are also employed, such as education, training and discussion forums. All the case studies analysed in the scope of the DESAFIO project include some form of social participation mechanism. The mechanisms implemented depend on whether the community is sought to participate at all stages of the implementation process, as for example in the Echo-technological model (D2.4) and in the Community Management model (D3.3), or just required to participate, for instance, as a control and or monitoring actor. In the most recent interventions of the SISAR model, for instance, the community wishing to enrol the SISAR services must already be equipped with a water supply system and an *a priori* designed operational and management model of shared responsibilities is implemented.

2.2.2.A. Socio-political and cultural: Historical case studies

The SISAR model (D2.1) is an example of a top-down model for the implementation of water and sanitation services, but seeking the participation of communities to guarantee a less centralised and more participative management model. Guidance, either through education,

training and meetings, was provided to the communities to help in the creation of community associations that would become the residents' legal representatives. Community involvement is valued from the request for a system to the discussion of projects and afterward in the construction, operation and maintenance of these systems. Once the system is implemented, the model's guidelines ideally implicate that users with questions or complaints will communicate them to their local operator first. One of the innovative elements of the Condominial Sanitation System (D2.2) is the required negotiation, from both the political and social perspectives. The Condominial Sanitation System envisioned social participation through a wide range of contributions from the community: adhesion to the system, agreement to pay the condominium extensions, commitment to guarantee the system maintenance and infrastructure construction. The long-term feasibility of the model was encouraged through environmental and health educational campaigns, which should contribute to the awareness of the community for the importance of water and sanitation services systems. Though without a formal management model, the implementation of the Communal Springs (D2.3) proved that a certain level of community organization is always necessary. As an example, one of the springs analysed was located in a private area but the residents managed to guarantee the public access to the water source. One of the goals of the Echo-technological model (D2.4) was to stimulate the community participation at all steps, from design and planning to implementation and evaluation, strengthening the management capacity of the community, providing technical advice and training.

2.2.2.B. Socio-political and cultural: Current case studies

The current case study assessed to evaluate the SISAR/CE model (D3.1) follows the same socio-political and cultural framework as the case study assessed in the D2.1. The Integrated Sanitation System (D3.2) foresees basic sanitation services as instruments of social equalization and citizenship building. While assuming that the primary responsibility for essential services provision lies in the state, proposing mechanisms for effective public responsibility, this model also proposes forms of co-responsibility of citizens-users at all stages of interventions, including management monitoring and long-term maintenance. Additionally, it incorporates the educational dimension as a central element of interventions to strengthen the capacity of citizens-users to participate qualifiedly in the different stages of the interventions. The Integrated Sanitation System provided community education and training in a range of areas, including technical aspects of the systems (needed to participate in monitoring the works and the performance of the services), public health, and environmental aspects. The Community Management model (D3.3) is greatly concerned in developing a participative methodological process in which the communities are involved from identifying the problem, to operation and maintenance. Community independence regarding system's operation and maintenance is provided through formal education of resident operators.

2.2.2.C. Socio-political and cultural: Intervention case studies

The Participative Generation of a Water Treatment System (D4.1) is also concerned in implementing a participative methodological process, in which the community

participates from the first step of problem identification, to the discussion, selection and implementation of the best solution. One of the guiding principles of this model, implemented in one the most traditional Brazilian communities, was to respect the history of struggle for the rights of all the traditional populations in Brazil. A model where students and professionals are trained in use of the participatory process was applied, and the gained skills should then be applied to encourage the active participation of the entire community throughout the whole process. The intervention case study assessed to evaluate the SISAR/CE model (D4.2) follows the same socio-political and cultural framework as the case studies assessed in the D2.1 and D3.1. Social participation and community empowerment within the water supply systems in use in the Santa Fe communities were evaluated by the Capacity Building model (D4.3) to evaluate community perception. This would provide a working knowledge basis to justify and contextualise the necessity of a model which seeks to promote and strengthen the participation of the community and its stakeholders, trying to make them real agents of their own changes. The model proposes to work initially with students and teachers from secondary-education schools to promote the communities engagement on the solution of their own problems.

2.2.3. Economic-financial dimension

The governance regime selected by each model has implications in the economic-financial mechanisms adopted to fund the systems' implementation. For one hand, fully privatist regimes were not attractive because the provision of water and sanitation services is seen, by private investors, as a non-profitable commodity when implemented in low income communities, frequently located in areas lacking urban planning. On the other hand, administrative regimes became bureaucratic and with the only intention to create powerful public institutions and with little room for exercise of political rights in relation to decision-making processes. The majority of the case studies evaluated, as for instance the SISAR/CE (D2.1) and the Community Management model (D3.3), applied a governance regime with characteristics from both the abovementioned approaches, where the state would contribute to system implementation, relying on public-private partnerships (which include non-profitable organizations and at times the community itself) (Figure 4). To guarantee the economic-financial sustainability of the systems, the majority of the systems also implemented a management model based on shared responsibilities between the providers and the user-community, applying a variety of billing systems. Even for the case where the state assumed the total cost for implementation -the Integrated Sanitation system D3.2- the community was responsible for purchasing the water and sanitation service, in the form of tariffs.

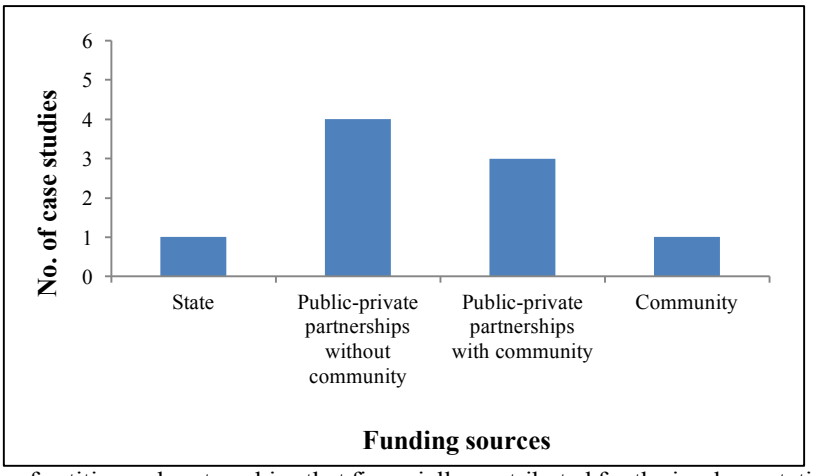


Figure 4. Types of entities and partnerships that financially contributed for the implementation of the water and sanitation systems.

2.2.3.A. Economic-financial: Historical case studies

Throughout its history, the SISAR/CE model (D2.1) has altered the form of its *quid pro quo* with communities. Initially, interventions occurred in Ceará's rural water and sanitation services by means of the partnership between the Brazilian public authorities and the German KfW Bank, within the scope of transformations in Latin American water and sanitation system policies. In January 1990 a contract was signed for a loan of 15 million German marks between the Brazilian and German governments with the KfW Bank as main financial agent, for the implementation of water supply systems. The public authority took responsibility for providing the physical infrastructure for water supply and treatment systems, while users should pay for SISAR services by dwelling or establishment. Service payment was established through the implementation of tariffs that included fees for water consumption, electricity, operator gratification and an administrative fee. The SISAR model strives to guarantee financial surpluses, even if the construction of systems is subsidised. The Condominial Sanitation System (D2.2) envisages a low total cost solution, with low investment from the public sector and with community investment from the beneficiaries. The contribution from the user community can include the payment of condominium extensions (the private part of the system), the maintenance costs of home extensions, and even the absorption of the private system construction (under technical guidance of the service provider). Due to the lack of formal planning, management and operation, the Communal Springs' model (D2.3) provides free water supply services lacks any economic-financial framework. The financial support to implement the low-cost solution envisioned by the Echo-technological model (D2.4) came from several public entities: public services' providers, health and environmental authorities and universities. The community also contributed financially to its implementation, to guarantee the necessary funds to implement a water supply system with associated water treatment plants.

2.2.3.B. Economic-financial: Current case studies

The SISAR/CE model (D3.1) follows an identical economic-financial framework as the previous SISARs, but has recently introduced a progressive price table (value increases after a certain volume of water consumption) and the interruption of service for users with unpaid bills. Moreover, currently local associations are encouraged to participate in the decision of certain fees' amounts. Contrary to the Condominial Sanitation System (D2.2), the Integrated Sanitation System (D3.2) claims that the communities are too vulnerable to support part of the costs and therefore interventions must be fully funded by state public institutions, through planned actions in an integrated and coordinated way in order to join forces and resources, through a cooperatively approach. In the particular case of Mustardinha, over 70% of the investment was funded by the municipality, and the rest came from the provincial government. The Integrated Sanitation System established tariffs based on social equity. The Community Management model (D3.3) guarantees its inter-institutional nature also through the allocation of funds which come from a variety of different institutions on a private-public partnership. The community, which actively participated at all stages of the implementation process, also provided labour and financial resources.

2.2.3.C. Economic-financial: Intervention case studies

The Participative Generation of a Water Treatment System (D4.1) guarantees financial support from federal public institutions which seek for public-private partnerships. Other federal institutions provide technical and financial support for disease control. Locally, the community has the financial support from state and municipal institutions for infrastructure construction. The intervention case study assessed to evaluate the SISAR/CE model (D4.2) follows the same economic-financial framework as the case studies assessed in the D2.1 and the D3.1 The Capacity Building model (D4.3) evaluated the provision of water supply services in 5 communities' located in Argentina, Santa Fé. Three different schemes of water provision were evaluated: through Cooperatives, through public water and sanitation services Company and water supply without formal network. Though the information gathered evaluates the water price perception, indicating that the system relies on a pay-per-use approach, there is little information with respect to the economic-financial system.

2.2.4. Techno-infrastructural /operational dimension

The DESAFIO project selected a variety of examples that range from communities without water supply, to communities with non-potable water supply and others with non-treated residual water. The socio-technical innovations implemented were designed, and/or, adapted, to guarantee alternative solutions suitable to solve the above-mentioned problems and feasible for implementation in rural areas or urban areas without urban planning. The considered models had into consideration the local realm and the solutions presented and have either evolved in time to meet the rural communities' needs, as is the case of the SISAR/CE model (D2.1, D3.1. and D4.2), or were designed together with the user community to guarantee that their needs would be attended, as is the case of the

Community management model (D3.3). The techno-infrastructural/operational specificities of each case study evaluated are described next.

2.2.4.A. Techno-infrastructural/operational: Historical case studies

In the beginning, the communities wishing to enrol the SISAR/CE model (D2.1) had to contribute in the various tasks involved in the implementation of systems (excavating ditches to install distribution networks, for example), whereas the public authorities were responsible for the installation of water meters. Operationally, the community associations are expected to provide preventative and corrective technical assistance, monitor water quality, perform educational activities in relation to water and sanitation services, and provide operational information about the systems to public authorities. The users are responsible for service payment, preservation of water distribution system and reinforcement of local associations. The SISAR is responsible for management, maintenance and water quality control and environmental training. The Condominial Sanitation System (D2.2) introduced the condominium as an innovative element in the techno-infrastructural and operational dimensions. Its goal was to implement a simplified infrastructure by reducing the network size, reducing the pipe diameter, introducing flexible infrastructures adaptable to irregular areas and introducing network extensions with shallower depths. Communication between local authorities and the community are encouraged throughout the entire process of system implementation, including operation and system management. The Communal Springs' model (D2.3) provides technically simple solutions (wells and springs) implemented at will by the community. The Echo-technological model (D2.4), as the name suggests, proposes the development and transfer of echo-technologies for potable water and residual water treatment. It offers simplified systems, with associated environmentally-friendly and low cost solutions: construction at low depths; pipes far away from locations with heavy traffic; strategic location of the wastewater treatment plant to avoid rainfall water and aggregate domestic water from as many houses as possible; pre-treatment systems inside each house. The community is responsible for management, operation and maintenance of systems, after training provided by the public entities.

2.2.4.B. Techno-infrastructural/operational: Current case studies

The techno-infrastructural framework of the current case study selected to evaluate a current example of the implementation of the SISAR/CE model (D3.1) is similar to older implementations, however, currently, a community wishing to enrol the SISAR/CE services must already be equipped with a water distribution network including canalizations, individual water meters for each dwelling or establishment, a water macro-meter and appropriate electric installations for the operation of a water distribution station. The Integrated Sanitation System (D3.2) did not introduce new designs and technologies, though it rejected to introduce the Condominial Sanitation System (D2.2) in unserved areas and proposed only the upgrade of previous condominial systems where it had already been implemented. Technically, the Integrated Sanitation System adapted previously existing sanitation models. This model also adopted an integrated perspective of infrastructure implementation, where the water network, sewerage and drainage should

be combined with paving and household improvement. The Community management model (D3.3) strives to provide echo-technological alternatives for the provision of water with good quality for human consumption. The proposed alternatives, which should encourage the use of local materials, are selected in conjunction with the community and taking into account the local reality. The operation and maintenance mechanisms are simple and easy to understand by local workers with low education level.

2.2.4.C. Techno-infrastructural/operational: Intervention case studies

The Participative Generation of a Water Treatment System (D4.1) also proposes the analysis of several alternative collective water treatment techniques in use in the community and the participatory selection of the optimal solution. The intervention case study assessed to evaluate the SISAR/CE model (D4.2) follows the same techno-infrastructural framework as the case studies assessed in the D2.1 and D3.1, but only in what relates to the water supply network. Additionally, and for the first time, the SISAR/CE model (D4.2) included the provision of sanitation structures to communities lacking sewerage and other sanitation elements. The Capacity Building model (D4.3) is still under implementation and it has only achieved its first goal which was to strengthen citizen awareness regarding water and sanitation systems. A second demand, that is, the selection and construction of appropriate technology for water treatment is still under development.

2.2.5. Health dimension

Though some of the models might not include this dimension in a straightforward manner, the implementation of water supply and sanitation systems is by itself a mechanism for health and environmental improvement. Some socio-technical innovations are focused in water quality monitoring and in providing treated water, others in guaranteeing sanitation and waste disposal.

2.2.5.A. Health: Historical case studies

The SISAR/CE model (D2.1) was initially focused only in guaranteeing the provision of good quality water. The model proposes water quality monitoring by local associations and water quality control by the SISAR offices. More recently, the model has implemented promotion programs for community empowerment with impact on public health. The Condominial Sanitation System (D2.2) does not directly address the health dimension, though one of the main goals of this model was to reduce the prevalence of waterborne diseases related to lack of sanitary conditions in the Mustardinha region, Brazil. The Communal Springs' model (D2.3), as a result of its informal management, still lacks water treatment and has poor sewage coverage leading to water contamination of water table. The Echo-technological model (D2.4) in the community of La Vorágine - Colombia emerged due to the necessity of solving water contamination problems. During the 1980s, lack of maintenance of the existing sanitation systems contaminated nearby superficial waters, resulting in high negative impacts on local tourism and in community

health. The implemented solution intended to guarantee treated water supply and eliminate residual water contamination.

2.2.5.B. Health: Current case studies

The current case study assessed to evaluate the SISAR/CE model (D3.1) follows the same health guidelines as the case study assessed in D2.1. The Integrated Sanitation System (D3.2), similarly to the Condominial Sanitation System (D2.2), does not directly address the health dimension, though one of the main goals of this model was to reduce the prevalence of waterborne diseases related to lack of sanitary conditions in the Mustardinha region, Brazil. The core of the Community Management model (D3.3) is to implement technical alternatives to improve water quality. An echo-technological alternative denominated Multiple Stage Filtration (Slow sand filtration plus pre-treatment) was selected to solve water quality problems.

2.2.5.C. Health: Intervention case studies

The goal of the Participative Generation of a Water Treatment System (D4.1) is to adapt pre-existing water treatment systems and analyse all the alternative collective water treatment techniques used in the community, to find the best solution. Nevertheless, the health dimension was not a specific object in the D4.1 and thus, was not directly addressed. The adapted SISAR/CE model implemented and currently under evaluation as an intervention case study (D4.2) recognises that the relationship between public health and interventions in water supply and water sanitation must be understood in a broad context of environmental health. This explains this first approach of the SISAR to the implementation of a sanitation infrastructure. This study advances that the continuous distribution of water in appropriate quantity and quality, as well as improvements in dwelling-specific sanitation, are ways of promoting a community's health. It also advances that these practices do not only encompass individual behaviour but organizational forms of society and politics as well, with their respective organizational structures. The Capacity Building model (D4.3) was applied in a group of communities ranging from those with formal water supply systems to those without water supply providers. Model tasks included the collection of water samples for water quality analysis, whose results should support the discussion regarding water quality standards and raise community awareness about the quality of water consumed.

2.2.6. Ecological-environmental dimension

Regarding the ecological-environmental dimension, little attention has been paid to it and therefore, the information available is scarce. The lack of information in the different case studies occurs for different reasons: because the innovation disregards the ecological-environmental dimension and the alternatives selected are unaware of the ecological-environmental impacts; because the ecological-environmental dimension is defined solely as environmental sanitation, binding this dimension to the health dimension; because the DESAFIO partners have not fully addressed these dimensions; among other possible reasons. The health dimension was not directly addressed by several of the

innovations under study, though most of them report waterborne diseases and/or contaminated water in the communities assessed.
According to the available information, of the available historical case studies, D2.1, 2.2 and 2.3 have not directly addressed this dimension. Of the current case studies, those evaluated by the D3.1 and 3.2 have not also directly addressed this dimension. Of the intervention cases, the case studies evaluated in D4.1 and D4.3 assess this dimension as a mean to find the best solution to cope with the environmental problems encountered in the community with respect to water quality. The available information is described next for each case study.

2.2.6.A. Ecological-environmental: Historical case studies

The SISAR/CE model (D2.1) was implemented in the Ceará region, in Brazil, where it has long been necessary addressing the subject of the region's water, frequently that associated with irrigation, due to its climatological characteristics. Ceará is a semi-arid region characterised by high temperatures, an elevated solar index and high rainfall irregularity in terms of distribution in time and space. In periods of severe drought, increased levels of evaporation and generalised destruction of native hinterland drainage systems may be observed. The SISAR/CE model was designed to guarantee water supply to these climatically vulnerable areas, but the environmental dimension was not directly addressed and the concept of environment is tied to the concept of health and environmental sanitation. The Condominial Sanitation System (D2.2) and the Communal Springs' model (D2.3) also do not address the ecological-environmental dimension. In the case of the Echo-technological model (D2.4) the term innovation is closely linked to find creative ways to solve problems of water pollution, while adapting to the environmental conditions and to the local community socio-economic specificities. The main concern of the locals was to improve the water quality of the river Pance because their income had been affected by the decline in tourism. As a result, priority was given to the construction of the sewerage over the water supply system. Environmental constraints and environmental impacts were taken into consideration by the community while selecting the optimal echo-technology for wastewater decontamination as well as the location of the Wastewater Treatment Plan. Issues such as topography and land use were taken into consideration, for instance to avoid the entrance of rainwater into the sewerage.

2.2.6.B. Ecological-environmental: Current case studies

The SISAR/CE model (D3.1) was also designed to guarantee water supply to climatically vulnerable areas, but again the environmental dimension was not directly addressed and the concept of environment remains tied to the concept of health and environmental sanitation. Likewise, the Integrated Sanitation System (D3.2) did not directly address the ecological-environmental dimension. Nevertheless, the Integrated Sanitation System incorporates the environmental dimensions as integral components of interventions and introduces the concept of environmental sanitation. This model proposed to act on the living conditions by changing the set of physical environmental conditions that allow the reproduction of waterborne diseases in the critically affected areas. One of the goals was

to increase environmental quality through adequate regulation and treatment of collected sewage. Environmental issues were again strongly tied to the concept of health. The socio-technical solution designed and implemented by the Community Management model (D3.3) had into consideration the environmental characteristics of the region. Though implementing a viable, and operationally simple, solution for water purification was the main goal, it was necessary to adapt the technology to account for the climatic and hydrologic characteristics of the basin. Pre-existing technologies had shown to be infeasible due to the high turbidity of the water, especially in the rainy season. Moreover, the basin showed pollution-associated problems due to community wastewater discharges, small local industry discharges and damage caused by mining. A set of pre-treatments were designed, tested and implemented to account for the local realm.

2.2.6.C. Ecological-environmental: Intervention case studies

The Quilombola community, where the Participative Generation of a Water Treatment System model (D4.1) was implemented, directly consumed water from the river, without any treatment, even though the main water sources in the region were polluted due to industrial and agricultural contamination. The environmental dimension, in this model is shaped in such a way as to evaluate the community's environmental situation, to identify locations for the installation of a water supply system and to identify the best solution able to cope with the environmental problems encountered in the community with respect to water quality. The optimal solution selected was based on laboratory analyses of water. The intervention case study where the adapted SISAR/CE model (D4.2) has been implemented, also ties the concept of ecological-environmental dimension to the concept of environmental sanitation. The Capacity Building model (D4.3) also addressed the ecological-environmental dimension characterising the biophysical conditions of the region and assessing the environmental perception of the community. In this case, the goal was to provide a deeper understanding of the interviewees' previous knowledge on environmental conditions. The model intends to plan and define how to get closer to acquire consciousness and for that it was essential to know the environmental living conditions of the students and population.

2.3. Temporal scales

The following questions were asked to the partners: '*what is/are the temporal scale(s) of the design and implementation of each innovation* and *what is/are the temporal scale(s) of the impact sought through the innovation'*. Answering these questions will help understand whether successful innovations correspond to those that took longer to design, and if so, could that mean that they were more carefully designed? Moreover, the temporal scales within which the innovations were designed and implemented might give an indication of the time interval needed to implement future innovations of the same nature. The temporal scales of each innovation are presented on Table 2.

Two contrasting situations emerge from this table. The SISAR/CE model (D2.1, D3.1, D4.2) was carefully designed in the 1980s and is still under development as new challenges emerge, as for instance the need for sanitation (D4.2). This system has been successful until today. On the contrary, the Communal Springs' model (D2.3) had no

formal planning, but is still in use until today, as the communities resort to wells and springs when their potable water supply needs are not fulfilled by the local authorities.

Table 2. Temporal scale(s) of design and implementation of the innovation and temporal scale(s) of the impact sought.

	Case-study									
	Historical			Current				Intervention		
DESAFIO systems	SISAR - Politico-Institucional Evaluation	Condominial Sanitation System (CS)	Communal Springs	Ecothecnological System	SISAE/CE - Ethnographic Assessment	Integrated Sanitation System (IS)	Community Management	Participative Generation of a Water Treatment	SISAR/CE - Community oriented WSS	Capacity Building
	D2.1	**D2.2**	**D2.3**	**D2.4**	**D3.1**	**D3.2**	**D3.3**	**D4.1**	**D4.2**	**D4.3**
Temporal scale of design and implementation of the innovation										
design	1980s	late 1980s	-----	1993	1980s	2000-2001	1991 - 1994	2013	1995	2014
implementation	phase1: 1990s phase2: 2005 phase3:2011 phase4: under discussion	1993-1994	responds to needs	1995-1996	2013	2002	1995	2013-2015	2013	2014
analysed time interval		1993-2000	2009-2010	1993-1997	2013	2001-2004	1994-1995 2014	2013-2015	2013-2015	2014-2015
Temporal scale(s) of the impact sought through the innovation										
long-term	X	X		X	X	X	X	X	X	X
medium-term										
short-term			X							

2.4. Transformations through the innovation

This section aims at responding to the following questions '*what kind of transformations are intended through the innovation?'* and '*what mechanisms are used by the innovation to produce these transformations?'*

All models, except, the Communal Springs model (D2.3) proposed mechanisms that would guarantee the community engagement and empowerment and thus the preservation of an efficient service in the long-term. The Community Management model (D3.3) and the Integrated Sanitation System (D3.2) additionally envisioned the inter-sectoral and inter-institutional collaboration as a mean to guarantee an effective and

permanent service. In common, all these models have their source of innovation, which arose from above, with significant inputs from public entities.

The Communal Springs' model (D2.3) is a community-led model for free water supply, with informal planning and management. Its only purpose is to guarantee water for as many users as possible, building rudimentary infrastructures based on the community's water needs.

For the remaining innovations, the mechanisms used to produce the transformations are diverse and cover a wide range of dimensions. Economically, the SISAR/CE model (D2.1, D3.1 and D4.2) relies on the implementation of an economic-financial structure, whose tariffs have evolved from an equitable division of tariffs to a progressive price table. Likewise, the echo-technological model (D2.4) implemented water bills with differentiated tariffs. The Condominial Sanitation System (D2.2) implemented an economic-financial structure where the community had to invest in the infrastructure, whereas the Integrated System (D3.2) totally abolished the community funding. Technically, the SISAR/CE (D2.1, D3.1 and D4.2) introduced water meters as a mean to implement differentiated water bills, whereas the Condominial Sanitation System (D2.2) and the echo-technological model (D2.4) relied on the implementation of simplified structures to guarantee the service provision to the low-income population. Mechanisms were also introduced at the operational level: the Condominial Sanitation System (D2.2) introduced the Community Agreement to assure the population engagement; the echo-technological model (D2.4) created a working group to control system operation and maintenance and a community association to manage the water and sanitation system; the Integrated Sanitation System (D3.2) assured the close participation of the population allowing them to present complaints and requests. Institutionally, the SISAR/CE model created the Rural Sanitary Management Department (GESAR), whereas the Integrated Sanitation System (D3.2) and the Community Management model (D3.3) introduced mechanisms to guarantee inter-sectoral coordination and inter-federal collaboration. As for the socio-political dimension the mechanisms introduced were essentially to guarantee the communities' participation at all or some steps of the implementation and management process. Specifically, the Condominial Sanitation System (D2.2) strived to guarantee the adaptation of the local authorities' role; the Participative Water Treatment System (D4.1) organized local assemblies to select the most appropriate alternative solution considering the local reality; the Community management model (D3.3) developed and implemented an institutional program in a participatory and organized manner and the Capacity Building model (D4.3) based its' model on the participation of students and teachers from secondary schools which should later transmit the acquired information to the community. Some of the innovations also included education and training to the community, either on technical issues, operational, management, health and/or environment.

2.5. The innovation and the process of democratisation

This section aims to understand the relationship between the innovation and the process of democratisation of the access to and the management of water and sanitation services. The implementation of people-centred governance practices and institutions grounded on substantive democracy and citizenship implies social participation and control over the

decision-making process. 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. The implementation of technically-centred projects where the role of beneficiaries comes down to providers of labour resources or mere service clients results in the weakening of local governments and civil society. The extent to which the socio-technical innovations are characterised by "social" and/or "technical" features, helps understanding the relationship between the innovation and the process of democratisation of the access to and the management of water and sanitation services.

2.5.1. "Social" and/or "technical" innovations

This section aims to respond to the question '*in what sense/to what extent the innovation is "social" and/or "technical"?'* Some of the case studies analysed are more focused on introducing social participation mechanisms, whereas others are more technically-centred. Here, we summarise the role of beneficiaries at all steps of the implementation process as a mean to understand whether the socio-technical innovation implemented active or passive citizen-user participation.

All the case studies analysed promote active participation of the community, though not all include mechanisms for citizen participation at all levels of the implementation process.

Of the four historical case studies, the Condominial Sanitation System (D2.2) is the most technically-centred, as participation of the community is incentivised to guarantee the acceptability of the Condominial Agreement, labour and service costs. Regarding the SISAR/CE (D2.1), the community is out of the decision-process regarding the design of the project, but the final goal is to implement a management model with shared responsibilities between the SISAR offices and the community, which is consulted on several aspects, such as in the decision of certain fee's amounts. On the contrary, the Communal Springs' model (D2.3) is by nature a socially-centred project, as all steps are a responsibility of the community. The Echo-technological model (D2.4) is also socially-centred as it a simplified sewerage for water decontamination, with active participation from the community at all steps: problem diagnosis; selection of the most appropriate technology; control over the construction of infrastructure and over the operation and system management, as well as water quality monitoring.

Regarding the current case studies, the SISAR/CE (D3.1) also excludes the community from the design-making process but also implements a shared-management model of the system, where the communities are able to take decisions. The Integrated Sanitation System (D3.2) and the Community Management model (D3.3) rely on qualified citizen-user participation at all stages of the process.

With respect to the intervention case studies, the SISAR/CE (D4.2) implements a model similar to the previous SISAR/CE, in what concerns the "social and/or technical" nature of the model. On the contrary, the Participative Generation of a Water Treatment System (D4.1) promotes the participation of the community from the first step of problem identification. The Capacity Building model (D4.3) actively incentivises the community participation as this model intends to intends to build a new set of links between individuals in order to know, understand and solve immediate necessities, using

technology and social networking, as well as develop learning mechanisms to encourage people for the engagement on social control of water and sanitation provision.

2.6. Advantages and drawbacks of the socio-technical innovations

To harness existing and developing new appropriate and innovative socio-technical solutions requires the acknowledgement of the pitfalls and shortcomings, as well as the advantages, of existing solutions. DESAFIO covers a wide range of different socio-technical innovations from which we can draw lessons for the future. The advantages and drawbacks of the historical, current and intervention case studies are summarised on tables 3 to 12.

2.6.A. Advantages and drawbacks: Historical case studies

Table 3. Advantages and drawbacks of the SISAR/CE innovation (D2.1).

Advantages	Drawbacks
a) full and uninterrupted operation of systems b) systematic preventive and corrective maintenance c) supervision of water quality d) low cost for communities e) financial and operational support f) role of communities in the supervision of systems g) dissuades excessive or irresponsible uses of water h) financial sustainability	a) implementation of user bill payment without auxiliary income generating projects b) in the beginning, communities were meant to contribute in the various tasks involved in the implementation of systems, but these conditions were suspended due to the socioeconomic conditions c) some of the SISARs became financially unsound and measures had to be taken to guarantee their self-sustainability

Table 4. Advantages and drawbacks of the Condominial Sanitation System innovation (D2.2).

Advantages	Drawbacks
a) improvements to sanitary conditions b) increased community awareness about the interrelations between sanitation, public health, and the environment c) suitable for unplanned and disorganised urban areas, as well as for all other urban designs d) suitable for developing countries, with high urban growth and great demand for sanitation services	a) sewer network, disconnected from other infrastructures (e.g. drainage, garbage) b) requires high level of user commitment and organization

Table 5. Advantages and drawbacks of the Communal Springs' innovation (D2.3).	
Advantages	**Drawbacks**
a) water provision to peri-urban areas, without adequate formal public water supply b) experience accumulation from technicians from public authorities; c) promotes socialization	a) difficulties in monitoring the quality of all alternative sources of water b) time spent for water collection c) informal management creates risks for human health due to water contamination d) lack of efficient sewage collection and treatment systems, which may be causing the contamination of the water table, and therefore the water extracted through wells and springs (unregistered cases of diarrhoea and hepatitis A) e) low water quality perception, though it differed between communities

Table 6. Advantages and drawbacks of the Echo-technological innovation (D2.4).	
Advantages	**Drawbacks**
a) simplified sewerage system b) flexible design c) adapted to local social and cultural realm d) low cost solution e) differentiated tariffs	a) unsuitable to collect rainwater b) collapse of WWTP

2.6.B. Advantages and drawbacks: Current case studies

Table 7. Advantages and drawbacks of the SISAR/CE innovation (D3.1).	
Advantages	**Drawbacks**
a) full and uninterrupted operation of systems b) systematic preventive and corrective maintenance c) supervision of water quality d) low cost for communities e) financial and operational support f) role of communities in the supervision of systems g) dissuades excessive or irresponsible uses of water h) financial sustainability	a) implementation of user bill payment without auxiliary income generating projects b) in the beginning, communities were meant to contribute in the various tasks involved in the implementation of systems, but these conditions were suspended due to the socioeconomic conditions c) some of the SISARs became financially unsound and measures had to be taken to guarantee their self-sustainability d) expenses related to electricity paid by the municipal government, and not equally distributed throughout the user base in the SISAR's monthly bill e) anarchic operational model f) not able to supply potable water, especially during the summer g) absence of appropriate democratic forums h) nowadays, contrary to years passed, many governmental programs will no longer invest in infrastructural projects if there is no guarantee of a subsequent management organisation (like the SISAR or an SAAE) that will take charge of the constructed system

Table 8. Advantages and drawbacks of the Integrated Sanitation System (D3.2).	
Advantages	**Drawbacks**
a) no cost to communities b) public financial and operational support c) public participation in all stages of the process d) inter-sector coordination e) inter-federal collaboration	a) the creation of Local Integrated Sanitation Desks in the neighbourhoods exposed the authorities to public scrutiny and accountability and the tensions created by this innovation led first to the weakening of these participatory mechanisms

Table 9. Advantages and drawbacks of the Community management model (D3.3).	
Advantages	**Drawbacks**
a) improved physical, chemical and bacteriological quality of the water b) simple construction, with local material and handwork c) reduced costs of construction and operation d) operation and maintenance are easy and can be operated by local workers with low education level e) reliable system as there is no need to stop water flux to solve some imminent problem f) simple cleaning though laborious	a) echo-technological solution with limitations and cannot be implemented in every context b) depends on political willingness

2.6.C. Advantages and drawbacks: Intervention case studies

Table 10. Advantages and drawbacks of the Participative Generation of a Water Treatment System (D4.1).

Advantages	**Drawbacks**
a) community education and training b) professionals training in the participatory process c) process of selection of the most appropriate technique guarantees the community engagement	a) difficult cooperation with collective activities due to internal conflicts, financial and managerial problems b) selection of the most appropriate technique was done without taking into account easiness of construction: difficulties emerged when hiring a company willing to construct the solution selected

Table 11. Advantages and drawbacks of the SISAR/CE innovation (D4.2).

Advantages	Drawbacks
a) full and uninterrupted operation of systems; b) systematic preventive and corrective maintenance c) supervision of water quality d) low cost for communities e) financial and operational support f) role of communities in the supervision of systems g) dissuades excessive or irresponsible uses of water h) financial sustainability i) water supply to households in less than five minutes j) provide sanitation and waste disposal infrastructures k) health and environmental problems' decrease	a) implementation of user bill payment without auxiliary income generating projects b) In the beginning, communities were meant to contribute in the various tasks involved in the implementation of systems, but these conditions were suspended due to the socioeconomic conditions c) some of the SISARs became financially unsound and measures had to be taken to guarantee their self-sustainability d) implementation of user bill payment without a differential billing structure for low-income users e) infant diseases not eliminated

Table 12. Advantages and drawbacks of the Capacity Building model (D4.3).

Advantages	Drawbacks
a) community education and training b) process of selection of the most appropriate technique guarantees the community engagement	(the model is still under development and no information regarding possible drawbacks is yet available)

3. Factors and processes that explain the emergence of the innovations

This section compiles the factors and processes that facilitated the emergence of the socio-technical innovations. National, regional and/or local political, social, cultural and/or environmental circumstances are able to explain the development of the solutions implemented.

3.A. Factors and processes: Historical case studies

Three of the historical cases were implemented in Brazil and emerged under an economic-financial crisis occurred throughout the 1980s, which caused the deterioration of the water and sanitation sector, especially regarding the provision of water and sanitation services for poor populations, due to the reduction of national public investment. This period was also characterised by institutional instability and instability of national policies, followed by policies embracing processes of privatization of state companies. As a result, national public policies for rural regions, and especially for the semi-arid region, were abandoned. The situation changed from mid-1980s onward, when international cooperation was promoted to invest in areas such as water and sanitation services. The SISAR/CE model (D2.1) was designed to serve rural regions with high demographical occupation, low-income population and health and education indicators below national averages. Additionally, the system intended to solve water supply problems to semi-arid regions with long drought periods, and more recently, to diminish water sanitation deficiencies. The Condominial Sanitation System (D2.2) emerged to assist poor urban areas with high and unplanned urban growth and with great demand for sanitation services, exposed to water-related infections (lymphatic filariasis). Both the SISAR/CE model and the Condominial Sanitation System benefited from high social mobilization and community participation and the level of commitment of local associations and public entities. The Communal Springs' model (D2.3) emerged as a response to the insufficient coverage of WSS networks in Brazilian peri-urban areas, whose implementation depended on political power. Because there was no intention, whatsoever, of public authorities to expand the formal network system in the short-term, peri-urban communities were consistently left out of the investment programs facing severe water supply problems: absence of network, intermittent supply, frequent shortages of water and water quality' problems. These regions were characterised by high social-environmental vulnerable communities, high and unplanned urban growth, high population growth and with a complex hydrographical network. This informal water supply system emerged under the cultural belief that water from wells and springs is of better quality. The emergence of the Eco-technological model (D2.4) was not possible until the 1990s, when a new directive stating that the public services could be provided by any type of actor (public, private or both) came into action. This meant that autonomous community management was finally a possibility. In addition, in 1994, another directive implemented public participation as a control mechanism of public management, providing the basis for the democratisation of water and sanitation services. At the time, high inequalities existed in the provision of water and sanitation services, since rural and peri-urban areas were poorly covered and frequently relied on artisanal water supply infrastructures and had no sanitation coverage. The community where the

Eco-technological system was implemented is characterised by high population fluctuations due to tourism (between 500 (residents) up to 30000 (tourists), high environmental pressure and high levels of water contamination. A cholera outbreak registered in Colombia, during the 1990s, was also observed in this community and four, out of ten, diseases were water-related. The necessity for the implementation of the innovation emerged after tourism decline, in the beginning of the 1990s, due to sewage contamination of the Pance river.

3.B. Factors and processes: Current case studies

Regarding the current case studies, the SISAR/CE model (D3.1) was implemented in a community where rainwater was the most valued water source due to water contamination as a result of illegal modifications to the distribution network performed by the users. As a consequence, the water distribution network was disabled between 2000 and 2005 and a new distribution network was built funded by the public entities, in 2008. The Integrated Sanitation System (D3.2) was implemented after the failure of the Condominial Sanitation System (D2.2). As elections approached, the living conditions of vulnerable communities became key elements in the electoral campaign and more attention was paid to the provision of water and sanitation services. The implementation process relied, thus, on political commitment, which culminated in the creation of the Secretary of Sanitation to take charge of the design and implementation of the programme to provide a definitive solution to the lack of sanitation in Recife's vulnerable areas. The Community Management model (D3.3) also emerged in Colombia, during the 1990s, under a cholera outbreak. During this period, the national government created the Departmental Water Plans (PDA) as the national strategy for water and sanitation sector, which assigned the responsibility for planning, infrastructure construction and even creating regional companies of water and sanitation service to the lowest administrative unit (the departments). By the time, the water and sewerage coverage reached 98% in urban areas, while in rural areas only reached 49% and 15% respectively. In the specific case study evaluated, the already vulnerable water supply system totally collapsed after a severe earthquake that occurred in 1994. Though the water service was restored right after the earthquake, it was identified that 45% of the population located in the highest part of the town had no water supply and 75% had health problems related to water-related diseases, because 100% of the population was consuming poor quality water, due to the mixture of water supply networks with domestic wastewater. It was declared the state of sanitary emergency for the community.

3.C. Factors and processes: Intervention case studies

Regarding the intervention case studies, the Participative Generation of a Water Treatment System (D4.1) arose has a necessity to adapt potable water distribution systems to rural communities, with lack of organizational capacity and trained personnel for systems' operation and maintenance. The implementation process benefited from collaboration with national and local NGOs familiar with the local reality and willing to support the process. Additionally, it benefited from cooperation from University and public institutions. The SISAR/CE (D4.2) intervention case was implemented in a

community with low quality sanitation infrastructures and low coverage of water supply systems. Wells, springs and rainwater constitute the main water sources. The community is characterised by low-income population, whose houses are scattered throughout the territory. The Capacity Building model (D4.3) arose has a necessity to empower populations without potable water supply. High levels of arsenic were known in the evaluated region, mainly those from small communities, but the high cleaning costs prevented from solving the problem.

4. Evaluation of the socio-technical innovations

4.1. Methodological framework

The methodological framework employed for the evaluation of the case studies comprised a) literature review for the assessment of the state of art, b) data compilation from both primary and secondary sources of information, c) data record and d) analysis of results.

All case studies followed a mixed methods approach for the analysis of the results, i.e,, both quantitative and qualitative methods were employed, for which both primary and secondary sources of information were collected. The primary sources of information, which were collected in the field, consisted mainly of semi-structured interviews (Table 13), both at the individual and collective level, after the identification of the communities (Table 14) and the key players (Table 15). The secondary sources of information were gathered from national, regional and/or local authorities and/or non-governmental institutions (Table 16).

Table 13. Field work approach for each case study.

Case study			Field Work
Historical	D2.1	SISAR/CE	A. Semi-structure interviews (individual) No. of communities: 11 No. of interviewed inhabitants: 36 B. Participant observation
	D2.2	Condominial Sanitation System	A. Semi-structured interviews (individual and collective): No. of individual interviews: 16 No. of collective interviews: 10 No. of persons in collective interviews: 2 to 10 B. Workshops: B1. with community members B2. with techno experts involved in the implementation and management of the system C. Participant observation D. Large public events to promote debate among key actors (a conference) E. Data record: Multi-media platforms (photographic, video and audio)
	D2.3	Communal Springs	A. Semi-structured interviews: Field campaign temporal interval: between January and February 2014 (summer) Questionnaire duration: 5 to 6 hours No. of questionnaires: 90: 55 from Jardim da Fonte and 35 from Vila do Rosário No. of questions: 9 B. Participant observation

			C. Data record: Researcher's personal journals and photographic record
	D2.4	Echo-technological	A. Semi-structured interviews to non-users players B. Workshops with the community association. No. of participants: 15 C. Questionnaire applied to end-users
Current	D3.1	SISAR/CE	A. Interviews * Local Communities: Immersive approach (semi-structured or non-structured interviews and informal conversations were carried out) * Public entities: semi-structured interviews * Field campaign temporal interval: 3 phases, of 3 weeks each. 1st phase - professionals linked to SISAR 2nd and 3rd phase - research in the communities A.1. local communities: semi-structured, non-structured (informal conversations to local residents): No. of interviews 80 (40 per community). Most were SISAR users. A.2. Public entities: SISAR managers, CAGECE employees and professionals from other organisations (i.e. the World Bank) No. of interviews: 6 with representatives of local associations; 2 with the operators of each of the communities; 3 with the SISAR-BME's managers; 1 with the social coordinator of the CAGECE's Rural Sanitation Management (GESAR) service; 1 with a World Bank representative; B. Participant observation B.1. Observation of an 'accompaniment reunion', between SISAR managers, local delegates and community users B.2. Observation of the fifth assembly of SISAR-CE and the Bahia Central Community Association for Water Systems Maintenance (CENTRAL-BA)
	D3.2	Integrated Sanitation System	A. Semi-structured interviews (individual and collective): Questionnaire with 48 questions Sample criteria 1) Census Sector 033: 1 out of 3 households, with an error margin of 7% and considering a potential loss of 10%, which gave us an expected number of 90 questionnaires. 2) remaining sectors: 1 out 9 households, also with an error margin of 7% and considering a potential loss of 10%, which gave us an expected number of 150 questionnaires. B. Workshops: B1. with community members B2. with techno experts involved in the implementation and management of the system C. Participant observation D. Large public events to promote debate among key actors (a conference) E. Data record: Multi-media platforms (photographic, video and audio)
	D3.3	Community management	A. Semi-structured interviews (non-users) B. Workshops with plumber, system operator, plant operator, members of the Board and former president of the same C. Questionnaire applied to end-users: Sampling design: random and systematic (1 out of 3 houses and a total of 180)
Intervention	D4.1	Participative Generation of a Water Treatment	A. Rural Participatory Appraisal (4 stages: exploratory, planning, action, evaluation (intermingled)) A.1. Preliminary survey: compilation of basic information to assist in the identification of the criteria in each community No. of surveys: 40 A.2. Exploratory visits: semi-structured interviews, daily routines and crossings and group activity for participatory mapping Lagedo was the 1st community: 23 houses out of 40 Mensal visits have been done to the Lagedo community with a community meeting

			Some questionnaires, simple, have also been applied
	D4.2	SISAR/CE	Data collection time interval: May to November 2014 A. Semi-structured interviews B. Water sampling and quality analysis (a total of 46) C. Blink calendars: to seize the flashing in the various collective water sources D. Stool tests to children up to 5 years E. Participant observation
	D4.3	Capacity Building	A. Questionnaires to determine vulnerability degree of population 13 questions; oral and written Survey is applied to community by the students. Each has made 5 surveys, geographically distributed B. Georeferencing sources of pressure C. Water samples' collection and analysis D. Photographic records of phenological stages of winter crops (wheat) and summer (soybean and corn) E. Survey of the various sources of bottled water consumed

Table 14. Criteria for the selection of the communities to evaluate.

Case study			**Communities' selection criteria**
Historical	D2.1	SISAR/CE	* geographic location within the same Regional Department as the CAGECE office * out of the municipal centre * geographic location in relation to the state's climatic zones * population between 250 and 2 000 inhabitants * localities with available electricity * with effective participation between involved parties * systems' age (both old and recent systems' were chosen)
	D2.2	Condominial Sanitation System	* The Mustardinha ZSSI was one of two ZSSI's in the city to be given top priority in the implementation of the sanitation system, among other issues owing to the high rates of water-related infections, particularly lymphatic filariasis, recorded there
	D2.3	Communal Springs	
	D2.4	Echo-technological	
Current	D3.1	SISAR/CE	
	D3.2	Integrated Sanitation System	* out of the 12 census sectors, one was selected due to comprehensive implementation of the SI system (1 out of 3 houses with a total of 90 questionnaires) * out of the remaining sectors, 5 were randomly selected (1 out of 9 houses)
	D3.3	Community management	
Intervention	D4.1	Participative Generation of a Water Treatment	* community with surface water catchment with high turbidity, that was recognised as a Quilombo by the Palmares Cultural Foundation (FCP) and titrated, or in the titling process, by INCRA No. of communities: 23, based on preliminary surveys
	D4.2	SISAR/CE	* communities' selection: 1 intervention case (Cristais) and 3 control case studies (SISAR communities)
	D4.3	Capacity Building	

Table 15. Criteria for the selection of the key players to interview.

Case study			Players' selection criteria
Historical	D2.1	SISAR/CE	* geographic location (both centre and peripheral zones) * role in the communities (users, system operators, communities' associations administrators, SISAR and GESAR employees)
	D2.2	Condominial Sanitation System	* role in the design and implementation (model founder; community leaderships; NGOs representatives; health, environment and WSS specialists; local government other public institutions representatives)
	D2.3	Communal Springs	* developed role in the local community * knowledge pertaining to the research subject * availability in collaborating with the research * ability to communicate his/her knowledge; * impartiality
	D2.4	Echo-technological	* role in the entire process from design to maintenance * operation and maintenance technician * system design engineers (3) * representative of municipal health authorities * end users (>18)
Current	D3.1	SISAR/CE	
	D3.2	Integrated Sanitation System	
	D3.3	Community management	* role in the entire process from design to maintenance * operation and maintenance technician * system design engineers * representative of municipal health authorities * end users (>18)
Intervention	D4.1	Participative Generation of a Water Treatment	
	D4.2	SISAR/CE	
	D4.3	Capacity Building	* 1st phase: Schools of secondary education Criteria: WSS services in the community * 2nd phase: community

Table 16. Type of secondary sources of information collected by each case study team.

Case study			Secondary Sources
Historical	D2.1	SISAR/CE	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * Documentary material: SISAR reports; water analyses informs; communities' associations minutes
	D2.2	Condominial Sanitation System	* Statistical sources: a) national censuses; b) special surveys by local, regional, and national authorities * Documentary material: a) official public archives (mainly from Pernambuco's Water and Sanitation Company, COMPESA, and Recife's Municipality); b) local community and private archives especially archives from several associations of Mustardinha and community leaders
	D2.3	Communal Springs	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * State and local press * Web pages: City Hall, resident groups and associations

	D2.4	Echo-technological	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * Community association archive * Photographic and audio-visual material * Local press
Current	D3.1	SISAR/CE	* Statistical sources: national censuses, special surveys by local, regional, and national authorities
Current	D3.2	Integrated Sanitation System	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * Documentary material: a) official public archives (mainly from Pernambuco's Water and Sanitation Company, COMPESA, and Recife's Municipality); b) local community and private archives especially archives from several associations of Mustardinha and community leaders
Current	D3.3	Community management	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * Community association archive * Photographic and audio-visual material * Local press
Intervention	D4.1	Participative Generation of a Water Treatment	(no information available)
Intervention	D4.2	SISAR/CE	(no information available)
Intervention	D4.3	Capacity Building	* Statistical sources: national censuses, special surveys by local, regional, and national authorities * Local press * Satellite images analysis and photographic validation * Water and sanitation bills

4.1.1. Evaluation criteria per analytical dimension

A compilation of all the indicators and corresponding metrics, when available, used by each study to analyse the socio-technical innovations is available on Tables A4 to A9 of the appendix. Each table corresponds to one of the six analytical dimensions defined by DESAFIO: policy-institutional (Table A4), socio-political and cultural (Table A5), economic-financial (Table A6), techno-infrastructural/operational (Table A7), health (Table A8) and ecological-environmental (Table A9). The tables are divided into 5 columns. The first three correspond to a hierarchical representation of the indicators used. The fourth column shows the metrics employed to measure the indicator. As the methodological approach has, in many cases, relied on semi-structure interviews, the specific quantitative/qualitative metric used to assess each one of the indicators cannot be, in many cases, clearly defined. Take the Communal Springs' model (D2.3) as an example: the report presents the results of questions related to water sources and water uses as the % of answers per category and presents the results related to the water quality perception as a detailed, not systematised, description of interviewees' answers.

When no metric was identified the field was left in blank. The fifth column shows the case studies that have measured the indicator.

Figure 5 shows an example of how the indicators have been systematised into hierarchical categories. The diagram presented in the figure shows the type of indicators for the assessment of citizen-empowerment, within the socio-political and cultural dimension (also available on Table A5). Citizen-empowerment has been analysed evaluating community and institutional mobilisation, social participation, community attitudes and institutional transparency perception. Each one of these sub-indicators have been, whenever appropriate, analysed through other sub-indicators.

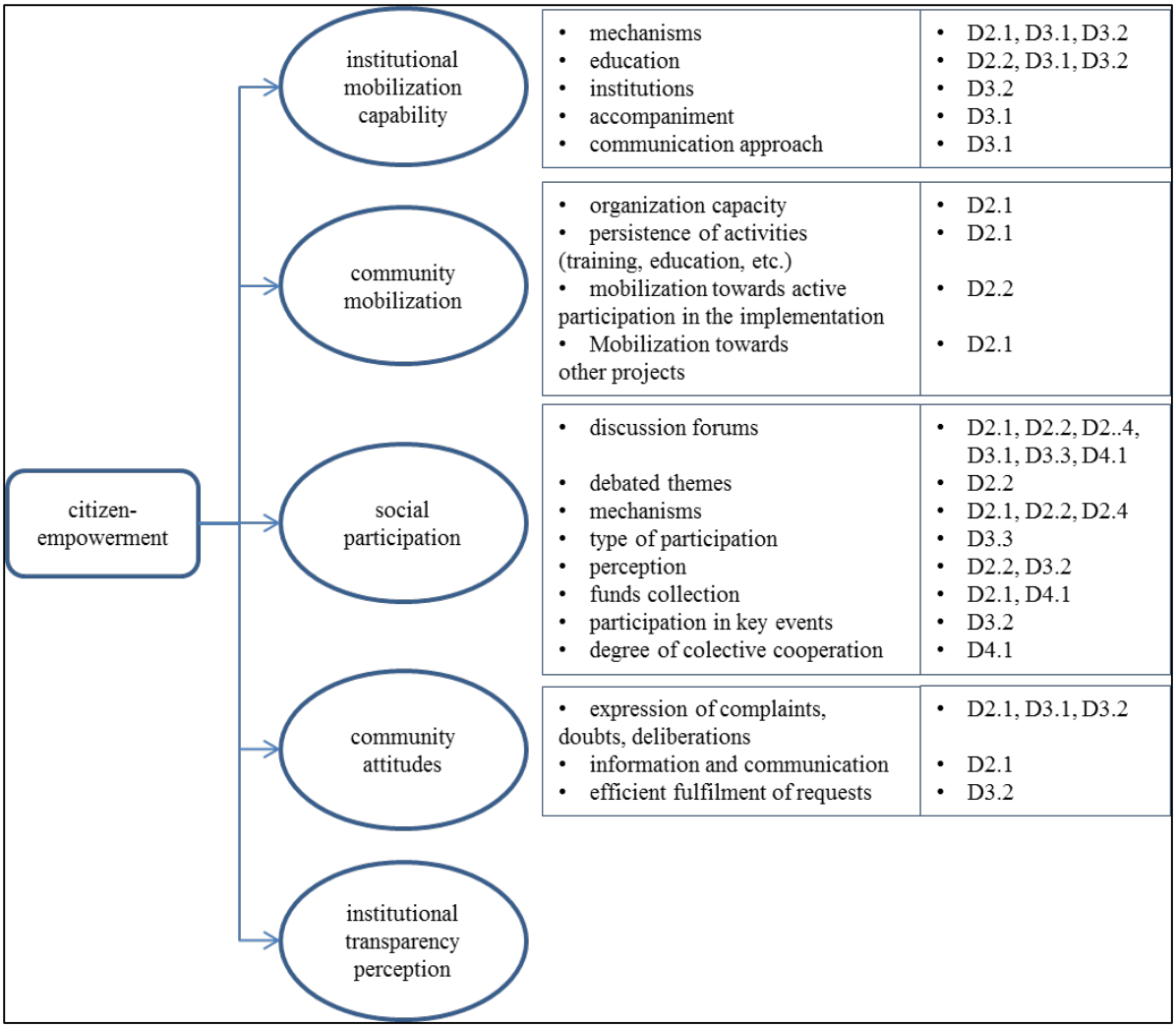


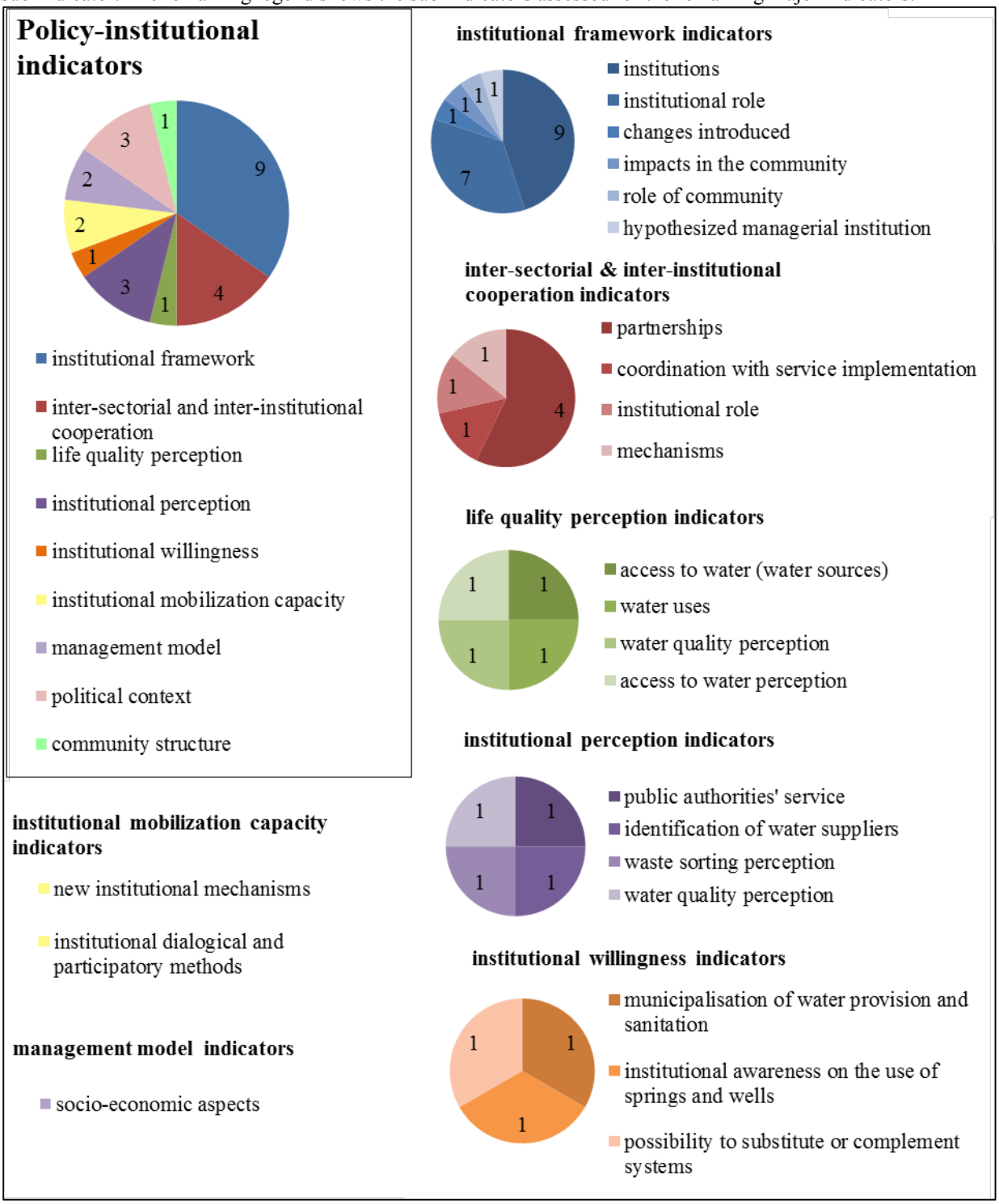
Figure 5. Diagram of the type of indicators for the evaluation of citizen-empowerment, of the socio-political and cultural dimension, per case study. Historical case studies: D2.1-SISAR/CE model; D2.2-Condominial Sanitation System; D2.3-Communal Springs; D2.4-Echo-technological; Current case studies: D3.1- SISAR/CE; D3.2-Integrated Sanitation System; D3.3-Community management; Intervention case studies: D4.1-Participative Water Treatment System; D4.2-SISAR/CE; D4.3-Capacity Building.

Analysing the indicators' table for the assessment of the policy-institutional dimension (Table A4) it stands out that only the Communal Springs' model (D2.3) presents quantitative data and that the information provided evaluates life quality perception and not actual policies and institutional frameworks. The socio-political and cultural is the

dimension with the highest number of indicators assessed (Table A5). From this table, it stands out that different case studies had different metrics to evaluate the same type of information. For instance, the SISAR/CE (D2.1 and D3.1) reported whether the expression of complaints, doubts and deliberations was present in the community, whereas the Community Management model (D3.3) actually measured the number of occurrences per type of expression per year. Regarding the economic-financial indicators (Table A6), it stands out that only the Condominial Sanitation System (D2.2), the Integrated Sanitation System (D3.2) and the Participative Generation of a Water Treatment System (D4.1) feature data regarding intervention costs; that the information regarding the billing system is highly variable and that only two case studies (D2.2 and D4.3) provide information necessary to evaluate whether the costs resulting from water and sanitation facilities are reasonable and affordable to the beneficiaries. It is also observable that the Echo-technological model (D2.4) and the Community Management Model (D3.3) are focused on indicators of community structure whereas the Communal Springs (D2.3) and the SISAR/CE (D4.2) are focused on indicators of life quality perception. The techno-infrastructural/operational dimension is covered by a wide range of indicators (Table A7), from those more obvious that measure implementation, maintenance and operational management, to others that measure community structure, life quality perception, water quality, funds and consumption habits. Another type of indicators, applied by the Participative Generation of a Water Treatment System model (D4.1) measure the feasibility of the solutions over the table to be selected by the communities: indicators of selection and evaluation. Possibly, some of these indicators, though indicated to have been used to assess the techno-infrastructural dimension, would have been more suitable to measure other dimensions. Regarding the indicators for health assessment it stands out that indicators of community structure and life quality perception are again applied (Table A8). This occurs because the Communal Springs' study (D2.3) stated that these indicators were used to evaluate all six dimensions, even though it might not be straightforward their contribution to the assessment of some of the dimensions, as is the case of the health dimension. Notice also, that the Participative Generation of a Water Treatment System study (D4.1) only reported the type of diseases observed in the study area. Finally, the ecological-environmental indicators were essentially focused on environmental commitment, environmental perception and biophysical characterisation. Only the Echo-technological model study (D2.4) took an ecosystem approach and only two intervention case studies, the Participative Generation of a Water Treatment study (D4.1) and the Capacity Building study (D4.3) assessed environmental conditions and problems in the vicinities.

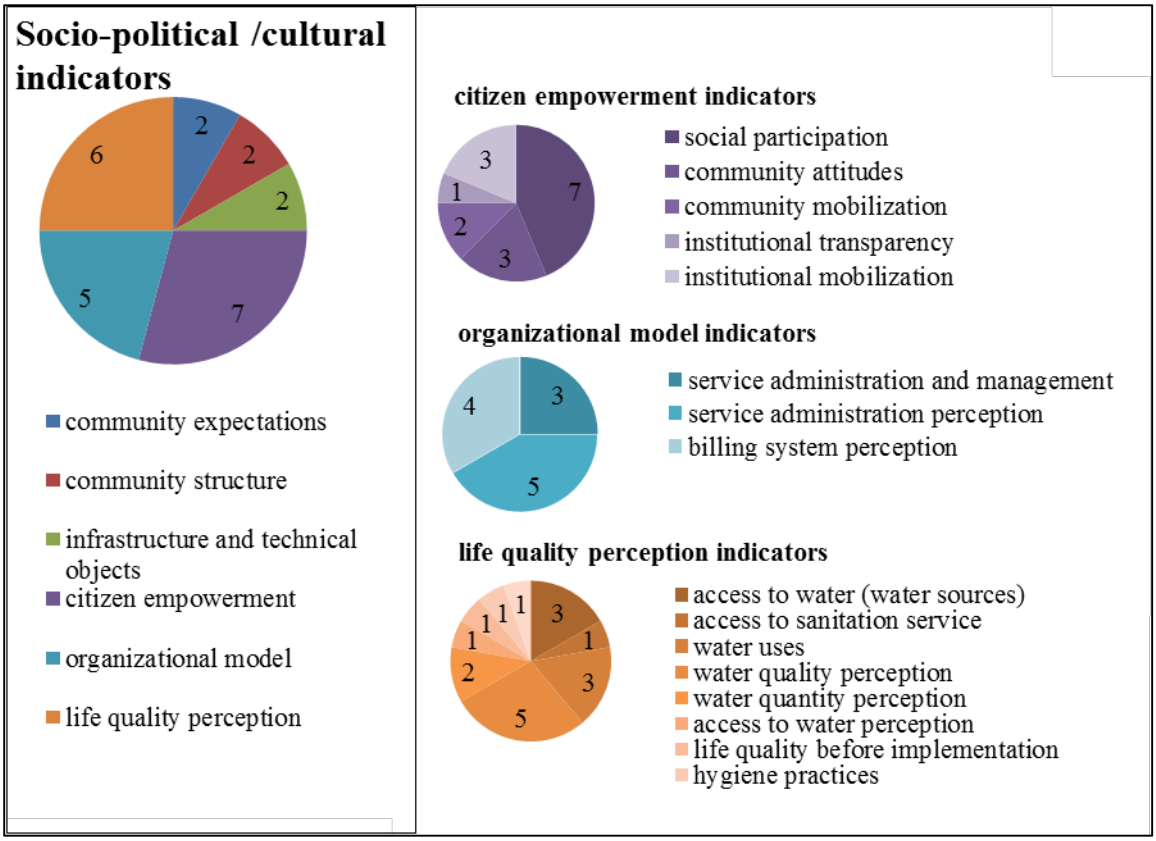
Figures 6 to 11 show the number of case studies per type of indicator for each analytical dimension: policy-institutional (Figure 6), socio-political and cultural (Figure 7), economic-financial (Figure 8), techno-infrastructural/operational (Figure 9), health (Figure 10) and ecological-environmental (Figure 10). Analysing these figures it is possible to perceive the indicators most frequently used. For the policy-institutional dimension, 9 out of 10 case studies describe and/or discuss the institutional framework, while only 1 case study evaluates life quality perception and institutional willingness as indicators for the assessment of the policy-institutional dimension (Figure 6).

Figure 6. Number of case studies per type of policy-institutional indicator. The box in the upper left shows the number of case studies per major indicator. The remaining plots show the number of case studies per sub-indicator. The remaining legend shows the sub-indicators assessed for the remaining major indicators.



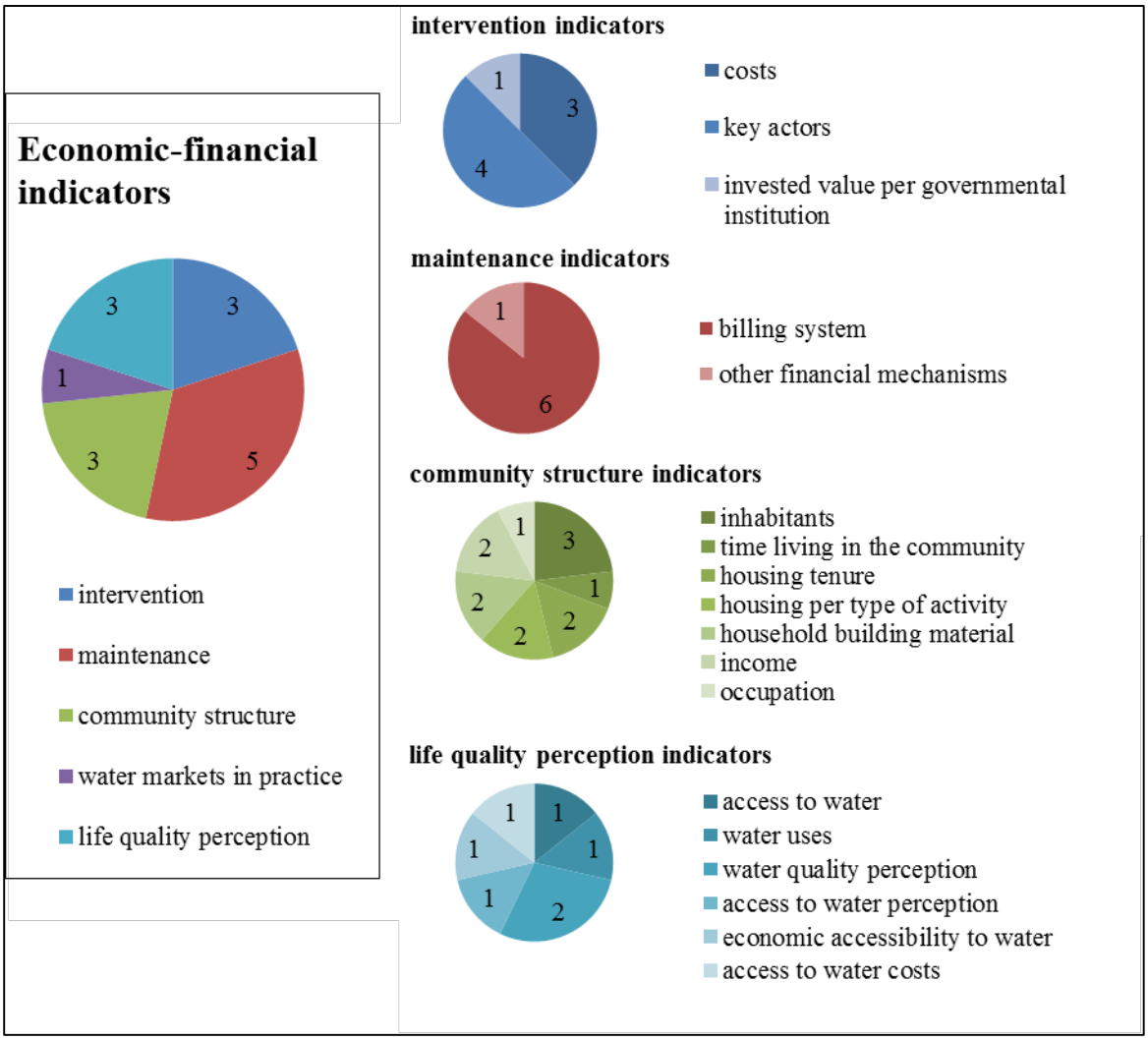
To assess the socio-political and cultural dimension, the indicators most frequently evaluated are citizen-empowerment, organizational model and life quality perception (Figure 7).

Figure 7. Number of case studies per type of social-political and cultural indicator. The box in the left shows the number of case studies per major indicator. The remaining plots show the number of case studies for the sub-indicators most frequently used.



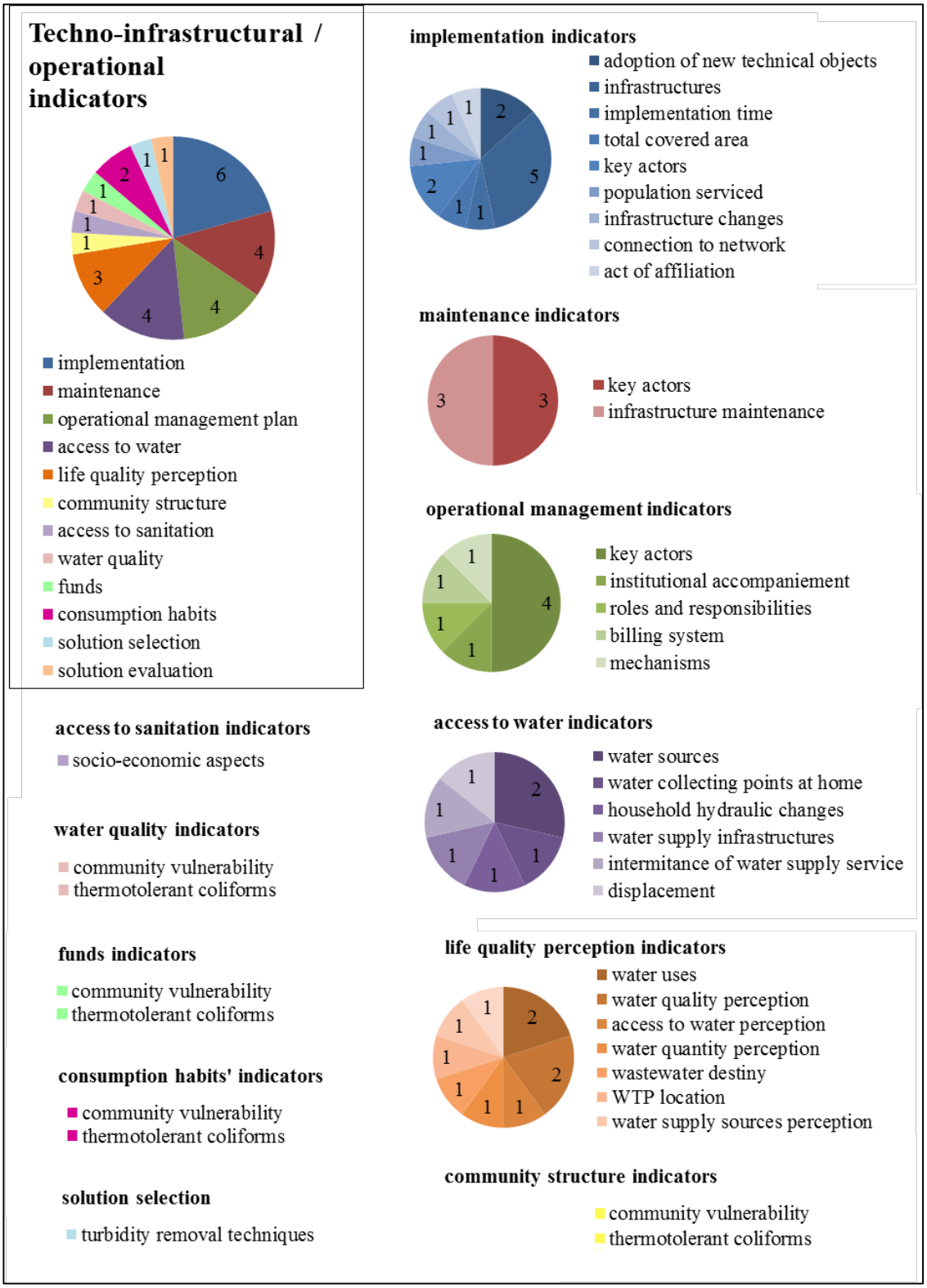
For the economic-financial dimension, the indicators most frequently evaluated are those related to system maintenance, followed by those related to intervention cost values and actors, community structure and life quality perception (Figure 8).

Figure 8. Number of case studies per type of economic-financial indicator. The box in the left shows the number of case studies per major indicator. The remaining plots show the number of case studies for the sub-indicators most frequently used.



For the techno-infrastructural/operational dimension, the indicators most frequently evaluated are those related to the implementation process, followed by those related to maintenance, operational management plan and access to water (Figure 9).

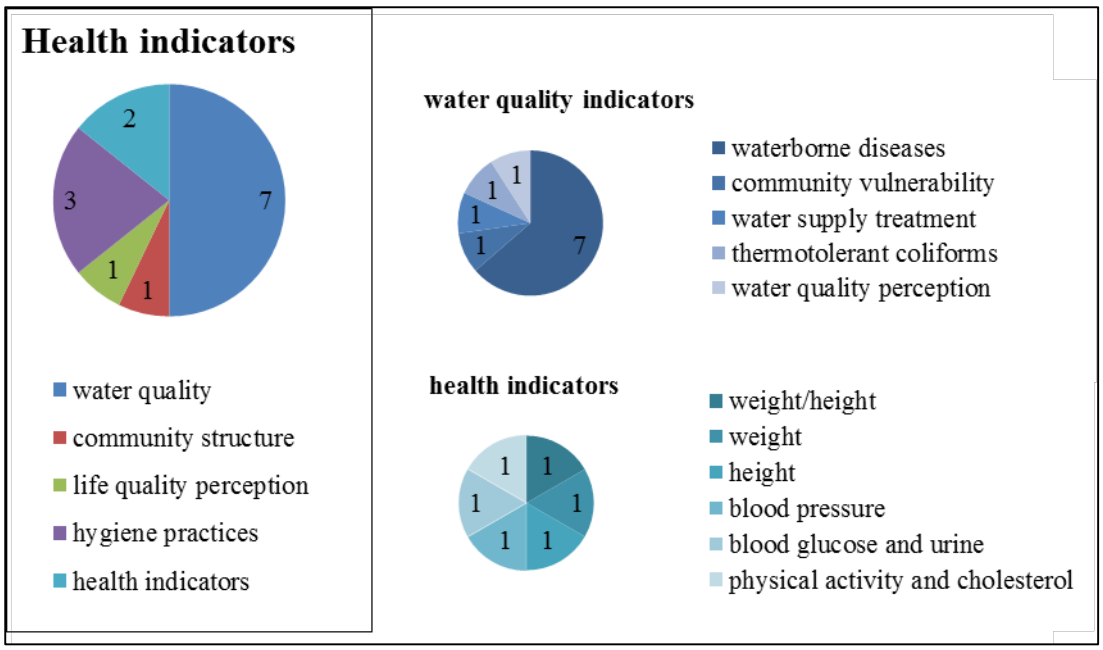
Figure 9. Number of case studies per type of techno-infrastructural/operational indicator. The box in the left shows the number of case studies per major indicator. The plots on the right show the number of case studies for the sub-indicators used by more than one case study. The remaining legend shows the sub-indicators assessed for the remaining major indicators.



The techno-infrastructural dimension shows the widest variety of indicators among all the dimensions evaluated.

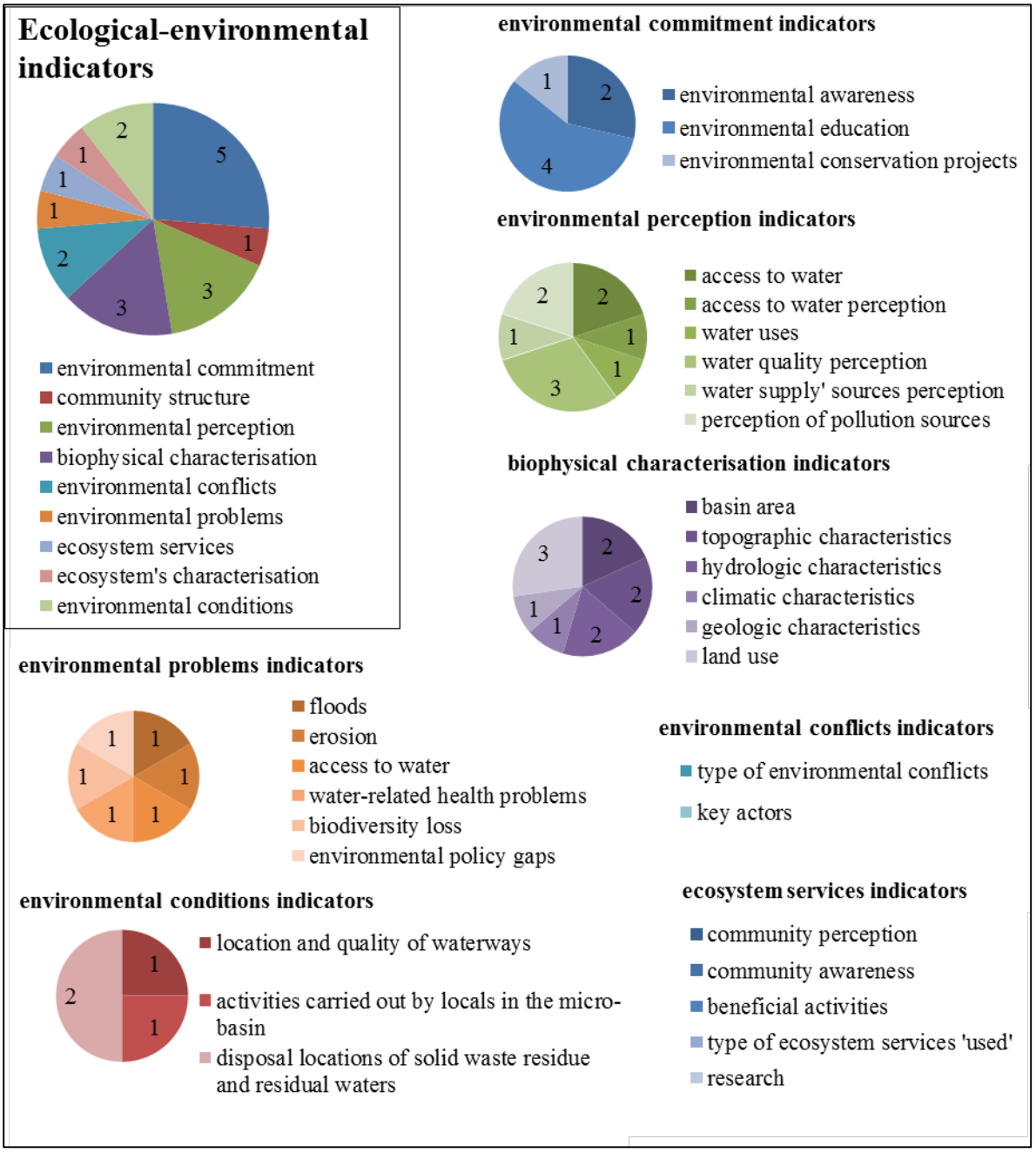
To evaluate the health dimension, the indicator most frequently assessed was water quality, with 7 case studies, followed by the hygiene practices, with 3 case studies, which was evaluated assessing only the type of practices for which water is used (Figure 10).

Figure 10. Number of case studies per type of health indicators. The box in the left shows the number of case studies per major indicator. The plots on the right show the number of case studies for the indicators with more than one sub-indicator and used by more than one case study.



As mentioned before, the ecological-environmental dimension has been poorly characterised and evaluated. This is also reflected in the type of indicators employed (Figure 11). Most of the case studies evaluation was focused on environmental commitment and/or perception and the effective implications of the innovations on the ecological and environmental realms have not been assessed. Frequently, it was only evaluated the relationship between the health and the environmental dimensions, as a mean to describe the environmental sanitation conditions. Likewise, with a few exceptions, it was not clearly assessed whether the ecological-environmental characteristics of the area under study, were taken into account at the time of planning and implementation.

Figure 11. Number of case studies per type of health indicators. The box in the left shows the number of case studies per major indicator. The plots on the right show the number of case studies for the indicators with more than one sub-indicator and used by more than one case study.



4.2. Results

The ultimate goal of the case studies' evaluation was to *assess whether the innovation contributed to increasing access to water and/or sanitation*. To attain this goal, one needs firstly to assess whether there were changes after the implementation of the innovation, either comparing before and after, or comparing with some other control community. Moreover, changes in the access to water can be measured at different levels: water quantity, water quality, availability, economic accessibility and physical accessibility.

The total coverage of the SISAR/CE in the state of the Ceará indicates that the physical access to water has improved. Currently, the SISAR covers a significant portion of the state's rural areas (135 of 182 municipalities) and provides service to an approximate population of 406 000 inhabitants. This includes the communities of Arataca and Andreza – Itapeim Complex- evaluated by the D3.1. Comparing these communities with the community of Cristais, which was recently intervened (D4.2), the results indicate, that though physical and economic accessibility are similar between the Itapeim complex and Cristais, the newly intervened community is still more vulnerable considering the quantity, the quality and availability of water.

The failure of the experience of the Condominial Sanitation System, analysed in the D2.2 report, meant that the poorest sectors of the population remained without access to the basic sanitation, and the living conditions of a large section of the population were appalling. According to studies of the period, the figures of coverage for basic sanitation remained unchanged during the 1990s, and the impact of water-related diseases remained very high. On the contrary, the Integrate Sanitation System (D3.2) implemented in the same area, years after, succeeded in completing a total of 33 projects in the city, among which is included the case study considered in the D3.2 report.

The Communal Springs' model (D2.3) has shown to increase the access to water as these solutions are essentially implemented where formal networks do not exist or are still characterised by high levels of water intermittence. Nevertheless, this solution hardly contributes to the increase of the access to water of good quality and hardly reduces physical accessibility, as the communities spend a considerable amount of time to fetch water.

The Cinara Institute, in Colombia, was at the core of the success of the implementation of socio-technical innovations in two communities analysed by DESAFIO: La Vorágine (D2.4) and Mondomo (D3.3). The increase of water supply coverage and the improvement of the water quality parameters indicate that the access to potable water has increased in both communities. Likewise, the increase of sanitation coverage has shown that the access to sanitation has increased in La Vorágine.

The socio-technical innovation developed by the Participative Generation of a Water Treatment case study (D4.1) is directly related to the treatment of contaminated surface water that is currently used for human consumption without treatment in the Quilombola rural community. Though the final monitoring and evaluation of the treatment system's is still not concluded, the preliminary water quality analysis of the selected solution indicate that the goal of increasing the access to potable water will be attained.

Though the preliminary results of the Capacity Building (D4.3) case study indicate that the participative approach applied has been successful, we are not able, by now, to advance on whether the access to non-contaminated water has increased.

4.2.1. Conditions, opportunities and limitations to the socio-technical innovations implementation

4.2.1.A. Opportunities and limitations: Historical case studies

The SISAR/CE model (D2.1) has evolved since its first design in the 1980's, accumulating various experiences and adjusting to the local rural milieu and to the encountered limitations, which were mainly related to the financial self-sustainability of the system and to the communities' participation which tended to decrease once the main goal (water provision) was achieved. Social commitment decrease was in part related to local associations' leadership which, in some cases, was not strong enough to guarantee long-term commitment and avoid communities' demobilisation. In turn, the absence of financial self-sustainability in some SISARs was related to the low purchasing power of the families that did not permit the readjustment of tariffs.

The Condominial Sanitation System (D2.2) was a political experience, based on intense mobilisation of the population in the initial stages of the project. Despite the high level of commitment of local leaders and community, the scale and intensity of participation diminished over time due to the normal attrition of the participative processes and to the lack of financial resources to implement a complete sewerage network. As a result, failures in the implementation, management, operation, and maintenance of the system emerged, condemning the system to failure. The most limiting aspects were related to the lack of agreement with respect to the system's maintenance, to the insufficient capacity of the wastewater lift station and to the lack of funds for urban planning, network extension and monitoring teams.

The Communal Springs' model (D2.3) benefited from a self-motivated community willing to implement and manage a solution for water supply in low-income areas, in a context of lack of political and financial support from public authorities. Though, the number of water sources increased, the informal management and lack of monitoring led to the supply of low quality water with negative consequences within the health and environmental dimensions.

The Echo-technological model (D2.4) benefited from an attitude of respect by the public institutions, which has contributed to a beneficial horizontal relationship between the community and the institutions, favouring the constant access and exchange of information and consequently community empowerment. The implemented model also benefited from the transference of monitoring responsibilities to the community and from the inclusion of builders and works inspectors as team members. The sustainability of this system is nonetheless compromised by land use changes in the middle basin; by the low participation of the community in meetings; the lack of tariffs' equity; the lack of administrative staff and operator overloading. Additionally, the tourists' behaviour may exert more pressure in the city and affect the ecosystem.

4.2.1.B. Opportunities and limitations: Current case studies

The implementation of the SISAR/CE model (D3.1) in the communities of Andreza and Arataca suffered from the same opportunities and limitations as the most of the SISAR/CE implementation processes and mentioned in the previous section of the historical case studies. However, regarding the specific case of these two communities,

the implementation of the SISAR model benefited from the prior existence of local associations, but some limitations were encountered: a) insufficient preparation before the SISAR's arrival; b) lack of continuous proactive accompaniment; c) weak resident attendance at affiliation assemblies; d) lack of training for local actors; e) absence of an official, standardised medium that formally established each actor's responsibilities, as well as the SISAR's model and modus operandi; f) insufficient 'routine' assemblies for community 'accompaniment' per year.

The urgent necessity to solve sanitation problems in low-income areas was a decisive element for the design and implementation of the Integrated Sanitation System (D3.2). This model was set as an alternative to the conventional sewerage system and to the Condominial system which did not considered the urban planning as an object of intervention, nor envisioned the implementation of sanitation as an inter-sectorial process. Due to its holistic characteristics, the model highly depends on political willingness, which as decrease a few years after the first projects' implementation. As a result, recommended partnerships were not established and the role of the municipal government was restricted to network construction in low-income areas, though the responsibility of system regulation and monitoring should have been assigned to the municipal government.

The Community Management model (D3.3) emerged from the necessity to rebuild a highly damaged water supply infrastructure and benefited from a pre-existing echo-technological solution which was locally adapted to a low income and vulnerable population. It also benefited from a prior community-led management model, though informal. Limitations to its implementation are mainly related to vulnerable political decisions, with impact on system's funding.

4.2.1.C. Opportunities and limitations: Intervention case studies

The Participative Generation of a Water Treatment System (D4.1) implemented in a low-income community with specific cultural characteristics successfully invested in community education and training, managing to achieve the goal of selecting the alternative that best suited the community. It was nonetheless affected by financial and managerial problems, as well internal conflicts that have hindered the discussion. Moreover, excluding private companies from the participatory process, capable of implementing the alternatives under scrutiny, revealed implementation difficulties, as some technical limitations were not discussed previous to selection of the solution.
The Capacity Building model (D4.3) benefited from the commitment of both students and teachers involved in the initial phase of model implementation. However, the ability to build original and proper knowledge, and the ability to exercise productive work, might be hindered by two antagonistic social realities: insecure social strata, for one hand, and social strata with privileged monopoly of knowledge production, on the other hand. As the second phase of implementation of the Capacity Building model is yet to accomplish, it is not possible to advance on the further opportunities and/or limitations of this model.

5. Factors, conditions, and processes that help explain the success or failure of the innovations

This section responds to the questions '*what are the critical requirements to make successful socio-technical innovations sustainable and replicable? What are the obstacles to their sustainability and replication?'* Generally speaking, a socio-technical innovation is successful if it remains operational, fulfilling the necessities of the community, for a long-term. This can only be achieved if the socio-technical solution is sustainable at all levels: political, institutional, social, cultural, technical, operational, health and environmental. For cases of top-down implementation and management, political willingness will play a major role as it could chunk the process right before it starts. Lack of inter-sectorial and inter-governmental collaboration could hinder the implementation process or condemn a system to failure as water and sanitation services systems depend on the effectiveness of other sectors of the society, such as urban planning. Lack of social participation also plays a major role, either because the operation and or management are a responsibility of the user-community, or because the control over the service will depend on the community awareness and dynamic attitude. Lack of a suitable economical-financial framework to support both the implementation and the maintenance of the system might in turn condemn a system due to lack of financial sustainability. Technically unsuitable systems, unless fixed in due term, could collapse or could prevent the service to reach the entire community. Regarding the health dimension, unless potable water is supplied to the community, residual water is treated conveniently and the population is aware of the necessary hygiene practices, water-related health issues will always emerge in a community possibly with severe consequences for the population. As for the ecological-environmental dimension, sustainable water and sanitation services are frequently associated to appropriate sanitary conditions, but environmentally sustainability requires taking into consideration other issues such as the biophysical characterisation of the region which plays a crucial role in the construction of the network.

Critical requirements and obstacles to the sustainability and replicability of the socio-technical innovations evaluated in the scope of the DESAFIO project are described in Tables 17 and 18. For each case study, and whenever appropriate, the requirements and obstacles are listed by analytical dimension: policy-institutional, socio-political and cultural, economic-financial, techno-infrastructural/operational, health and ecological-environmental.

Table 17. Critical requirements, by case study and analytical dimension, to make successful socio-technical innovations sustainable and replicable.

Case study			Requirements
Historical	D2.1	SISAR/CE	* Policy-institutional: a) significant state government intervention is needed to guarantee the model's expansion to other locales; b) technological support of state institutions; c) program's institutionalization by the state *Social-political and cultural: a) participation - Charismatic leaderships that guarantee the maintenance of public interest in participation; b) Attitude - involvement of communities in the monitoring of the systems' functioning and quality and consequent report; face-to-face communication; c) Transparency and accountability; d) mobilization * Economic-financial: a) fund raising for the operation and maintenance; b) effective bill payment control and collection; c) public resources distributed equitably * Techno-infrastructural/operational: a) water quality must be guaranteed; b) studies that provide adequate support to the choice of efficient treatment schemes
	D2.2	Condominial Sanitation System	A good technological solution coupled with political commitment to guarantee long-term maintenance which, in turn, guarantee a satisfied and engaged community: * Policy-institutional: a) Political commitment * Social-political and cultural: a) Community organization; b) Participatory planning tool; c) Community awareness * Techno-infrastructural/operational: a) techno teams with experience in participatory approaches; b) construction works provided by public company
	D2.3	Communal Springs	* Policy-institutional: a) recognition from public sectors pertaining to water and sanitation services * Social-political and cultural: a) participatory process of discussion regarding water supply solutions in Queimados; b) in depth knowledge of the existing forms of water provision
	D2.4	Echo-technological	* Social-political and cultural: a) participatory process of discussion; b) suitable training of officials and communities
Current	D3.1	SISAR/CE	(same as D 2.1)
	D3.2	Integrated Sanitation System	* Policy-institutional: Favourable political context; b) political, technical and intellectual commitment with the project and its democratic character
	D3.3	Community management	* Policy-institutional: a) community and institutions involvement in the process: from problem identification, to participatory selection of technology; b) participation of a multidisciplinary and inter-institutional group acting as facilitator * Techno-infrastructural/operational: a) system technologically efficient: with low consumption of energy; b) operationally simple; c) with multi-filters preventing the obstruction of the network; d) technician living nearby the infrastructure facilitating maintenance; e) private-public partnership, guaranteeing initial funding; f) implementation of tariffs for long-term sustainability
Intervention	D4.1	Participative Generation of a Water Treatment	* Policy-institutional: a) reconciliation of all different partners' agendas and engagements, and the latter's ability to understand their role in this process * Social-political and cultural: a) dialogue and knowledge of local reality as prerequisites to the installation of water supply systems in isolated rural communities; b) accompaniment of the solution implemented; c) educated and trained community, facilitators and staff of public authorities

	D4.2	SISAR/CE	* Policy-institutional: a) necessity of advancing public policies oriented towards sanitation in a transversal and cross-sector fashion * Social-political and cultural: a) required action beyond the supply of sanitary services, considering cultural factors that influence household sanitary conditions * Techno-infrastructural and operational: a) introduce a service fee framework that includes reduced fees; b) implantation of hydraulic installations in dwellings that do not yet have them; c) dissemination of information concerning the measurement structure (water meter) and the billing system
	4.3	Capacity Building	* Policy-institutional: a) public entities engagement to guarantee transfer of knowledge * Social-political and cultural: a)full community engagement through students and teachers with the potential to communicate and replicate their experience; b) suitable training * Techno-infrastructural/operational: a) public entities willing to cooperate with water quality analysis

Table 18. Obstacles, by case study and analytical dimension, to the sustainability and replication of socio-technical innovations.

Case study			**Obstacles**
Historical	D2.1	SISAR/CE	* Social-Political and Cultural: a) public demobilization; b) youth withdrawal * Economic-financial: a) self-sustainability (high cost of operation and repairs; increased non-payment bills; insufficient 'unreal' tariff); b) lack of equitable distribution of public resources * Techno-infrastructural/operational: a) lack of studies to support choice of treatment schemes
	D2.2	Condominial Sanitation System	Highly dependent on local conditions and circumstances: *Policy-institutional: a) lack of inter-sectorial dialogue; b) lack of political decision to design institutional frameworks * Social-political and cultural: b) lack of community articulation, long-term engagement and awareness; c) break of Condominial Agreement *Techno-infrastructural/operational: a) lack of resources; b) incomplete implementation; c) system disconnected from other infrastructures; d) lack of suitable management and operation; e) lack of continuity and prioritization over time (lack of agreement with public sanitation company to guarantee maintenance and lack of community capacity to guarantee effective maintenance); f) lack of urban planning * Ecological-environmental: a) lack of environmental education
	D2.3	Communal Springs	* Social-political and cultural: a) conflicts amongst the population ; b) clientelistic culture * Economic-financial: a) lack of funds * Techno-infrastructural/operational: a) difficulties to reach or find water table; b) lack of organised community and/or public administration support; c) change the technological paradigm (centralised macro-system) of water and sanitation services organization * Health and Ecological-environmental: a) contaminated water table
	D2.4	Echo-technological	* Techno-infrastructural/operational: a) unsuitable sewerage system to collect both residual and rainwater; b) unsuitable WWTP
Cu	D3.1	SISAR/CE	* Social-political and cultural: a) population resistance to change (introduction and dissemination of innovations is inevitably a process of

			transgression. Innovations call into question behaviours and attitudes that can often be routine and sources of balance) * Techno-infrastructural/operational: a) ineffective enrolment mechanism; b) obscure existence of progressive price tables; c) lack of clear definition of each actor's responsibilities; d) deficient accompaniment from SISAR's actors
	D3.2	Integrated Sanitation System	*Policy-institutional: a) inertial forces that prevent institutional change, in particular in relation to reforms geared at promoting inter-sector collaboration; b) Policy-institutional instability and fragility: uneasy relationship, tensions, and contradictions between electoral politics and the politics of substantial democratisation * Social-political and cultural: a) public authorities discredit previously built among vulnerable communities
	D3.3	Community management	* Policy-institutional: a) political willingness * Techno-infrastructural/operational: a) suitable only for rural communities from 1000 up to 25000 inhabitants, with endowments ranging from 80-120L / person / day (approximately 35L /s) * Social-Political and Cultural: a) population education with respect to environmental dimension
Intervention	D4.1	Participative Generation of a Water Treatment	*Policy-institutional: a) difficulties in reconciling the different partners' agendas * Techno-infrastructural/operational: a) suitable for small communities
	D4.2	SISAR/CE	* Social-political and cultural: a) rural cultural factors, that prevent the use or correct use of infrastructures; b) low income communities, which prevent the increase of tariffs and may therefore compromise the economic sustainability of the system
	D4.3	Capacity Building	* Social-political and cultural: a) antagonistic social identities: for one hand, helplessness and insecure communities and on the other hand privileged monopoly of knowledge production

6. Lessons learned

Addressing the gaps in current water and sanitation systems can promote the discussion for long-term sustainable socio-technical innovations, especially for vulnerable communities. Aiming to develop sustainable strategies and alternatives that allowed to '*excavate the complex origins of the problems that we face and clearly identify the key factors, drivers, thresholds and processes at work at different scales*', the DESAFIO project considered several types of socio-technical innovations, broadly divided into three main categories: i) focusing only on sanitation issues, ii) focusing only on water supply issues, iii) considering both water supply and sanitation (Figure 12A). Additionally the extent of the performed innovation was also a crucial aspect for its sustainability and reproducibility issues (Figure 12B).

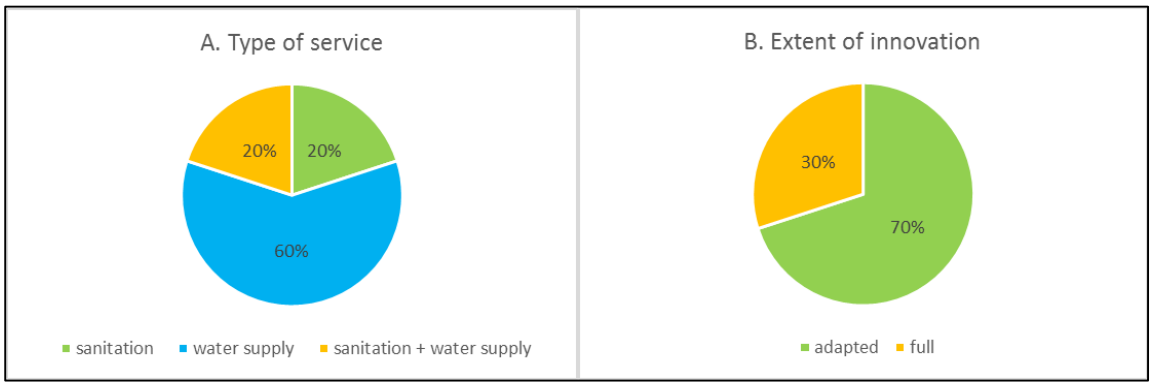


Figure 12. Innovations covered by the case studies: A. type of services considered; B. extent of the innovation undertaken.

Drawing on the DESAFIO 10 case studies, from 3 Latin America countries (Argentina, Brazil, and Colombia), in this section aims to 1) analyse the main promoters and constrains to ensure the sustainability and reproducibility of the analysed innovations to larger scales, while 2) comparing it to other experiences observed in other countries.

Most of the DESAFIO case studies relied on a bottom-up management of water supply and sanitation systems after its implementation, usually led by Governmental institutions. These were, for example, the cases in Colombia, Mustardinha (Recife) or the SISAR model. These studies identified two major needs: 1) the need to empower local communities; while 2) training them to ensure that they had the adequate skills and tools to manage water systems effectively. These findings are in accordance with several experiences and outcomes observed worldwide (e.g. Moriarty et al. 2013). Community Management approaches are characterised by users having control over their systems (Lockwood 2004), after its completion, and have been applied in many countries, especially on rural areas. For instance, in rural areas in Panama there is a clear separation between the implementation of water projects and its effective management. Rural water systems are usually constructed by governmental institutions (e.g. Ministry of Health) but after its completion the management of the systems is from the responsibility of local citizens, normally through a water committee (Braithwaite 2009).

These approaches have been implemented worldwide as a way to ensure the democratisation of water and sanitation systems. However, the implementation approach and the tools given to communities are going to determine the success, or failure, of such experiences. This is particularly evident on rural areas. Often, when a top-down approach is adopted, meaning that a governmental institution implements a water supply or sanitation system in a specific rural area, the risk of failure at the long-term is high. Among the main causes for potential failure of these systems, assuming that they were initially well implemented, are the fact that local communities, which stay in charge for the system maintenance, lack adequate skills, education or even capital to ensure the accurate system functioning (Braithwaite 2009).

In this context, several issues emerge as key aspects to take into consideration when implementing socio-technical innovations related to water and sanitation systems: 1) the scaling issues to be considered; 2) the dimensions (and the accurate indicators) that should be monitored; 3) the viability of innovations; and, finally, 4) the broader political context where these innovations occur.

6.1. Scaling issues

'To ensure an effective transfer of knowledge, at which scale should it be done?' Local and/or at the level of national governments, non-governmental organizations, households (private sector). Or should it rely on an inter-sectorial and inter-institutional coordination at all levels?

A common aspect of all DESAFIO case studies was the spatial scale considered, usually at the local level. Relying on a bottom-up approach from the obtained results/outcomes and trying to extrapolate it to other systems, the implications of the several DESAFIO case studies can be organised when considering the wider spatial scale implementation of these socio-technical innovations. In this context, a core question from a policy perspective is to determine the optimal scale at which the several considered socio-technical innovations might be implemented, from an environmental, health, institutional and cultural perspective. From the several case studies, there were some examples that could not be applicable to all communities or even to wider spatial scales, such as the Communal Springs model on Baixada Fluminense (D2.3), due to a number of limiting factors, among others, availability of hydric resources, or quality of the water supplied. However, there were also some examples that could present a reliable solution for larger populations, like, for example, the Integrated Sanitation System (D3.2) and the SISAR/CE (D2.1, D3.1, D4.2).

Additionally, the temporal scale of the tested socio-technical innovations also play a role when evaluating its effectiveness. Some of the analysed innovations clearly play a short-term solution, in terms of social, economic, environmental or even technical perspective. This was, for example, the case of Communal Springs model on Baixada Fluminense (D2.3). Other innovations present a well-structured approach, designed and implemented with communities, which might ensure its long-term sustainability and possible reproducibility. Among these, the case of the Quilombolas communities (D4.1) can be pointed as an example.

6.2. Dimensions to be analysed: open issues

All six analytical dimensions defined by the DESAFIO project should be taken into consideration when planning and designing a socio-technical solution for the provision of WSS. As the success of the implementation of a WSS system depends on a wide range of factors, it could be counter-productive to neglect one or several dimensions when evaluating the long-term suitability of an alternative. As an example, cultural and educational issues were overlooked when implementing the Participative Generation of a Water Treatment System model (D4.1). It was not expected that residents in the Quilombola community would remain defecating outdoors and in rudimentary pits compromising the success of the installation of the water treatment system. Another example was the implementation of a billing system (economic-financial dimension), by the SISAR/CE model (D2.2), without auxiliary income generating projects and initially without a progressive water price table suitable for the local realm. As a result, residents would not pay for the service and some of the SISARs became financially unsound.

Likewise, evaluating the suitability for replication of socio-technical innovations needs a thorough analysis of all six dimensions. Otherwise, inaccurate conclusions can be drawn. The ecological-environmental dimension was the most neglected throughout the case studies' analysis. In some deliverables this dimension was completely overlooked (D2.2, D2.3) and in others only issues related to environmental sanitation were assessed (D2.1, D3.1, D4.2, D3.2, D4.3). The proper assessment of the analytical dimensions requires a prior and clear definition of the dimension that should be accessible to all project partners and clear ecological-environmental indicators provided beforehand. In face of the scarce ecological-environmental information available, the goals to relate "*i) point (urban) and diffuse (rural) source water pollution to the chemical status of surface waters; ii) the chemical status of surface waters to the ecological status of aquatic ecosystems, and iii) the ecological status of aquatic ecosystems to ecosystem functions, services and values, to assess the environmental, economic and welfare implications of stakeholder-defined WSS scenarios*", are yet to be accomplished as well as the goals to identify which ecosystem services were/will be affected as well as their ecological/economic value.

Methodological issues have also hindered a proper evaluation of the economic-financial constraints and opportunities. This dimension ought to evaluate the "*costs, effectiveness and/or benefits of WSS interventions"*, for which household surveys are highly applied. The 10 case studies gathered economic-financial data at the household level, but the indicators used are a) highly variable between case studies (Table A6), b) some were only qualitatively evaluated and c) a clear baseline situation for each case study is yet to be established. The information gathered so far is more appropriate for a descriptive analysis of the economic and financial characteristics.

An incomplete and/or imprecise set of indicators and an imprecise description of the '*criteria used to define the "zero point", the baseline, to evaluate the functioning and results of the innovation'* hinders the possibility to properly evaluate the innovations under study. The DESAFIO partners were asked to characterise the innovations according to some criteria and to evaluate the results against a baseline, however, seldom this criteria was clearly identified.

Regarding the comparison within studies, the DESAFIO Project suggested to compare the before and after implementation and/or compare the evaluated community with a control. Of the 10 case studies, 2 used control communities to evaluate the implementation: the SISAR/CE model (D4.2) and the Communal Springs model (D2.3). The Capacity Building model (D4.3) also proposes to compare communities within different types of water supply frameworks, but comparison is yet to be performed. Likewise, though the Integrated Sanitation System (D3.2) was implemented after the failure of the Condominial Sanitation System (D2.2) a straightforward comparison between the two models still needs further assessment. On a totally different approach, the Participative Generation of a Water Treatment System (D4.1) compared the "*participatory and dialogical process utilised in this study with that which is used by government institutions*", focusing the comparison at the policy-institutional level only. A good example of a comparison before and after the implementation is provided by the Echo-technological model (D2.4) which clearly presents results for the same indicators before and after.

Another issue that needs further discussion is the concept of vulnerability. A community might be vulnerable for a number of reasons: socially and culturally vulnerable, for instance, as a result of low education levels; economically vulnerable due to low average income; politically vulnerable as a result of institutional instability; ecological-environmentally vulnerable if, for instance, the region is exposed to environmental problems such as floods or even exposed to high levels of water contamination; and a community might even be vulnerable due to systematic health issues as a result, for instance, of low hygiene practices. Determining the vulnerability degree of a community is a vital departing issue to evaluate the key dimensions to be taken into account when designing and implementing alternative WSS solutions.

6.3. Viability of socio-technical innovations implementation

When considering the main factors that determine, or undermine, the success of socio-technical innovations it is fundamental to evaluate the underlying conditions where those innovations are going to be implemented. From the DESAFIO case studies it was possible to highlight three main key factors: social skills and/or awareness, political willingness and suitable economic-financial framework.

It is expected that an empowered community, through education and participation mechanisms, will take responsibility for the system and will be mobilised to find the optimal solutions for their region and to guarantee its long-term sustainability. The Capacity Building intervention case study (D4.3), in Argentina, was designed based on these principles, oriented to "*promote and strength the participation of the community and the social actors on the base of reinforcing the civil society to be the real agents changing their life quality*". Likewise, the Participative Generation of a Water Treatment case study (D4.1) was concerned in implementing a process where social groups were stimulated to "*actively participate in the research process*". These are successful examples. On the contrary, the Condominial Sanitation System (D2.2), which was based on the idea of sharing responsibilities between the State and the beneficiary, suffered from lack of proper articulation between the community and the public authorities and lack of user community awareness.

The political will to support the implementation of a WSS also plays a crucial role, even for bottom-up innovations. The Communal Springs' model (D2.3) is a good example. Though the community took total responsibility for system implementation and maintenance, serious health and environmental problems emerged. The community was not aware of the consequences of implementing such a technically vulnerable solution, and even when they were, the necessity for water supply overlapped the necessity to avoid possible negative consequences. Institutional support, either technical, educational, etc., could have prevented key problems. Top-down innovations, in turn, might become highly dependent on institutional stability and on the capacity for inter-sectorial and inter-institutional coordination. One of the obstacles to the success of the Condominial Sanitation System (D2.2) was the lack of inter-sectorial dialog, preventing the proper maintenance of the system.

A suitable economic-financial framework is also mandatory for all situations. For top-down implementations, the public authorities, or private-public partnerships, must guarantee that the necessary intervention funds are available, even if the community is

expected to contribute in some manner. For cases where financial sustainability depends on the implementation of a billing system, it must be guaranteed that all sectors of the community are capable of supporting the implemented tariffs. The SISAR/CE model, implemented in Ceará, Brazil, is an example of struggle to attain a feasible financial structure for system self-sustainability. Quite the reverse, was the attitude of the water supplier in Brazil responsible for the implementation of the Condominial Sanitation System (D2.2) which started charging for water tariffs before the system was completed.

6.4. Policy issues

The DESAFIO project used the social learning and empowerment as the conceptual driver to explore the potential for innovative and effective socio-technical systems to trigger a collaborative process between governmental institutions and local communities, which could contribute to the improvement of populations' well-being, especially on vulnerable communities. The question that arises in this scenario, and foreseen in the DESAFIO proposal, is actually '*how these can be harnessed to change policies, to develop new strategies and practical interventions, and to enhance policy learning'*, allowing for its translation into regional, state or even national politics.

The way these findings can be integrated into wider policies is the upcoming challenge that requires further investigation. The outcomes from the DESAFIO project have highlighted two main issues that have the power to drive decisions:

a) Political willingness
b) Broad approach focused on societal management

a) <u>Political willingness</u>

A key factor for the long-term sustainability of the socio-technical innovations, and especially for peri-urban or rural communities, is the capacity and interest for local or national institutions to continue providing support, even after the intervention is finalised (the so-called 'political willingness' covered in section 6.3). In some of the case studies covered by the DESAFIO project, there was a positive intention to guarantee the accompaniment of the innovations management (D2.1, D2.4, D3.1, D 3.2, D3.3, D4.2), mainly in cases where those interventions were aligned with broader national politics or programs for improving populations well-being. Conversely, there were also some situations that present a high risk for lack of interest in supporting some interventions, leaving their management to the local communities (D2.2, D2.3, D4.1), regardless it is a rural, peri-urban or urban system. This lack of support may be related to the inability of authorities to control the processes and management of the interventions. Among the reasons that can lead to these events can be pointed: the weak decentralised capacity (D2.3), difficulty to reach the communities (D4.1), or even the poor urban planning (D2.2).

b) Broad approach focused on societal management

The involvement and participation of local communities has emerged, also in line with previous experiences in other countries, like Panama (Braithwaite 2009), Bangladesh (Rahman and Jahan 1997), or Kenya (Harvey and Reed 2007), as a crucial issue that can determine the success or failure of the analysed socio-technical innovations. Community management systems have been faced as the predominant approach to be adopted to ensure sustainable water and sanitation system services and the MDGs attainment, especially to rural communities (Lockwood 2004). However, and as discussed in section 6.3, a number of factors can contribute to the fail of fully involvement of communities, which can consequently lead to the failure of the interventions (e.g. Moriarty et al. 2013). To guarantee its success, an accompaniment of the interventions has to be done, using flexible procedures and demonstrating the importance of the system maintenance, if necessary, creating an ownership sense. The next step would be to 'scaling up' the successful cases, ensuring the provision of services to a wider population.

7. Conclusions

Due to the nature and characteristics of the socio-technical innovations considered and to the socio-political situations in which each case study was embedded on, like system studied (rural, urban, peri-urban) or even democratisation processes stage, making of cross-comparisons among case studies can be a difficult and hard task. Even so, from the several case studies' methodological approach it was possible to find common issues that help to tackle the difficulties in ensuring the democratisation of water and sanitation services.

Firstly, the outcomes from most of the case studies suggest that the approach selected has been well designed, yet its implementation still demanded for further investments, especially for some of the dimensions covered by the DESAFIO project (e.g. the ecological-environmental dimension was sparsely covered in most of the case studies).

Secondly, there should be a consistent approach among case studies, ensuring that the selected indicators and metrics for the several dimensions are uniform among innovations evaluation. Recognising the need for specific indicators depending on the type, and extent, of innovation, an additional effort has to be done to ensure a common framework among case studies to enable cross comparisons and wider generalisations of results.

Thirdly, to guarantee a comprehensive evaluation of the innovations, a set of indicators, metrics and data should be available to allow sound cross-comparative assessments.

From these findings two major conclusions can be drawn: 1) the DESAFIO project can be regarded as a pilot project, which can be used as a starting point for further investigation and collaboration among innovations and teams; while 2) ensuring that a more consistent approach is applied to the case studies.

WATERLAT-GOBACIT Research Network

5th Floor Claremont Bridge Building, NE1 7RU Newcastle upon Tyne, United Kingdom
E-mail: redwaterlat@gmail.com – Web page: www.waterlat.org

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9. Appendix

Table A 1. Main features of recent (Historical) case studies.

DESAFIO systems	Case study			
	Historical			
	SISAR - Politico-Institucional Evaluation	Condominial Sanitation System (CS)	Communal Springs	Ecothecnological System
	D2.1	**D2.2**	**D2.3**	**D2.4**
Location	Brazil / Ceará	Brazil / Recife / Mustardinha (ZSSI)	Brazil / Rio Janeiro / Baixada Fluminense / Queimados - Jardim da fonte and Vila do Rosário	Colombia / Santiago de Cali / La Vorágine
Type of System				
Rural	X			
Peri-Urban			X	
Urban		X		X
Source of innovation	from above	from above	from below	from above
Extent of innovation	adapted	adapted	full	full
Management type				
Public companies	X	X		
Cooperatives				
Communities	X	X		X
Informal management			X	
Type of service	Water supply	Sanitation	Water supply	Water supply and sanitation
Type of actors	* public authority (SISAR/CAGECE's offices) * financial institution: KfW Bank (German) * local communities (community associations / resident operator / population)	* municipal authorities * local communities	* local communities	* public institutions * local communities
Served Population (no.)				
municipalities	2013: 130	1	1	1
communities	2013: 1 1	1 (ZSSI)	2	1
area		57 ha		
inhabitants	2013	1991: 13 000 2000: 19 000	Queimados: 5 000	1994: Residents: 240 Floating: between 3 600 and 4 700 per day
systems / dwellings / households	2013		2010: 21 springs identified	1994 households: 37
users	2013	1991: 13 000 2000: 19 000	Not known. Formal and informal water supply systems coexist	1994: Residents: 240 Floating: between 3 600 and 4 700 per day
users under analysis	36	1991: 13 000 2000: 19 000	Jardim da Fonte Spring - 300 Vila do Rosário Spring - ?	1994: Residents: 240 Floating: between 3 600 and 4 700 per day
Temporal scale of design and implementation of the innovation				
design	1980s	late 1980s	-----	1993
implementation	phase1: 1990s phase2: 2005 phase3:2011 phase4: under discussion	1993-1994	responds to needs	1995-1996

analysed time interval		1993-2000	2009-2010	1993-1997
Temporal scale(s) of the impact sought through the innovation				
long-term	X	X		X
medium-term				
short-term			X	
Key Agents				
planning	Public administration	Public administration	none	Municipal public institutions and R&D Institution
implementation	Public administration and Community	Community	Community	Community with financial support from municipal institutions
operation	Community	Community	Community	Public administration and Community
maintenance	Community	Public administration and Community	Community	Regional public entity and Community

Table A 2. Main features of current case studies.

DESAFIO systems	Case study		
	Current		
	SISAR-BME - Ethnographic Assessment	Integrated Sanitation System (IS)	Community Management
	D3.1	**D3.2**	**D3.3**
Location	Brazil / Ceará / Andreza and Arataca	Brazil / Recife / Mustardinha (ZSSI)	Colombia / Cauca / Sanatander de Quilichao / Mondomo
Type of System			
Rural	X		X
Peri-Urban			
Urban		X	
Source of innovation	from above	from above	from above
Extent of innovation	adapted	adapted	adapted
Management type			
Public companies	X	X	
Cooperatives			
Communities	X		X
Informal management			
Type of service	Water supply	Sanitation	Water supply
Type of actors	* public authority (SISAR/CAGECE's offices) * local communities (community associations / resident operator / population)	* public authority (all levels of government: municipal, provincial and federal and public service provider: CAMPESA) * local communities	* Private company * national and international NGOs * international cooperation organisms * national, departmental and municipal governments * Community: Board Administration Aqueduct, community leaders, educational institution, community support groups and Users * University (CINARA)
Served Population (no.)			
municipalities			1
communities	2		1
area		38 ha	
inhabitants	Andreza: 685 Arataca: 470	11093	3 400
systems / dwellings / households	Dwellings with SISAR accounts: Andreza: 245 Arataca: 144	Households: 3149	
users	Andreza: 685 Arataca: 470	11093	3 400
users under analysis	Andreza: 685 Arataca: 470	11093	3 400
Temporal scale of design and implementation of the innovation			
design	1980s	2000-2001	1991 - 1994
implementation	2013	2002	1995

analysed time interval	2013	2001-2004	1994-1995 2014
Temporal scale(s) of the impact sought through the innovation			
long-term	X	X	X
medium-term			
short-term			
Key Agents			
planning	Public administration and Community	Public administration and Community	Community, NGOs, associations; federal government, University
implementation	Public administration and Community	Public administration and Community	Community, NGOs, associations; federal government, University
operation	Community	Public administration and Community	Community, NGOs, associations; federal government, University
maintenance	Community	Public administration and Community	Municipal administration; Community

Table A. 3 Main features of intervention case studies.

DESAFIO systems	Case study **Intervention** Participative Generation of a Water Treatment	 SISAR/CE - Community oriented water and sanitation services	 Capacity Building for Monitoring Water Quality in Vulnerable Communities
	D4.1.	**D4.2**	**D4.3**
Location	Brazil / Minas Gerais / Lagedo / Quilombola territory	Brazil / Ceará / Cristais and Itapeim Complex (IC) (Itapeim, Andreza and Arataca)	Argentina / Santa Fé Province / Carcaraña (city), Coronda (city), La Chispa (town), San Francisco (town), Cañada de Gómez (city)
Type of System			
Rural	X	X	X
Peri-Urban			
Urban			X
Source of innovation	from above	from above	from above
Extent of innovation	adapted	adapted	full
Management type			
Public companies		X	X
Cooperatives			X
Communities	X	X	
Informal management			X
Type of service	Water supply	Water supply and sanitation	Water quality
Type of actors	* Social Movements, NGOs * federal government institutions * University * Community:	Integrated Rural Sanitation System of the state of Ceará (SISAR/CE) Community	* Researchers * Students * School teachers
Served Population (nr.)			
municipalities	1		4
communities	1	2	5
area	60 000 ha		
inhabitants	16 sociocultural communities		Carcaraña: 17 000 Coronda: 18 000 La Chispa: 352 San Francisco: 300 Cañada de Gómez: 30 000
systems / dwellings / households		Dwellings: Cristais- 235 and 36 infants ICx: 344 and 31 infants	
users		Dwellings: Cristais- 235 and 36 infants ICx: 344 and 31 infants	Public Water Company (ASSA): 60% of pop of 15 towns Water Supply Providers (Communes, Cooperatives and Associations): ? Private wells: ? Carcaraña: 17 000 (Cooperative) Coronda: 18 000 (Cooperative) La Chispa: 352 (Private Wells) San Francisco: 300 (Private Wells) Cañada de Gómez: 30 000 (ASSA)
users under analysis	Quilombola nuclei: 38 families	Dwellings: Cristais- 235 and 36 infants ICx: 344 and 31 infants	Initial Sampling - Students + Teachers: Carcaraña: 32 + 6; Coronda: 44+4; La Chispa & San Francisco: 29+3; Cañada de Gómez: 47+2
Temporal scale of design and implementation of the innovation			
design	2013	SISAR: 1995	2014 ?

implementation	2013-2015	Cristais: host to installation IC: 2013	2014 ?
analysed time interval	2013-2015	2013-2015	2014 ?
Temporal scale(s) of the impact sought through the innovation			
long-term	X	X	X
medium-term			
short-term			
Key Agents			
planning	Community, NGOs, associations; federal government, University	Public administration and Community	DESAFIO Researchers
implementation	Community, NGOs, associations; federal government, University	Public administration and Community	DESAFIO Researchers and School Community
operation	Community	SISAR/CE and Community	DESAFIO Researchers and School Community
maintenance	Community	SISAR/CE and Community	Community

Table A4. Indicators applied for political-institutional assessment per case-study.

indicators			**metric**	**case-studies**
institutional framework	institutions	current		D2.1, D2.2, D2.4, D3.1, D3.2, D3.3, D4.1, D4.2
		hypothesised		D2.3
	institutional role	current		D2.1, D2.4, D3.1, D3.2, D3.3, D4.1, D4.2
		hypothesised		D2.3
	changes introduced			D2.2
	impacts in the community			D2.2
	role of community	hypothesised		D2.3
political context				D2.1, D2.2, D3.2
inter-sectorial and inter-institutional cooperation	partnerships	public-private		D2.1, D2.2, D2.4, D3.2
		other partnerships		D2.2
	coordination with other essential services			D2.2
	institutional role			D2.4
	mechanisms			D3.2
community structure	inhabitants		inhabitants per dwelling	D2.3
life quality perception	access to water (water sources)	dwellings with network connection	% of answers / category	D2.3
		dwellings with artesian well	% of answers / category	D2.3
		no. of travels to fetch water / day or week	% of answers / category	D2.3
	water uses	type of use	% of answers / category	D2.3
	water quality perception	water quality	% of answers / category	D2.3
		water source preference		D2.3
	access to water perception	existent problems		D2.3
		most vulnerable areas/populations		D2.3
institutional perception	public authorities' service	community opinion		D2.3
	identification of water suppliers	infrastructure, equipment, water quality monitoring		D4.1
	waste sorting perception	responsible institutions		D4.3
	water quality perception	responsible institutions		D4.3
institutional willingness	municipalisation of water provision and sanitation	is it possible?		D2.3
		how, with which sources?		D2.3

	institutional awareness	use of springs and wells		D2.3
	possibility to substitute or complement systems			D2.3
institutional mobilization capability	new institutional mechanisms			D3.2
	institutional dialogical and participatory methods	meetings	presence/absence of public authorities	D4.1
		professionals training	presence/absence	D4.1
management model	guidelines			D3.3
	activities and organization	method used for infrastructure installation		D4.1
		community participation		D4.1

Table A5. Indicators applied for socio-political and cultural assessment per case-study.

indicators			**metric**	**case studies**
citizen-empowerment	institutional mobilization capability	mechanisms		D2.1, D3.1, D3.2, D4.1
			presence/absence	D2.1, D2.2, D3.1
			invitation to education activities	D3.2
		institutions		D3.2
		accompaniment	presence/absence	D3.1
		communication approach		D3.1
	community mobilization	organization capacity		D2.1
		persistence of activities (training, education, ...)		D2.1
		mobilization towards active participation in the implementation		D2.2
		mobilization towards other projects		D2.1
	social participation	discussion forums	attendees participation	D2.1
			% of attendees	D2.2, D2.4, D3.3
			no. of attendees	D3.1
			% of active participants	D2.4
			presence/absence	D3.1
			frequency	D3.1
			participatory appraisal activities	D4.1
		debated themes		D2.1, D2.2
		mechanisms		D2.1, D2.2, D2.4
		type of participation	% answers/ category	D3.3
		perception	mechanisms	D2.2, D3.2
			changes observed	D3.2
		funds collection		D2.1, D4.1
		participation in key events		D4.1
		degree of collective cooperation		D4.1
	community attitudes	expression of complaints, doubts and deliberations	presence/absence	D2.1, D3.1
			number of occurrences / type * year	D3.2
		information and communication		D2.1
		efficient fulfilment of requests	number of days to respond	D3.2
	institutional transparency perception			D2.1
community expectations	life quality			D2.2
		improvements	% of households / category	D4.2
	health			D2.2
	environment			D2.2
	economic-financial aspects			D2.2

	institutional aspects			D2.2
	social participation			D2.2
community structure	inhabitants		no. of inhabitants (per genre; total)	D2.2, D3.1
			average age	D3.1
life quality perception	access to water (water sources)	dwellings with network connection	% of answers / category	D2.3
			no. of dwellings with SISAR accounts	D3.1
		dwellings with artesian well	% of answers / category	D2.3
		no. of travels to fetch water / day or week (6 categories)	% of answers / category	D2.3
		type of water sources		D3.1
		water sources before the implementation		D3.2
		water market a part from the innovation model		D3.1
		access before the implementation (quality perception)		D3.2
		changes observed after implementation		D3.2
	access to sanitation	access before the implementation		D3.2
		changes observed after implementation		D3.2
		sanitation problems identification		D3.2
	water uses	type of use	% of answers / category	D2.3, D3.3, D4.2
			% of households / use	D4.2
	water quality perception	water quality	% of answers / category	D2.3, D3.3, D4.2
			% of category/source	D4.2
		water source preference	(descriptive)	D2.3, D3.1
			% of households/source	D4.2
			% answers / source	D4.3
		water related concerns	(descriptive)	D4.3
		water related concerns by each interviewed user and institution	% answers / category	D4.3
	water quantity perception	water quantity	% of answers / category	D3.3
		water consumption habits: quantity of water consumed per day	% answers / volume of water range group	D4.3
	access to water perception	existent problems	(descriptive)	D2.3
		most vulnerable areas/populations	(descriptive)	D2.3

	life quality before implementation		(descriptive)	D3.2
	hygiene practices	perception	% answers/ category	D3.2
		changes observed		D3.2
	public services' quality perception before implementation	urban cleaning services before		D3.2
		urban cleaning services changes		D3.2
		waste disposal services before		D3.2
		waste disposal services changes		D3.2
		urban drainage before		D3.2
		urban drainage changes		D3.2
		urban paving before		D3.2
		urban paving changes		D3.2
		health services before		D3.2
		health services changes		D3.2
		sanitation services before		D3.2
		sanitation services changes		D3.2
		sanitation maintenance before		D3.2
		sanitation maintenance changes		D3.2
organizational model	service administration and management	key actors		D2.4
		services per key actors		D2.4
		type of water supply infrastructures built		D3.1
		type of modifications to water supply structure		D3.1
		legal / illegal modifications to structure		D3.1
	service administration perception	service administration (water supply, sanitation, WWT, maintenance..)	% of answers / category	D2.4, D3.3
			(descriptive)	D3.1, D3.2, D4.2
		institutional structure		D3.3
		users	number	D3.3
		actors		D3.3
		quality of water supply service		D3.1
		identification of water supplier	% answers per water supplier	D4.3
		waste disposal management :: garbage collection	% answers / no. of times.week	D4.3
		waste disposal management :: solid waste disposal location within the city	% answers / type of site	D4.3

		jobs related to waste sorting and sell in the city	% answers / category	D4.3
		available information (official, non-official mediums)	sufficient / non-sufficient	D3.1
	billing system perception	water supply	% of answers / category	D2.4
		water sanitation	% of answers / category	D2.4
		water supply tariffs	tariff / user category (cost/month; cost/m^3)	D2.4
			quality	D4.2
			tariffs suitability	D3.3
			interference with family total income	D4.2
		electricity	% of answers / category	D2.4
		billing information	sufficient / non-sufficient	D3.1
		progressive water price table knows how to use / does not know		D4.2
infrastructure and technical objects	available information and training			D3.1
	users' intervention	type of illicit interventions		D3.1
		hydrometer functioning (knows how to use / does not know)		D4.2

Table A6. Indicators applied for economic-financial assessment per case study

indicators			**metric**	**case studies**
intervention	costs		difference between the adapted and the original model (%)	D2.2
		damages		D3.2
		relocations		D3.2
		infrastructures built		D3.2, D4.1
		total		D3.2
		total per inhabitant		D3.2
	key actors		key actors	D2.1, D2.2, D3.1, D3.3
	invested value per governmental institution			D3.2
maintenance	billing system			D2.2
		water price table	criteria	D2.4
			presence/absence of progressive table	D3.1
		tariffs	% supported by the community	D2.2
			% answers / average cost of water per month range	D4.3
		payment	regular / non-regular	D3.1
		coercive mechanisms		D3.1
		payment model		D3.2, D3.3
		fines		D3.3
		responsible institution for electricity bills' payment		D3.1
	other financial mechanisms	type	(descriptive)	D2.2
community structure	inhabitants		inhabitants per dwelling	D2.2
			% no. of residents / household	D2.4, D3.3
	time living in the community		% of residents per time interval	D2.4
	housing tenure	rented, owned, other	% of households	D2.4, D3.3
	housing per type of activity	residential, commercial, service, etc.	% of households / type of activity	D2.4, D3.3
	household building material		% households / type of material	D2.4, D3.3
	income		% households / average income category	D2.4, D3.3
	occupation			D3.3
life quality perception	access to water (water sources)	dwellings with network connection	% of responses / category	D2.3
		dwellings with artesian well	% of responses / category	D2.3

		no. of travels to fetch water / day or week (6 categories)	% of responses / category	D2.3
	water uses	type of use	% of responses / category	D2.3
	water quality perception	water quality	% of responses / category	D2.3
		water source preference		D2.3
			% answers / source	D4.3
	access to water perception	existent problems		D2.3
		most vulnerable areas/populations		D2.3
	economic accessbility to water perception	cheap, reasonable, expensive	% of households / category	D4.2
			% of households / category / income	D4.2
	access to water costs		% of households with costs associated with water supply	D4.2
			% of households with costs / income	D4.2
			amount paid per cubic meter of water (R $ / m^3)	D4.2
			amount paid per inhabitant per month (R $ / inhab.month)	D4.2
water markets	shipments, water supply network	before implementation		D3.1

Table A7. Indicators applied for techno-infrastructural/operational assessment per case study.

indicators			metric	case studies
implementation	adoption of new technical objects	water meter, monthly bill		D2.1, D3.1
	infrastructure	model incorporated all the simplified elements of the original model		D2.2
		type		D2.4, D3.1, D3.3
		coverage	Total number of connections	D2.1
			area	D2.2, D2.4
			% of population	D3.2
		changes		D2.4
	connection to network		% of households connected	D2.4
			% of households with rainwater connection to network	D2.4
	implementation time			D2.2
	key actors			D2.2, D2.4
	population served		% of households with service	D2.2
			difference between population with sanitation before and after the implementation (%)	D2.2
	act of affiliation		presence/absence	D3.1
		key actors		D3.1
		information provided		D3.1
maintenance	key actors			D2.1, D2.2, D2.4
	indicators of infrastructure maintenance	garbage, rocks, etc. blocking the network		D2.2
		waste disposal	% of households / type of waste.destiny	D2.4
			% of population that separates solid waste disposal	D3.3
			% of solid waste per type of destiny	D3.3
			% households / type of waste.type of destiny	D2.4
			% households / type of disposal	D4.3
			% households / type of location	D4.3
		sewage	% of population per type of sewage disposal	D3.3
			% of community perception per type of water destiny	D3.3
	key actors			D2.1, D2.4, D3.1, D3.3

operational management plan	institutional support			D2.1
	roles and responsibilities			D2.4
	billing system	water price table criteria		D2.4
	mechanisms			D3.1
community structure	inhabitants		inhabitants per dwelling	D2.3
life quality perception	access to water (water sources)	dwellings with network connection	% of answers / category	D2.3
		dwellings with artesian well	% of answers / category	D2.3
		no. of travels to fetch water / day or week (6 categories)	% of answers / category	D2.3
		types of water sources in use		D3.1, D3.3
			% answers / water source	D4.1, D4.3
		water collecting points at home	% of households with water collecting points	D4.2
		household hydraulic changes	% of households with hydraulic changes after the innovation implementation	D4.2
		water supply infrastructures	presence/absence	D4.2
		intermittence of water supply service	% of interviewed users / category / source	D4.2
			% of occurrences / category	D4.2
		time spent fetching water (with and without displacement)	% of households	D4.2
		time spent fetching water (< 5 min, 5 to 10 min, 11 to 30 min, more than 30 min)	% of households	D4.2
		family member (Women, Men, Young, Toddlers)	% of households / family member	D4.2
	water uses	type of use	% of answers / category	D2.3
		type of domestic uses per water source	% use / source	D2.4
		type of domestic use per type wastewater system	% households / use.system	D2.4
	water quality perception	water quality	% of answers / category	D2.3, D2.4
		water source preference		D2.3
	water quantity perception	water quantity	% of answers / category	D2.4
		existent problems		D2.3

	access to water perception	most vulnerable areas/populations		D2.3
	knowledge regarding wastewater destiny		% of population	D2.4
	knowledge regarding WTP location		% of population	D2.4
	access to sanitation	bathroom	% of households / category	D4.2
			% of category in use / income	D4.2
			% of category in use / education level	D4.2
			% of category in use / age of household head	D4.2
			% of category in use / professional occupation	D4.2
water quality	community vulnerability	Water Quality for human consumption Risk index(IRCA)		D2.4
		Supply Risk Index (IRABA)		D2.4
	thermotolerant coliforms		presence -absence / 100 ml	D4.2
funds	fund raising	mechanisms		D2.4
		institutions		D2.4
consumption habits	water quantity		% of accounts with monthly water consumptions higher than 10 m^3	D3.1
			average monthly consumption per dwelling (m^3)	D3.1
		water consumption per capita	L/ inhab.day	D4.2
Solution selection	turbidity removal techniques	pH, turbidity, colour, hardness, alkalinity, temperature, total coliforms and *E. coli*		D4.1
	disinfection processes	total coliforms, *E. coli*	NMP/100 mL	D4.1
Solution evaluation	impacts	positive and negative impacts, foreseen and unforeseen, direct and indirect	(Discussion forums: Impact flowcharts)	D4.1
	changes observed	changes that occur during the period analysed	(Discussion forums: Seasonal calendars)	D4.1
	attitudes and degree of cooperation changes	qualitative measurements of less tangible changes	efficiency of meetings, amount of resources mobilised, internal communication etc. (Discussion forums: Scales)	D4.1

Table A8. Indicators applied for health assessment per case study

indicators			**metric**	**case studies**
water quality	waterborne diseases	before implementation	presence/absence	D2.2
		after implementation	presence/absence	D2.2
community structure	inhabitants		inhabitants per dwelling	D2.3
life quality perception	access to water (water sources)	dwellings with network connection	% of answers / category	D2.3
		dwellings with artesian well	% of answers / category	D2.3
		no. of travels to fetch water / day or week (6 categories)	% of answers / category	D2.3
	water uses	type of use	% of answers / category	D2.3
	water quality perception	water quality	% of answers / category	D2.3
		water source preference		D2.3
			% answers / source	D4.3
	access to water perception	existent problems		D2.3
		most vulnerable areas/populations		D2.3
water quality	waterborne diseases		no. of cases / year	D2.4
		before implementation	presence/absence	D3.2
		eradication approach		D3.2
		type		D3.3, D4.1
		prevalence of diarrhoea	% of children under 5 years old	D4.2
		intestinal parasites	% of children under 5 years old / parasite	D4.2
			% of answers / type of disease	D4.3
			% of answers / no. of known diseases	D4.3
	thermotolerant coliforms		average of CFU/100 ml per analysis	D4.2
			% of water analyses with *E. coli* out of standard	D4.2
			presence-absence / source / community	D4.2
	community vulnerability	Water quality risk index for water consumption (IRCA)		D2.4
		Supply risk index (IRABA)		D2.4
	water supply treatment		presence/absence	D3.3
hygiene practices	water usage		% of residents / hygiene practice	D2.4
		bath, laundry, dishwash	% answers / category	D3.3

			average volume water (m^3/month)	D4.2
			average no. of baths / day	D4.2
		hands wash		D3.3
		drink, cook	average volume water per category (l/per capita/day)	D4.2
health indicators	weight / height		comparison with WHO targets for children under 5 (per sex, per age)	D4.2
	weight, height, blood pressure, blood glucose and urine, physical activity and cholesterol			D4.3

Table A9. Indicators applied for ecological-environmental assessment per case study.

indicators			**metric**	**case studies**
environmental commitment	environmental education		presence/absence	D2.1, D2.2, D3.1, D3.2
	environmental awareness		presence/absence	D2.2, D3.2
	environmental conservation projects			D3.3
community structure	inhabitants		inhabitants per dwelling	D2.3
life quality perception	access to water (water sources)	dwellings with network connection	% of answers / category	D2.3, D3.3
		dwellings with artesian well	% of answers / category	D2.3
		no. of travels to fetch water / day or week (6 categories)	% of answers / category	D2.3
	water uses	type of use	% of answers / category	D2.3
	access to water perception	existent problems		D2.3
		most vulnerable areas/populations		D2.3
	water supply sources ' perception	community awareness	% of population that acknowledges the aqueduct as a water source	D3.3
biophysical characterisation	basin area			D2.4, D4.3
	topographic characteristics			D2.4, D4.3
	hydrologic characteristics			D2.4, D4.3
	climatic characteristics			D4.3
	geologic characteristics			D4.3
	land use		% area / type of land use	D2.4
			type of land use	D3.3, D4.3
			land use change	D3.3

ecosystems' characterisation	type of ecosystem		area / type of ecosystem	D2.4
ecosystem services	community perception			D2.4
	community awareness			D2.4
	beneficial activities			D2.4
	type of ecosystem services 'used'			D2.4
	research		no. of research documents / type of publication	D2.4
			no. of research documents / institution	D2.4
environmental perception	perception of pollution sources	solid waste, tourism, etc. / Very high, high, total	% answers / type of impact.category	D2.4
				D3.3
	water quality perception	current river status (good, regular, bad)	% answers / category	D2.4
		in ten years (better, without change, worse)	% answers / category	D2.4
		water quality	% of answers / category	D2.3
		water quality perception (upstream basin)	in the coming years	D3.3
		water source preference		D2.3
	water supply sources ' perception	source status		D3.3, D4.2
		community awareness		D4.2
environmental conflicts	type of environmental conflicts		type of press articles (1980-2014)	D2.4
			no. of press articles (1980-2014)	D2.4
	key actors			D3.3
environmental conditions	location and quality of waterways			D4.1
	activities carried out by locals in the micro-basin			D4.1
	disposal locations of solid waste residue and residual waters			D4.1
		garbage collection	no. of times / week	D4.3
environmental problems	floods			D4.3
	erosion			D4.3
	access to water			D4.3
	water-related health problems			D4.3
	biodiversity loss			D4.3
	environmental policy gaps			D4.3

Original report cover – Article 2

Cross Comparative Analysis of Country Practices within the Latin American context

Work Package 5 Report
(Deliverable 5.2)

Author

José Esteban Castro
Newcastle University

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Coordinator's Address: 5th Floor Claremont Bridge Building, NE1 7RU Newcastle upon Tyne, United Kingdom
E-mail us here – DESAFIO'S Website

Article 2

Cross Comparative Analysis of Country Practices within the Latin American context

Jose Esteban Castro[2]
Newcastle University

Introduction

DESAFIO's ten case studies cover a range of experiences with socio-technical innovations designed to democratize politics, management, and access in the field of essential water and sanitation services (WSS) that have been implemented in Brazil, Colombia, and Argentina over a time span extending over several decades. The Cross Comparative Analysis of Case Studies Report (Pinto et. al., 2015) has addressed in detail the main characteristics of the ten case studies, covering the project's six analytical dimensions, and systematizing key findings and results in relation to the original research questions that guided the project.

The main objective of this particular report is to present an updated overview of the situation of WSS in Latin America and the Caribbean (LA&C), with emphasis on the situation affecting the three countries participating in the study, and to discuss key project findings that are particularly relevant in the light of this situation.

It is worth highlighting here that Brazil has been the main focus of DESAFIO, as the original call for proposals asked for research on "social innovation for vulnerable populations […] in the context of the Brazilian experience" (European Commission, 2011: 23). As a result, seven out of our ten case studies focused on Brazil, and were conducted by four Brazilian partners. However, to enhance our learning about experiences of democratization in the field of WSS we also included two cases from Colombia and one from Argentina. This proved to be an excellent approach, and as this report argues, the resulting project findings are relevant for LA&C as a whole. These findings may also contribute to policy design and implementation in the WSS sector in other regions facing similar challenges.

To help focusing on the topic, it is also useful to revisit here DESAFIO's key research questions, which guided the case studies and our analysis:

> 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 [water and sanitation

[2] E-mail: esteban.castro@ncl.ac.uk.

> services] 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)

As stated in our original project proposal, our approach was based on several assumptions, which also provide the framework for the analysis presented in this report:

> We argue that the main challenges facing the international community in this area are not merely technical or environmental, but are rather grounded on and conditioned by economic, socio-political, cultural and policy-institutional processes. Therefore, what is required is the development of appropriate and innovative socio-technical interventions, grounded on the principles of substantive democracy and citizenship, to facilitate the involvement of users in the identification of their problems and in the design, implementation and monitoring of socio-technical solutions. This is needed to enable the relevant actors, and most particularly local communities and governments, to achieve efficacy and effectiveness, as well as efficiency, in the organization of universally available and safe essential WSS. […] We argue that [the] deficiencies [in the provision of adequate 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. Rather, the main causes for these and other unacceptable conditions -that the current development targets aim to reduce and eventually eradicate- are mainly of a socio-political, cultural, and policy-institutional nature. 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 (DESAFIO (2013: 3).

In this connection, owing to the nature of the problem studied DESAFIO had a strong interdisciplinary focus that involved technical dimensions, particularly with contributions from sanitary engineering, public health, and environmental sciences. However, DESAFIO was a project within FP7's Cooperation Theme 8 "Socio-economic Sciences and Humanities", and therefore the theoretical framework was informed by contributions from critical social science, most particularly urban political ecology, critical geography, and sociology. Departing from one of the key principles of political ecology, we argue that the causes of the extreme inequalities suffered by vulnerable populations, and the potential solutions that may help us eradicate these inequalities, are not primarily technical, but are rather fundamentally political in nature (e.g. Swyngedouw et. al., 2002; Castro, 2006). A very rewarding outcome of our research has been that many of the technical specialists consulted and interviewed during the research, particularly engineers and other experts that have been at the forefront of managing WSS in the

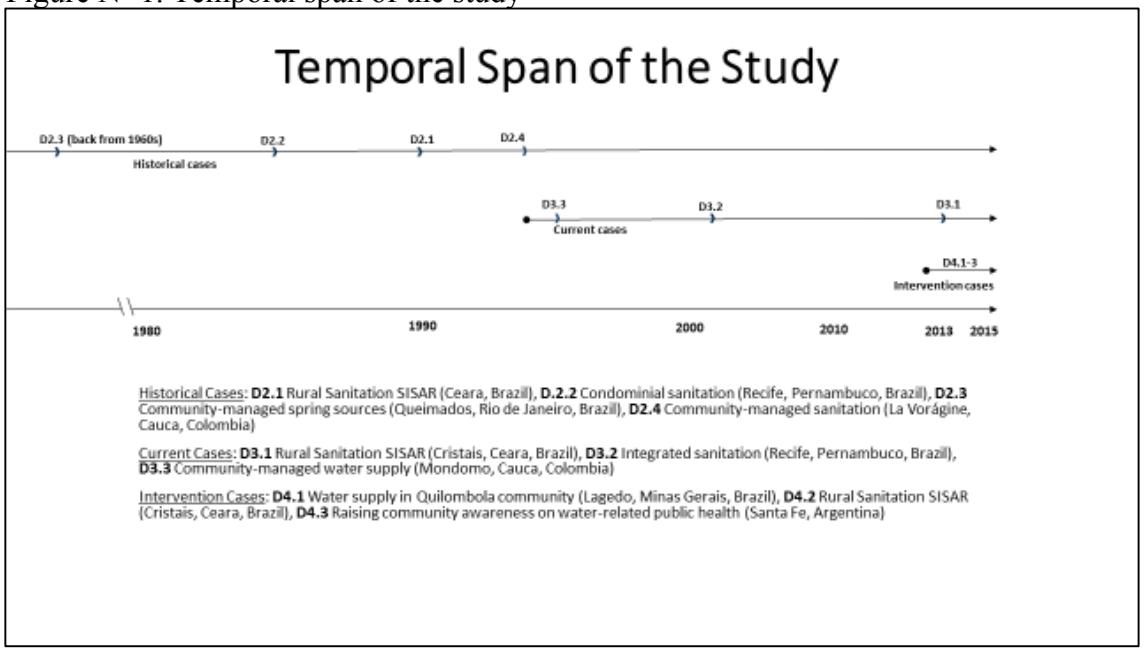
challenging circumstances affecting vulnerable communities, have reinforced this message: the main problems, and their potential solutions, are fundamentally political (e.g. Melo [JC], 2014, 2015; Miranda Neto, 2013, 2014, 2015; Montenegro, 2013, 2015a 2015b).

The First Section of the report examines the recent experiences that took place in LA&C in relation to political processes and the corresponding policy and institutional reforms introduced in the WSS sector that have been key conditioning factors for the emergence and implementation of the socio-technical innovations under study. We look first at the overall context in LA&C as a region, and then address the situation in Argentina, Brazil, and Colombia. The Second Section discusses the key project findings, along the lines of the project's research questions, and their relevance for the region and the individual countries. The Conclusions provide a brief summary of the key points.

Achievements and challenges facing the democratization of essential WSS in LA&C: politics, institutional reforms, and actual results

As mentioned before, DESAFIO's case studies addressed a range of socio-technical innovations designed to democratize the politics and management of WSS implemented in Argentina, Brazil and Colombia over several decades. These cases include from community-organized and managed spring water sources in the Rio de Janeiro Metropolitan Area (RJMA) dating back at least to the 1960s, to interventions implemented during the period of the research (2013-2015). Figure N^{o} 1 illustrates the temporal distribution of our ten case studies.

Figure N^{o} 1. Temporal span of the study



In practice, our focus was centred on the period beginning in the 1980s, when the bulk of our cases are concentrated. This is a significant period, as the 1980s witnessed a radical departure from the past in several aspects concerned with the provision of essential public services at the international level. In this period, there were introduced far-reaching transformations in the role of the State in relation to the organization, provision and regulation of essential services, with high impacts on vulnerable populations, a matter that has been the object of an extensive literature. We have discussed these transformations in more detail elsewhere in this project (Castro, 2015), and therefore will only revisit here some key issues that are relevant for this report.

Among the most influential processes that need to be mentioned, the 1980s saw the introduction of radical reforms, broadly termed "neoliberal" or "neoprivatist", which prompted the subordination of democratic political processes to the interests of globalized, powerful financial markets (Stiglitz, 2002). One of the main manifestations of these reforms in the sector of WSS was the de- and re-regulation of services, and the transfer of these services, most of which were in public hands, to a wide range of "private" actors, from Non-Governmental Organizations (NGOs) and religious charities, to community organizations, or to private businesses in cases that were deemed to be commercially attractive. This neoliberal project was reinforced by a strong strand of neoconservative politics that became extremely influential in the United States and Great Britain during the 1980s, which attacked the notion that access to essential services was a social right of citizenship or that these services constituted public goods that should be outside the market. Neoconservative thinking postulates that the State should no longer take responsibility for these services and that citizens themselves should take responsibility to provide for themselves and be either able to obtain the goods and services they need, including WSS, in the market place or, in the case of poor communities, fund the construction and long-term maintenance of the systems themselves by providing financial resources, raw materials and labour. It is important to differentiate here between long-standing traditions based on principles of solidarity, reciprocity, self-help, autonomy, that in Latin America can be traced back to the indigenous cultures that pre-existed colonization and the neoliberal/neoconservative project. These long-standing traditions are very much alive in Latin American popular culture, and have been reinforced by the role played by progressive religious groups, NGOs, and other organizations at least since the 1960s.[3] Although the neoliberal and neoconservative project is based on principles and objectives that are odds with these traditions of solidarity and reciprocity, it has often benefitted from the predisposition of poor communities to find solutions by themselves, especially in the absence of State intervention to tackle existing inequalities. As a result, often the old traditions of solidarity and reciprocity became entangled with the policies promoted by the neoliberal/neoconservative project that sought to free the State from responsibility to provide essential services and transfer this responsibility to the communities themselves.

In the 1980s, these transfers of the responsibility for essential WSS to any actor outside the State, including poor communities, was called "privatization", a term that in the 1990s would be reserved more precisely to the transfer of WSS to private, mostly

[3] See a synthetic reference to these traditions, including relevant literature, in, "Social participation from below" (in Spanish), Castro (2012b), pp. 144-149.

multinational, water monopolies (Castro, 2006). However, reflecting on this all-encompassing definition of "privatization" of the 1980s it is very relevant to understand the context of the socio-technical innovations under study, as several of them were designed and implemented during this period. In fact, this neoliberal agenda remains highly influential, and, to different degrees and in a diversity of ways, continues to be the dominant framework for public policy in the sector of essential services. For example, Colombia one of the countries included in the study now forms part of the Pacific Alliance of LA&C countries that has formally adopted the neoliberal approach for the provision of essential services (see more details in Section 1.4 of the report). Moreover, the neoliberal agenda has retained considerable influence even in countries like Argentina and Brazil, also addressed in the study, where since 2003 the governments introduced radical reforms to counter some of the worst impacts of neoliberal policies on the most vulnerable sectors of the population. This is because the neoliberal reforms of the 1990s have been extremely successful in erasing the notions that essential services like WSS constitute a public good or a social right that must be universally available independently of the capacity of payment of the users. Thus, many public-sector service providers now operate as commercial companies whose primary objective is to make "profit" rather than delivering a universal public service. This has become a major obstacle for achieving the universalization of essential services like WSS, as a large share of the unserved population is also unable to afford the cost of these services (Castro, 2012a).

Another important reform attempt introduced in this period was the "decentralization" of the State. "Decentralization" in fact was in the agenda of different social actors, from left-wing sectors seeking the democratization of the State to the international financial institutions (IFIs), notoriously the World Bank, the International Monetary Fund and the aid agencies of the United States and Europe that pursued the neoliberal agenda (Coraggio, 1991). An important objective of decentralization from the perspective of those seeking to advance the process of democratization was to bring governments and providers of essential public services closer to the users and make them more accountable to the democratic control of the citizenry. In Europe, the principles of decentralization as a democratizing force were laid out in the European Charter of Local Self-Government (Council of Europe, 1985). However, with hindsight, despite the advanced democratic principles of the European Charter the progress of the democratization process in Europe has been less satisfactory than expected (Mokre and Riekmann 2007). In developing countries, including the LA&C region, the situation has been even more difficult. Effective, truly democratic decentralization, involves not only the transfer of responsibility from central to local and regional governments, but more importantly requires the allocation of sufficient financial and human resources to make decentralized decision making and implementation viable and democratically accountable, most particularly in relation to the provision of essential public services in areas previously unserved or poorly served (FAO, 2004: 8-9). The evidence shows that this kind of decentralization has seldom taken place, and rather decentralization has often served as a complementary measure of neoliberal programmes to dismantle the State and transfer responsibility for essential services to other actors, particularly private businesses. The neoliberal objectives were clearly laid out by the IFIs during the 1990s, as in the following example:

> Private participation offers enormous potential to improve the efficiency of infrastructure services, extend their delivery to the poor, and relieve pressure on public budgets that have long been the only source of infrastructure finance. Encouraging more private involvement requires that governments change their role –no longer directly providing infrastructure services but mastering the new business of fostering competition among private providers, regulating where competition is weak, and supporting the private sector more generally. […] The Bank Group needs to maximize its leverage, concentrating on activities that produce systemic reform, catalyze private involvement, and expand private investment. […] Special attention needs to be given to IRDB and IDA lending to ensure that it facilitates private involvement in infrastructure by focusing on: public sector actions to strengthen the enabling environment for the private sector an promote systemic reform, activities to prepare enterprises for privatization or concessioning, and financing mechanisms to leverage private funding […] (World Bank, 1998: 1-2).[4]

Decentralization, together with de-regulation, were part of the systemic reforms promoted by the World Bank and other IFIs in the 1990s to "prepare enterprises for privatization or concessioning" to private companies. In relation to WSS, decentralization in LA&C took the form of a breakup of the monopoly structures created by the State during the 20th Century for the provision of these essential services, and the transfer of responsibility for these and other basic services to regional or local governments (Castro, 2004: 7-10). However, too often the decentralization of responsibilities was not accompanied by a transfer of the resources needed for local governments to fulfil the new role, which provoked a crisis in the provision of WSS, often leading to the dismantling of physical infrastructure and the loss of the specialized workforce (see for instance, Azpiazu et. al., 2014 for Argentina, a flagship country for these policies during the period under study; Costa, 1994, 2003, and Rezende and Heller, 2008, for Brazil). This neoliberal decentralization agenda became dominant, though the social sectors that sought decentralization as a vehicle to democratize the State continued their struggle and succeeded to protect public services in certain areas (see for example the reference to the experience of ASSEMAE in Brazil in Castro, 2004: 10) or even managed to use, consciously or not, some aspects of the neoliberal reforms to foster democratic objectives. There is evidence of these complex interrelations between formal neoliberal policies and actual practices in the ground in some of the experiences studied in DESAFIO.

Finally, another important element that played a central role in the transformations introduced in this period was the debate about the need for "appropriate technologies", originated in the critique of conventional development programmes and mainstream economic thinking. Among the most influential of these critics was Ernst

[4] As mentioned earlier, although it has been argued that this neoliberal agenda would have been abandoned, it continues to inform mainstream public policy internationally. For an example directly relevant to this report, see the almost identical approach currently adopted by the countries of the Pacific Alliance, as discussed in Section 1.4 in this report, especially the reference to CAF (2015).

Friedrich Schumacher, who in his work Small is Beautiful postulated the need for "small-scale technology", "non-violent technology", "technology with a human face", "intermediate technology", technology that is "simpler, cheaper, and freer than the technology of the rich", "self-help technology", "democratic or people's technology to which everybody can gain admittance", etc. (Schumacher, 1973). Therefore, the notion of appropriate technology came to refer to technologies that are small in scale and appropriate to local contexts as they seek to tap local sources of raw materials, energy, and labour, and that are simple enough and affordable to make them widely available, involving local communities directly in their management and maintenance, and giving the poor access to benefits that were before reserved to the rich and powerful. Several of DESAFIO's case studies focus on socio-technical innovations clearly influenced to some extent by this approach, most particularly the Condominial Sanitation system (Castro and Ferreira, 2015a), the Integrated Rural Sanitation System (SISAR) (Freitas et al., 2015; Brown, 2015; Passos et. al., 2015; Cortez, 2015; Alves, 2015; Melo [CVS], 2015; Sobreira, 2015), both in Brazil, and the community-managed WSS in Colombia (Peña et. al., 2015,b). However, within the prevailing neoliberal and neoconservative framework of the 1980s and 1990s, these arguments for small, context-sensitive, and locally appropriate technologies became often entangled with, if not incorporated as part of, the agenda to free the State from the responsibility to provide essential services to the population. In the extreme, governments that, whether out of conviction, under obligation, or because it seemed to be the only alternative available, found themselves implementing neoliberal reforms in the WSS sector since the 1980s, often became attracted by the "low cost" aspect of these technologies, most particularly in relation to the provision of essential services to the poor and very poor sectors of the population. This particular understanding of the "appropriate technology" approach often led to the design and implementation of policies that 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", who tend to be located in irregular, vulnerable urban and rural areas. This is not, however, a black and white picture and, as discussed later, in practice we find that these processes evolved over time in diverse forms and with often diverging results. Several of the experiences studied in DESAFIO provided excellent findings that contribute to improve our understanding of the actual impacts of those reforms and, more importantly, of the obstacles and opportunities that we still face in the process of democratization of the politics and managements of WSS. We come back to some of these aspects later in the document, but let us now move to the present and examine the context of DESAFIO's case studies in the light of the debate about the Millennium Development Goals (MDGs).

The situation of WSS in Latin America and the Caribbean

According to the latest official reports on the world's progress towards meeting the MDGs, the LA&C region is well ahead of the game in comparison with most other developing regions. The target for drinking water, according to these reports, was met ahead of time and surpassed, with 95% of the population having now access to an "improved drinking water source", an increase of 10 percentage points since 1990 when

only 85% of the population had access (UN, 2015a: 58; see also WHO-UNICEF, 2014). Although the sanitation target was missed (it was missed worldwide), considerable progress was made and 83% of the region's population has now access to "an improved sanitation facility", up from 67% in 1990 (UN, 2015a: 59; see also WHO-UNICEF, 2014).

However, it is widely accepted that the recognition of the progress made must not obscure the fact that these official figures must be taken with much caution. To start, in relation to drinking water, 11 countries of the region did not meet the targets, and in Haiti the situation continues to be extreme with only 58% of the population having access to "safe drinking water" (ECLAC, 2015a: 65). In addition, as already anticipated by previous reports, looking beyond the quantitative aspects of coverage, the evidence suggests that there exist many difficult problems with the quality of the services provided. For instance, 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, 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). The report adds that "[a]n improved water source (piped water, public tap/standpost, tubewell/borehole, protected dug well, protected spring, rainwater) can be safely managed" (op. cit.), which reinstates previous warnings about the fact that "improved drinking-water sources" are often not safe for human consumption. In fact, a recent study cited by the report suggests that "10% of improved sources may be 'high' risk" owing to faecal contamination (WHO-UNICEF, 2014: 42).

Actually, there is scant reliable information to ascertain what percentage of the population has access to safe drinking water in developing countries, and the LA&C region is not an exception. In a previous report it was indicated that around 52 million people in LA&C (or around 9% of the total population) get their drinking water through systems defined as "easy access" (i.e. open dug well, water trucks, superficial streams) which generally imply higher health risks (WHO, 2010). This situation is unlikely to have improved significantly by now, and there are reasons to believe that in certain areas it may well have worsened, as discussed later. The safety of drinking water received by the large part of the population that has formal access to the system deemed safest, piped water, must also be questioned. In LA&C there is a pattern of low quality of the water services offered, which is often characterised by intermittent service, low pressure and high water losses, problems that compromise the quality of the water that arrives at the individual households. An earlier study estimated that around 220 million people in LA&C (60% of the population being served) do not have continuous access to safe drinking water (Rojas et. al., 2007), again a situation that is unlikely to have improved since that study and that as discussed later in certain areas has been worsening.

An indicator of the prevailing situation with the access to safe drinking water is the dramatic increase in bottled water consumption, led in LA&C by Mexico (the world's leading country in per capita bottled water consumption, according to a number of industry reports; e.g.: Aguilar, 2014) followed by the three countries involved in this study, Argentina, Brazil, and Colombia. Although the reasons for consuming bottled

water are wide ranging, international studies show that a key trigger is the perception that tap water is unsafe (e.g. Jaffe and Newman, 2012). This has been demonstrated to be a myth in developed countries, where bottled water consumption is unjustified on safety grounds (e.g. Opel, 1999; Wilk, 2006). However, in LA&C, and developing countries at large, the safety of piped water is often compromised, which leads to the consumption of bottled water and other well-known alternatives (from industrialized soft drinks to the thriving business of poorly or seldom regulated street water vending), which also has a significant negative economic impact specially on the poorer sectors. It also reinforces the public perception that bottled water is safer although this is often not the case (see for instance Queiroz, 2011, for the case of Brazil; Pacheco-Vega, 2015, for the case of Mexico). This is a highly problematic area seldom considered in the official reports about the progress made towards the MDGs or even about the new Sustainable Development Goals (SDGs) approved by the UN on 25 September 2015 (UN, 2015b). However, the very high consumption of bottled water in LA&C is certainly an indicator of several worrying processes, particularly the fact that even the "improved drinking-water sources" are too often unsafe for human consumption and that there is a widespread distrust in the public provision of water services. This is also alarming, because the public perception that bottled water is safer has been also demonstrated to be problematic, not least because of the lack of proper regulation and safety control over much of the bottled water sold in LA&C. We need to add here that the prevailing distrust in publicly delivered water is a significant problem that has been worsened by the politics and public policies prevailing in the water and sanitation sector (WSS) since the late 1980s, which we address in more detail in other documents. Regrettably, the politics of water continues to be a no-go area in the official discussions about the MDGs and the forthcoming SDGs, given that these discussions reduce their considerations mostly to technical aspects.

On this connection, the situation of inequality between urban and rural areas remains significant. In 2010, the reports showed that while 97% of the urban population in LA&C had access to drinking water from improved sources, in rural areas the figure was only 80% (WHO, 2010). This has not changed much since, as the 2015 figures are 97% and 81% (Ducci, 2015). In Bolivia, Colombia, Ecuador, Haiti, Nicaragua, Peru, and Venezuela, 80% of the rural population "lack sustainable access to drinking water" (ECLAC, 2015a: 65). In addition, it is well-known that a large proportion of rural water systems are abandoned or poorly maintained, and according to assessments made by the Inter-American Development Bank (IDB), between 30% and 40% of rural water systems in the region are out of working order, while others suffer chronic problems of water quality, intermittence, and quantity of water delivered (Ducci, 2015). The same IDB specialist points out that among the crucial problems affecting rural water systems in the region are the lack of institutional leadership from governments, reflected in the "lack of planning, policies, funding, information systems, and monitoring". The prevailing model of service in rural areas is community management, but the pattern is that these community-led systems lack support for the post-construction stages (op. cit.), that is, these systems are left without support for the crucial, long-term tasks of management, operation, and maintenance, that are required for their sustainability.

The situation is direr in relation to basic sanitation. The 2010 reports on MDG progress showed that there were 117 million people in LA&C, about 20% of the total population, without access to "improved sanitation facilities" (WHO, 2010). The figure

was reduced to 17% in 2015, which was not enough to meet the MDG target for the region, as 19 countries failed to meet their own targets (ECLAC, 2015a: 65). Moreover, the 2010 report pointed that a significant proportion of the population still relied on in situ sanitation systems (around 41% of rural dwellers and 27% of urban residents) and 11% lacked access to any facility and practiced open defecation (WHO, 2010). Similar to the case of drinking water, there are very large inequalities in the access to sanitation facilities between urban and rural areas. The 2010 report stated that the gap in basic sanitation coverage between urban and rural areas in Latin America was then among the highest in the world: while 86% of the population in urban areas used improved sanitation facilities, only 55% did in rural areas (WHO, 2010). Although the situation has improved, still only 64% of the population in rural areas has access to "improved sanitation facilities" in 2015. And this 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, 2015a: 65). Although the WHO-UNICEF report states that open defecation in the region would have been reduced from 17% in 1990 to 3% by 2015 (WHO-UNICEF, 2014: 21), the situation in rural areas continues to be very concerning: according to an IDB report the proportion of the region's rural population practicing open defecation in 2015 is 12% (Ducci, 2015). The report indicates that several countries are notorious owing to the large proportion of the population still practicing open defecation: ranging from 11% in Honduras and Ecuador, 13% in Brazil, 14% in Colombia and Nicaragua, to 35% in Haiti and 46 in Bolivia (op. cit., 2015).

On this connection, another important consideration correctly highlighted in one of the latest reports about the MDGs are the significant inequalities registered in the access to safe drinking water and basic sanitation, a topic that covered a whole section in the 2014 WHO-UNICEF report on MDG progress (WHO-UNICEF, 2014: 24-38). The report examines existing inequalities between and within urban and rural areas, across different social groups, and also indicates the lack of sufficient information in available data to gauge intra-household inequalities, a well-known significant yet overlooked dimension of inequality. The conclusions of this section of the report contain a very important consideration for our analysis:

> [I]t 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 managed to expand their coverage of improved drinking water or sanitation facilities intra-national

inequalities increased because the wealthier tend to benefit first. This is consistent with substantial evidence emerging from research carried out in the last two decades, showing that the public policy approach to WSS prevailing worldwide has abandoned the principle of equality that informed the massive public interventions that allowed developed countries to achieve universal access to these services during the twentieth century (Castro, 2006). Reforms introduced in the WSS sector since the late 1980s have been placing the emphasis on "profit", requiring even public companies to behave according to market rules rather than adopting what the WHO-UNICEF 2014 reports terms "an equity focus". We address this and related issues elsewhere in this and other final project reports, but will next focus on the specific contexts of the three countries involved in our study.

The recent experience of Argentina

The provision of WSS in Argentina was centralized at the national level until 1980 under the National Sanitary Works (OSN), an institution originally created in 1912. The work of OSN was complemented by the National Service of Rural Potable Water and Sanitation (SNAP) created in 1964, and by provincial subsidiaries of this organism also focused on rural WSS. The decentralization process in the country started in the final stages of the civic-military dictatorship (1976-1983), which was strongly influenced by the neoliberal agenda (Azpiazu et. al., 1986). In the WSS sector, the decentralization started with the transfer of the responsibility for these services from OSN to the provincial governments in 1980, while OSN retained responsibility for WSS in the Buenos Aires Metropolitan Area, which hosted around 34% of the country's population at the time. In historical perspective, it has been suggested that the 1980s decentralization, which at the time took mainly the form of a transfer of responsibilities to the provinces, may have been an obstacle to the achievement of a nationwide policy-institutional and regulatory framework for the provision of WSS (Lentini, 2011: 15). On the one hand, according to the country's federal Constitution the provinces retain significant control over the management of natural, including water resources, and there is high fragmentation and overlapping of often poorly interrelated institutional arrangements (Mathus Escorihuela, 2009). The decentralization of the responsibility for essential services started in 1980 contributed to create further institutional atomization by breaking up the existing national organisms that had been in charge of WSS for the best part of the 20th Century, which were not replaced by better institutional arrangements. On the other hand, the federal political structure of the country is overshadowed by the enormous weight of the province of Buenos Aires, and most particularly the Buenos Aires Metropolitan Area (BAMA), which includes the Federal Capital, restructured in 1996 as Autonomous City of Buenos Aires. The imbalance in development between the BAMA and the rest of the country has been historically the subject of much acrimony, and the decentralization started in 1980 contributed to further accentuate existing and create new structural inter-regional inequalities.[5]

[5] From another perspective, after the brief interregnum represented by the first democratic government (1983-1989) that followed the end of the dictatorship, the tension between decentralization of

After the return to democratic rule in 1983, the government of President Raul Alfonsín (1983-1989) attempted to transform the unequal institutional structure of the country, including a project to relocate the Federal Capital from Buenos Aires as a way to democratize the processes of decision-making and allocation of resources.[6] The government also tried to introduce reforms in the public sector, including the privatization of large public companies. In the WSS sector, the SNAP was transformed into the National Council for Potable Water and Sanitation (CoFAPyS), and gained new attributions beyond its original rural remit (ENOHSA, 2015). However, most reforms proposed by the government were rejected by the political opposition in Congress and eventually failed (Torre and Gerchunoff, 1999: 8). This was a very difficult and unstable period for the country, which ended with a political and financial crisis that led President Alfonsín to call for early elections. In July 1989 President Carlos Saúl Menem was elected, and he would remain a whole decade in power (1989-1999). During this long decade the country was radically transformed through the introduction of far-reaching reforms that made Argentina both a handbook and a laboratory of neoliberal policies. Just one month after becoming President in July 1989 the National Congress passed Law 23,696 on Reform of the State (Argentina, 1989), which provided the framework for the speedy implementation of neoliberal reforms. Law 23,696 declared "the provision of public services and all public companies in state of emergency" (Art. 1), while Articles 9-20 sanctioned the mechanisms to privatize all public companies and entities that the Executive might declare "subject to privatization" (Argentina, 1989).

The reforms soon focused on the WSS sector, and the CoFAPyS was called to play an important role in this new stage:

> Law 23,696/89 of Reform of the State provided the legal framework for the new institutional restructurations of the sector by declaring the emergency of the provision of public services and establishing the procedures for their privatization and concession. CoFAPyS was part of this process of transformation with the implementation of a programme co-funded by the IDB and the World Bank, the PRONAPAC [National Programme of Potable Water and Sewerage] (ENOHSA, 2015).

The process of privatization of WSS in Argentina became a flagship of neoliberal policies, not least because of the speed and the scale of the process. Apart from the cases of England and Chile, where WSS are fully privatized across the country, during the 1990s Argentina became the model to follow according to the IFIs. In just a few years between 1991 and 1999, Argentina passed from 0% of the population served by private

responsibilities to regional and local governments and centralization of political power and resources in the BAMA entered a new stage. A new Constitution was passed in 1994 (Argentina, 1994), which furthered the process of political decentralization introducing the concept of "municipal autonomy". The determination of the actual implications and extension of this autonomy recognized to local governments was left to the provincial congresses.

[6] The law to transfer the Federal Capital was passed by the Congress in 1987 (Argentina, 1987), and although the project was never implemented the law is still in place. In fact, there are ongoing discussions in Argentina to reopen the debate.

operators to 70%, and the concession given in the BAMA to the consortium Aguas Argentinas became the largest private concession of WSS in the world (Azpiazu et. al., 2014). For the best part of a decade privatisation policies went on virtually uncontested in Argentina, despite early signs of trouble and increasing evidence of failure. This is not the place to revisit in detail the failed experience of WSS privatization in Argentina, which has been the object of an extensive literature (e.g. Azpiazu and Castro, 2012; Azpiazu et. al., 2014). However, the reference here is justified because the reforms of the 1990s created structural constraints that are still acting as significant conditioning mechanisms for the design and implementation of public policies, including the WSS sector, and not just in Argentina (Castro, 2012a). Moreover, despite the failures of the 1990s, neoliberal reforms are back in the agenda with renewed strength internationally, and as discussed later, notoriously in Colombia and more recently also in Brazil, the other two countries covered in our study.

The well-known financial and political collapse of the neoliberal experiment in Argentina in 2001 provides many lessons that should be learnt. For instance, in the case of the privatization of WSS in the BAMA, according to the Tripartite Entity of Sanitary Works and Services (ETOSS), the regulator for WSS, between the start of the private concession in 1993 and 2002, the concessionaire Aguas Argentinas had only met 60.9% of its contractual commitments in relation to investment in infrastructure renewal and expansion of coverage. In relation to coverage of water supply, the target had been to extend it from 70% to 88% of the population within the concession's territory by 2002, but it only reached 79% in this period. In relation to sewerage, the target was to increase coverage from 58% to 74%, but in 2002 the figure was 63%. Only 7% of the original contractual targets for the provision of primary wastewater treatment were met by 2002 (ETOSS, 2003, cited in Azpiazu and Castro, 2012: 61). As the former head of ETOSS summarized it:

> The debilities of this scheme, the own errors and lack of compliance of the providers, the changes in government policy, the macroeconomic crisis, the discredit with the users and with civil society more generally, among other issues, led to the failure of this attempt (Lentini, 2011: 16).

In response to these and other failures, since the early 2000s virtually all WSS utilities that had been privatized during the 1990s were placed back in public hands in Argentina.[7] This reversion of neoliberal policies in WSS started during the government of President Nestor Kirchner (2003-2007) and was consolidated under President Cristina Fernandez de Kirchner (2007-2015). In the case of Aguas Argentinas in the BAMA, in 2006 the government cancelled the concession contract with the private operator on grounds of failure to comply with the contractual commitments. The same year the government also cancelled the contract with Aguas Provinciales de Santa Fe in the

[7] However, the return of privatized WSS utilities to the public sector started earlier, as some of the privatization contracts collapsed and the State had to intervene to take over the provision of services, as it happened in 1997 in the province of Tucuman (Crenzel, 2014) and in the province of Buenos Aires with the collapse of the private company Azurix Buenos Aires in 2002 (Azpiazu and Bonofiglio, 2006).

namesake province, where one of DESAFIO's case studies is located (D4.3). Another significant case was the province of Mendoza, where the private concession Sanitary Works of Mendoza was repossessed by the provincial government in 2010.[8] In their place, the national and provincial governments have created new public utilities and provided them with a clear mandate to reach the universalization of coverage.

In the case of the BAMA, the government created a new public company named Argentinian Water and Sanitation (AySA) that replaced the private concessionaire Aguas Argentinas in 2006. When AySA took over the WSS in the BAMA, "the deficit in service coverage was 16% (1.5 million people) for potable water and 36% (3.5 million people) for sewerage" (Azpiazu and Castro, 2012: 66). To comply with the government's mandate the company put forward an Immediate Action Plan (PIA) that involved public investments for about 32.3 million euros destined to recover the quality of WSS, expanding the network's capacity for treatment and distribution of potable water and expanding access to new users, and infrastructure rehabilitation and renewal. The PIA was soon replaced by a more comprehensive programme, the Water Supply and Sanitation Master Plan (PDS) 2006-2020, which gave AySA a roadmap that included the universalization of piped water supply in the BAMA by 2012 and the expansion of sewerage coverage to 80% of the population by the same year. The PDS also set the longer-term targets of expanding sewerage coverage to 95% of the BAMA population in 2020 and to improve the quality of drinking water and enhance environmental health in the region. The total public investment allocated to the PDS for the period 2006-2020 was around 4.6 billion euros, and the national government adopted the policy that the funds required could never be raised from charging the users, that is, it rejected the policy of full-cost recovery tariffs. Rather, the government established a system of shared responsibility between AySA and national, provincial and local authorities: AySA is expected to fund 52% of the total investment, the national government 38%, the Autonomous City of Buenos Aires 5%, and the Province of Buenos Aires jointly with the municipal governments of the BAMA the remaining 5% (Azpiazu and Castro, 2012: 66).

Another relevant aspect of this process is related to issues of social justice concerning the the affordability of the tariff of WSS. In the BAMA, at the end of the period of fixed-exchange rate between the US dollar and the Argentinian peso in 2002, the cost of the tariff for privatized WSS for the poorest 10% of the population represented about 9% of the family income (Azpiazu and Forcinito, 2014: 38-39). The government of the time decided a freeze of tariffs in January 2002, while at the same a Social Tariff was introduced for the first time to cover the needs of the poorest consumers. This Social Tariff benefitted a yearly average of 100,000-120,000 households between 2002 and 2008. The number of households that received this Social Tariff fell sharply from 2009, which may be explained by the combined effect of the tariff freeze (that was extended well into the 2010s) and the rapidly improving socio-economic situation of the poorest families as a result of government policies implemented to tackle the crisis such as direct transfers. The government also implemented other policies targeted at the most vulnerable families. Some of these policies had already been implemented before the

[8] These cases are significant because of the size of the population involved, as the provinces of Buenos Aires, Santa Fe, and Mendoza account for 58.5% of the country's population according to the 2010 National Census (Argentina, 2010).

cancellation of the privatization contract with the objective to protect these families from the worst effects of the privatization. Examples of these policies were the Participatory Management Model (MPG), popularly known as Plan for Poor Neighbourhoods, started in 2003, and the WATER+Work Plan introduced in 2004. These and similar initiatives directed at counter the negative effects of privatization on vulnerable sectors were all to be either fully publicly funded or partly funded by the communities themselves through the provision of materials and labour, and after the cancellation of the privatization in 2006 the public company AySA took responsibility for the programmes. The radical reconstruction of the WSS since 2003 that de-privatized most WSS systems in the country was also accompanied by a new institutional framework. In 2003, the government created the Ministry of Federal Planning, Public Investment, and Services (MINPLAN), which was given overarching powers over key areas of infrastructure and services including WSS. Also, in 2007 the government passed Law 26221 that set the new regulatory framework for WSS. The Law replaced the regulator ETOSS with the Water and Sanitation Regulatory Entity (ERAS), and created a new Planning Agency (APLA), both within the MINPLAN. The new arrangements, supported with heavy State investment, are contributing to reduce the deficit accumulated in previous periods, although there is much room for improvement, also in relation to the institutional framework (Azpiazu and Castro, 2012: 64ff).

The country has achieved excellent results since the reforms started in 2003. In relation to the MDGs, Argentina reported that 99% of the population has access to an "improved water source", with the same percentage applying to urban areas and 100% in rural areas. In relation to sanitation, 96% of the population has access to an "improved sanitation facility", with the same percentage applying to urban areas and 98% in rural areas (ECLAC, 2015b). However, as mentioned in the previous section, these official figures must be read with caution, as the statistics do not provide adequate information about the quality of the services being provided. For instance, despite the enormous efforts made, in the BAMA that houses almost a third of the country's population according to the 2010 Census (Argentina, 2010), the official coverage of piped potable water is currently 86.3% and for sewerage is 66.9% (AySA, 2015).[9] These figures indicate that the ambitious targets set by the government in the PDS 2006-2020 were not met, and there is much challenging work ahead, given that AySA has now the target to universalize access to piped potable water and sewerage by 2018-2020 (AySA, 2015). However, problems are more acute in the interior of the country, particularly in the Northern provinces that have been historically neglected, in particular Catamarca, Chaco, Corrientes, Formosa, Jujuy, Misiones, Santiago del Estero, Salta and Tucuman, grouped as the Great North Region (NGA). The NGA corresponds to about one third of the country's territory and 20% of the total population, and has been historically characterized by "high poverty levels, exclusion, marginality, and backward development" (Argentina, 2012: 2). The coverage of water supply has been improved in the region with an average rate of access of 83%, however the quality of the services is compromised by poor water quality and intermittence. The coverage for sanitation in the NGA is around 41% on average, but in Misiones, Santiago del Estero, Chaco and Formosa it is about 24% (Argentina, 2012: 2). The NGA is home to a significant share

[9] AySA's concession does not cover the whole of the BAMA

of the remaining indigenous population of Argentina, who are among the most marginalized groups in the country. A recent government study about access to WSS in a sample of indigenous communities across the country showed that 50% had serious problems in accessing these services, with only 28.1% reporting continuous access to water (Argentina 2011: 13). Since 2003, the government has made significant efforts to reverse the historical neglect of the indigenous communities, and is carrying detailed studies to ascertain the actual size of these communities and their spatial distribution in the country. Recent reports show the lack of attention paid to this population in the past, and suggest estimated figures for the indigenous population ranging from 400 thousand to 1.5 million people (Argentina, 2011: 11). The government has recently launched a development programme to tackle the situation affecting the NGA, which has a strong focus on WSS (Argentina, 2012).

There are also significant challenges in other areas too, such as widespread and worsening problems with the pollution of water sources, including naturally occurring arsenic pollution affecting a large area of the country. Arsenicosis is extended across the country, including the marginalized areas of the NGA but also much wealthier regions in the provinces of Buenos Aires, Córdoba, Mendoza, and Santa Fe. The matter has received renewed attention in recent years in the country, and the Congress of the Province of Buenos Aires passed a new Law in 2014 setting new standards to tackle the problem. There is also an ongoing debate in the national Congress. DESAFIO addressed this issue in case study D4.3 developed in the Province of Santa Fe (Portapila et. al., 2015; see also Litter, 2014; ISGSD, 2014).

The situation in Argentina is now entering a new stage. The period started in 2003 with the government of President Nestor Kirchner and the two subsequent periods in government by President Cristina Fernandez de Kirchner ends in 2015. The decisive reforms in the WSS sector introduced during this period have focused on reversing some of the negative processes that had affected the country during several decades. In this recent period, the State has played a crucial role in setting the policy-institutional framework for WSS and taking a strong lead in providing the necessary investments to achieve the universalisation of safe WSS. However, the policies implemented during this period have been strongly resisted by sectors of the political opposition, which have succeeded in stopping the changes in some regions, and aim to reverse the changes including a return to the neoliberal model that collapsed in 2002. Taking into account the patterns of the recent past, one of the main challenges facing the country will be to maintain the progress in the process of democratization of the politics, management and access to WSS with independence of the vagaries of electoral politics.

The recent experience of Brazil

In recent years, Brazil has made significant progress in establishing legal frameworks and strengthening the institutional set up to tackle the deficit in water and sanitation coverage, with a special focus on the problems affecting vulnerable communities. A new Federal Constitution passed in 1988 (Brazil, 1988) shortly after the end of the dictatorship that ruled the country (1964-1985), set the framework for the establishment of more decentralized mechanisms in the water and sanitation sector, providing municipal

governments a more active role in decision-making and implementation by sanctioning that public services of "local interest" were a municipal competence (Art. 30). The Constitution also promoted the introduction of more meaningful forms of citizen participation in debates about policies and in monitoring service providers. However, largely the institutional setting of WSS in the country continues to be determined by the structures created during the civil military dictatorship that ruled the country between 1964 and 1985. The government of the period established a National Sanitation Plan in 1970, which despite being phased out has left a strong imprint in the country's WSS sector (Heller, 2012). In addition, the financial and political crises of the 1990s posed a significant obstacle to the implementation of the progressive aspects of the 1988 Constitution, and in many respects provoked a regression. In particular, in the 1990s there was a severe withdrawal of the State from its responsibilities in relation to the provision of essential public services, with a significant reduction of the funding available to municipalities and public companies (Rezende and Marinho, 1995; Vasconcelos, 1995; Costa, 2003; Rezende and Heller, 2008). Brazil became a target for the neoliberal policies implemented in the period, with the creation in 1991 of the Project for the Modernization of the Water and Sanitation Sector (PMSS), a specific instrument funded by the World Bank, the Inter-American Development Bank, and national financial institutions that.[10] In this period the PMSS became a sort of public-policy think tank for the Brazilian WSS sector, and was highly influential in the public policies adopted by the Federal Government since 1995, which gave priority to the privatization of public WSS utilities that were considered to be commercially attractive (Costa, 2003: 72; for an analysis of the privatization of WSS in Brazil during the period 1995-2003, see, among other, Vargas, 2014). In the case of the most vulnerable sectors of the population, in general also the poorest, the main approach during this period was the promotion of "focalized policies" directed at the poor, such as emergency funds, the mobilization of voluntary organizations and NGOs, and the transference of responsibility for the provision of WSS to the vulnerable communities themselves. This included responsibility for the partial funding of the infrastructure and the management of the systems, whether in cash or in kind (mostly the provision of materials and labour). Some of these projects received funding from international funding agencies, as was the case of the Integrated Rural Sanitation System (SISAR) started in 1991 that was the object of DESAFIO's case studies D2.1 (Freitas et. al., 2015), D3.1 (Brown, 2015), and D4.2 (Passos et. al., 2015), that initially was partly funded by the German public development bank KfW. Another significant example was the Condominial Sanitation system, whose origins go back to the early 1980s, and was covered by Case Study D2.2 (Castro and Ferreira, 2015a). Some analysts of the period have argued that this transfer of responsibility from the State to voluntary organizations or the users themselves contributed to erode the universalist agenda set by the 1988 Constitution, and had the effect of depoliticizing social relations and removing the "social question" from the public sphere (Costa, 2003). At the same time, it is important to highlight the fact that although socio-technical innovations such as the Condominial System and SISAR emerged in a period that was highly influenced

[10] After the arrival of the Workers' Party to the Presidency in 2003 the PMSS adopted a broader approach, in line with the institutional changes introduced in this period focused on strong State intervention and investment.

by the neoliberal-neoconservative international agenda that had a significant impact in the Brazilian context, their actual implementation in the ground and their subsequent evolution did not necessarily lead to neoliberal outcomes. Our four case studies dedicated to these innovations cast much light on the complexities and nuances of the processes involving these interventions, which we address in more detail in the Case Study Reports and refer briefly later in this document.

The arrival of the Workers Party (PT) to the national government in 2003 constituted a radical departure from the past, in particular in relation to the legal and institutional framework governing WSS, the level of funding allocated to the sector, and in the practical implementation of a much more progressive approach geared at the universalization of access to these services along the lines of the 1988 Constitution. In this connection, the government of President Lula da Silva introduced far-reaching changes, starting with the creation of a National Secretariat of Environmental Sanitation within the Ministry of the Cities, launched in 2003. A key marker of the changes introduced was the approval of the first Federal Water and Sanitation Law in 2007 (Brazil, 2007), which was the result of a highly participative process of debate that took place over a number of years and involved from local community organizations to national authorities. The Law introduced a more comprehensive approach to sanitation, which in Brazil now encompasses not just water supply and sewerage but also other essential services such as urban drainage, solid waste collection and disposal, and vector control. The Law also prompted the elaboration of a National Plan of Basic Sanitation (PLANSAB), which was finally approved in 2013. The PLANSAB introduces a fundamental institutional change as it involves long-term planning (2014-2033) in a sector of activity historically characterized by short-term decision-making and frequent change of direction owing to partisan politics. PLANSAB also includes a balance between hard and soft investment in infrastructure, introducing the notion that over time the heavier investments will have to switch from physical infrastructure to maintenance and management, which are required for the long-term sustainability of the systems (see Heller et. al., 2011). These institutional changes were supported with heavy public investment in infrastructure implemented through the Growth Acceleration Program (PAC) launched in 2007 (2007-2010). The PAC was entrusted to former Minister Dilma Rousseff, who became President of the country in 2011. The implementation of the PAC doubled public investment in infrastructure from 1.62% of GDP in 2006 to 3.27% in 2010, with a total planned investment of BRL 657.4 billion, about 295 billion Euros[11] (Brazil, 2010: 3). The PAC was then extended for two consecutive periods, 2011-2014 and 2015-2018 (Brazil, 2015a). In the water and sanitation sector, the impact was very important, and by late 2014, it was reported that the programme had completed 1601 projects around the country, with a total investment of BRL 11.5 billion, about 3.52 billion euros (Brazil, 2014a).[12] During the second period of the PAC (2011-2014), it was reported that sewerage connections in urban areas were increased by 11%, bringing the percentage of households connected to the sewerage networks up to 67% (Brazil, 2015b: 57). These advances represent a significant departure from the past, and helped to place water and sanitation policy higher in the policy agenda.

[11] At the exchange rate of 2.2280 BRL per Euro at 31 December 2010.

[12] At the exchange rate of 3.2626 BRL per Euro at 26 December 2014.

On the downside, although Brazil is one of the countries reporting good progress in meeting the MDG targets, as anticipated in the original text of DESAFIO there are still many difficult problems with the quality of the services provided, which is not adequately reflected in the official statistics (see the six chapters in the section "The Brazilian experience" in: Heller and Castro, 2013). According to the latest MDG reports, 98% of the Brazilian population has access to an "improved water source". The figure would be 100% for urban areas and 87% for rural areas (ECLAC, 2015b). According to this information, the deficit in relation to drinking water would be entirely in rural areas, which would suggest that much of the progress made in the country in recent years has been concentrated in urban areas. This deficit is more acute in North-eastern Brazil, where in 2008 around 7.7 million people (14.4% of the population) did not have access to a safe water supply, a situation that does not seem to have changed significantly according to the latest reports. In relation to sanitation, the same report indicates that 83% of the total population has access to an "improved sanitation facility", rising to 88% for urban areas and dropping to 52% in rural areas (ECLAC, 2015b). These figures reflect the significant contrast between urban and rural areas characterizing the country.

It is worth highlighting here that according to the latest Brazilian census, the rural population is around 30 million people, 16% of the total population (IBGE, 2010). Among the most marginalized rural communities are the Quilombola settlements, originally constituted by slaves who escaped from their owners, though today these communities often include a racial and cultural mix. In 2003 the government created a special Secretariat of Policies to Promote Racial Equality (SEPPIR) (Brazil, 2014b) with a special programme focused on Quilombola Communities, which constitutes another important step taken by the national government to make visible and tackle the situation of extreme inequality affecting these and other vulnerable rural communities. Their marginalization can be illustrated by the fact that still today it is difficult to ascertain the actual size of the population in these communities, and until recently the estimates ranged from 1.1 million people to half that figure. Although there are not precise figures yet, the most recent estimates suggest that the population would be under 600 thousand, distributed in some 2300 communities across the country but with a strong concentration in the states of Maranhão, Bahia, Para, Minas Gerais, and Pernambuco (Silva, 2013: 98; Brazil, 2014). The level of marginalization of these rural communities can be illustrated by data from one of DESAFIO's case studies, which reported that a study of 173 Quilombola communities in the state of Minas Gerais showed that only 6.4% had access to "treated drinking water", and only 4 out of 174 communities had access to some form of "basic sanitation facilities" (CEDEFES, cited in de Pádua et. al., 2015, pp. 39-40).

The situation of Quilombola communities illustrates that, as already discussed the official MDG figures must be taken with caution and scrutinized. In this regard, during one of the seminars with high-profile specialists organized by DESAFIO shortly after the end of the research, one of the presenters pointed at the fact that in Brazil there is scant information available, even to the authorities, about the quality of the drinking water that is distributed to the population (Montenegro, 2015b). This is a significant problem that raises serious questions about the data used by the MDG reports cited earlier to state that 100% of the urban population and 87% of the rural population would have now access to an "improved water source". Undoubtedly, more research is needed to ascertain the situation, not least in view of the worsening situation affecting the provision of drinking

water in Brazil's most populated metropolises, notably Sao Paulo (e.g. do Carmo et. al, 2014), but also Recife, Rio de Janeiro, Belo Horizonte, and other important cities. This urgent matter has prompted the creation in 2015 of a special Commission in the Lower Chamber of the Brazilian Congress (Brazil, 2015a). In relation to sanitation, there is a broad agreement both about the slow progress made overall in tackling the deficit of provision of basic sanitation facilities, but also about the unacceptable situation affecting rural areas, given the enormous gap in coverage. In addition, even where there are sewerage systems in place, only a relatively small fraction of the sewage collected receives some form of treatment and often much of the sewage never reaches the treatment plants. In this regard, one our project's strategic advisers made the point that in addition to the conventional concerns for water losses in the networks there should be also a concern with "sewage losses", which is a very significant problem that remains largely overlooked (Montenegro, 2015a,b).

To conclude this brief section on the current Brazilian context, we cannot fail to mention that the far-reaching institutional reforms in WSS sector described before from the start met strong resistance from the political opposition and from diverse interest groups, notably many of the powerful provincial water and sanitation utilities. In fact, the initial impetus showed by the government of President Lula da Silva since 2003 was soon tamed by the realpolitik of political alliances that included actors with agendas often at odds with the original project incarnated in the creation of the Ministry of the Cities and its National Secretariat of Environmental Sanitation. Probably the first public symptom of the changes ahead was the stepping down in 2005, just after two years in government, of the first Minister of the Cities, Olivio Dutra, a friend of President Lula and co-founder of the Workers' Party. Although this change did not immediately affect the course of the institutional reforms, with hindsight it becomes clear that many of the initial political commitments that led to the creation of the Ministry of the Cities suffered important setbacks. Moreover, the severe political and financial crisis affecting the country while we write this report is threatening to derail the ambitious investment programmes underway in the WSS sector. DESAFIO organized several seminars with Brazilian specialists, politicians, and representatives of workers' unions, NGOs, and local communities to debate these issues (see in particular the proceedings of the Seminar held in Recife on 19 August 2015, DESAFIO, 2015a,b).

The recent experience of Colombia

During the last three decades, Colombia has also made important progress in the institutional field of water and sanitation services, partly associated with a process of decentralization started in the late 1980s (Blanquer and Fajardo, 1991; KAF, 2010). A new Constitution passed in 1991 lifted the State's monopoly over the provision of WSS and opened new possibilities ranging from privatization to the transfer of responsibility to community organizations, particularly in rural areas (Colombia, 1991: Art. 366). This opening to multiple forms of service provision was consolidated in 1994 with the passing of Law 142 on the Regime of Domestic Public Services (Colombia, 1994b) that set the regulations for public services, including WSS. Law 142 sanctioned the creation of specific regulatory institutions such as the Superintendence of Domestic Public Services

(SSPD) and the Regulatory Commission for Drinking Water and Basic Sanitation (CRA). In addition, Law 142 introduced changes to the financing of essential public services through the allocation of 5.5% of the national budget to local governments.

Another influential change was fostered by Art. 270 of the 1991 Constitution, which makes provision for the democratic control of public management through citizen participation. This principle was enacted by the Law of Citizen Participation (Law 134), passed in 1994 (Colombia, 1994a). This opening of mechanisms for citizen participation has been used by civil society organizations, notably during the campaign started in 2008 that eventually led to the organization of a national Referendum over the Human Right to Water (Colmenares, 2014). However, Law 134 has been recently replaced by a new Statutory Law of Citizen Participation (Law 1757), passed in 2015 (Colombia, 2015). According to some analysts Law 1757 responds to widespread criticism about the limitations of Law 134 and to calls from citizen organizations to lift or made more flexible a large number of restrictions in that Law that made effective citizen participation very difficult (e.g. ICP, 2012).

Although in some respects the institutional landscape of decentralization and promotion of citizen participation has important commonalities with similar processes that took place in LA&C as a whole during the last three decades, the Colombian situation has important particularities. The Colombian governments of the last two decades have adopted a different political framework to that prevailing in Argentina or Brazil in relation to the provision of essential public services. As a recent report from the Andean Development Corporation (CAF) explains:

> There are […] two well-differentiated visions of the role of the State in the definition of public policies and services management [in LA&C]. On one side, the countries of the Pacific Alliance, constituted by Colombia, Chile and Peru (in addition to Mexico in North America), which seek to achieve the liberalization of the economy, the free movement of people, goods, services, and capital. […] The second block is integrated in the Bolivarian Alliance (ALBA) grouping 15 countries [including] Venezuela, Ecuador, Bolivia, and Argentina [note: Argentina is not formally an ALBA country but is included because it has similar policies according to the CAF report]. This group centres the attention on the struggle against poverty and social exclusion. It opposes reforms of the State that seek the deregulation and privatization of public services. Rather, these countries seek to strengthen the State and promote citizen participation in public affairs. They also propose State intervention to reduce social disparities. [… In contrast], the countries of the Pacific Alliance propose a subsidiary role for the State, having market regulation as the mechanism. The State at all levels tends to stop being a direct service provider to become an articulator, a mediator between the actors providing public services. In this context, the regulatory capacities of the State are focused on improving the quality of the services and the efficacy and efficiency of the operators. It tends to promote private activity, which requires establishing clear rules and specific regulations (CAF, 2015: 13).

Interestingly, despite that the CAF report attempts to contrast the distinctive policy options of two groups of countries, it excluded Brazil from the analysis, which as discussed before has been a champion of heavy State intervention and investment in WSS since 2003. Nevertheless, the CAF report helps to cast very neatly the fact that there is a significant gap between institutional frameworks and political realities in relation to the provision of essential services. According to the CAF report, despite all the institutional mechanisms implemented in Colombia to enact democratic citizen control as an effective mechanism, the government seeks to implement the neoliberal agenda that prioritizes the radical reduction of the State's role in the provision of essential services, and the privatization of public utilities. The CAF report also seems to suggest that promoting "citizen participation in public affairs" and "State intervention to reduce social disparities", which would be characteristics of the ALBA countries, would not be part of the agenda for the Pacific Alliance, of which Colombia is a key partner. Although we cannot take the CAF report as an authority to describe the Colombian government's political approach to the matter under discussion, it provides important insights to better understand the complex political scenario facing LA&C, including Colombia, in relation to the design and implementation of public policies in the WSS sector.

In this connection, according to a report from the Colombian regulator CRA, the country has made significant progress in the last decade: between 2005 and 2010 coverage for drinking water was extended from 81.9% to 91% and basic sanitation was extended to 85.5 of the population in 2012, an increase of 40% comparing with 1993 (CRA, 2013: 23). To keep the moment, since 2010 the government of President Juan Manuel Santos Calderón has committed to make heavy public investments in the sector, as suggested by the CRA report: between 2010 and 2014 the country would have completed 603 water and sanitation projects with a total investment of 775,000 billion Colombian pesos, over 300 million euros (CRA, 2013: 10).[13] The report adds that there were 990 additional water and sanitation projects being implemented across the country, with a total investment of 4.2 trillion Colombian pesos, about 1.8 billion Euros[14] (CRA, 2013: 10). Reflecting on this progress, the Colombian Minister of Housing, City, and Territory, Luis Felipe Henao Cardona stated:

> Reviewing these figures, we see that much has been done; more than in previous governments. This is clearly reflected in an improvement of the living conditions of the Colombian people, in their sanitary conditions. Thanks to the investments made through the Ministry of Housing, City, and Territory we have advanced in different regions of the country. […] Since 2010 when the current government started there has been clarity about the impacts that can be generated by investing in plans to improve the provision of drinking water and basic sanitation. […] We want to keep investing in projects that continue to improve the quality of life of the Colombian people, which in turn may contribute to sustain the process of poverty reduction of the last four years. With these investments we do not only improve the conditions of sanitation but also the collateral impacts

[13] At the exchange rate of 2.332,00 COP per Euro at 31 December 2012.

[14] At the exchange rate of 2.332,00 COP per Euro at 31 December 2012.

> of these policies allow to reduce unemployment rates, enhance the inclusion of children in the education system, and reduce water-related diseases. […] When we see the results of these investments in the population a question emerges: Why it was not achieved before, given that these are essential services? The answer may seem simple, but it is not: the key to achieve success is the articulation between public policy, adequate management of the resources, and overall, will and commitment from everyone (CRA, 2013: 9-10).

The official discourse of the Colombian government as reflected in the CRA report suggests that the government, at least rhetorically, does not follow to the letter the Pacific Alliance's neoliberal agenda, as suggested by the analysis put forward by the CAF cited earlier. Rather, it seems to openly recognize the crucial role of the State in taking the lead in relation to the much needed improvements in the WSS.

In this regard, let us know consider the progress made in Colombia in relation to the MDG targets. Like in the rest of LA&C the data must be read with caution, particularly because of the lack of reliable information about the quality of the services provided. According to the latest MDG reports, 91% of the Colombian population has access to an "improved water source", with the figure rising to 97% in urban areas and falling to 74% in rural areas (ECLAC, 2015b). In relation to sanitation, 81% of the total population has now access to an "improved sanitation facility", with the figure being 85% in urban areas and 68% in rural areas (ECLAC, 2015b). However, the situation is more complex than what these figures from the MDG report suggests. For instance, regarding the quality of the water that is delivered to the households, a "Diagnostic of the quality of water for human consumption 2010" by the Country's Ombudsman (Defensoría del Pueblo) showed that 57.3% of the country's municipalities (575) were providing non-potable water for human consumption, that is, the quality of the water posed "high risk" to the users as it did not meet the minimum legal standards (CRA, 2013: 43). In relation to basic sanitation, we need to remember here that the MDG figures include almost any "improved sanitation facility". However, data from the regular Quality of Life National Survey shows that in 2013 the coverage of networked sewage collection systems was 81.6% for the total population, and 92% for the urban population, which represented a drop of 6% percentages points in coverage for urban areas since 1997. For rural populations the coverage was 16%, just 1% point of advance from the figure of 1997 (CRA, 2013: 42). An IDB report suggests that 14% of the country's population still practice open defecation (Ducci, 2015). In addition, it is estimated that in 40% of the country's municipalities the sanitation systems are not in "proper working order" while only 35% of the residual waters produced in the country receive some form of treatment (UNDP, 2014: 41-42). Moreover, the overall figures comparing "urban" and "rural" areas obscure the enormous complexity of the situation in the ground given the high degree of diversity characterizing the country, while as a government report reminds us, overall figures "refer to nominal coverage, in relation to the availability of networks, but leave side the fact that many households lack an effective connection to these services" (Colombia, 2009: 1). Thus, for both water supply and sanitation services, while the Central Region, that includes the capital Bogota, is the best served, the regions with

greatest deficits are the Pacific Region, that includes the Cauca Valley where DESAFIO's two case studies are located, and the Amazon Region (Colombia, 2009: 1). Other reports based on data from the Quality of Life National Survey also indicate that 55% of the population lacking in-house sanitation facilities are located in the Caribe Region (UNDP, 2014: 43).

Nevertheless, these acute regional disparities coexist with the massive marginalization suffered by the rural areas of the country in relation to WSS coverage. According to the reports from DESAFIO's case studies in Colombia (D2.4 and D3.3), almost three decades after the launch of decentralization processes in the country, municipal governments still tend to concentrate their interventions in the urban municipal centres and have not been able to establish mechanisms to support the rural areas within their jurisdictions. Still, Colombia has 1,123 municipalities and around 12,000 officially registered service providers, of which about 11,500 are community organizations and the remaining 500 are a mix of public, mixed, and private utilities. That is, an average of 10.6 service providers per municipality. It is estimated that over 90% of these services providers are located in rural areas, and in small municipalities the services are run by community organizations such as Water Supply Management Boards, Community Action Boards, Users Associations, or cooperatives (Rojas et. al., 2010). A government report highlighted "the high degree of dispersion of service providers resulting from the decentralization process of the 1980s", and argued that this dispersion has a negative impact making it difficult to take advantage of economies of scale and atomizing efforts and resources (Colombia, 2009: 1). It has been also argued that the regulatory institutions created in the 1990s by Law 142, such as the CRA and the SSPD, created a highly bureaucratic one-fits-all framework for the provision of WSS in the country that must be uniformly applied everywhere, in large cities, in small municipalities and in rural areas. This affected especially rural areas, as many community organizations reacted to the norms rejecting their regularization to avoid being penalized for non-compliance with the bureaucratic framework. In fact, according to some interviewees in our research, the actual number of small water supply community providers operating in rural areas may be at least double the official figure of 11,500 legally registered. Although in late 2010 the government simplified the bureaucratic regulatory mechanisms, there is still much resistance to regularization from service providers, particularly small community organizations.

In response to the perceived difficulties in this area, in 2008 the national government launched a new national strategy for the WSS sector that partly reversed some aspects of the decentralization process. A key component of the new strategy have been the Department Water Plans (PDAs), that vested the responsibility for planning, infrastructure works, and the creation of regional WSS utilities in the departments, which are supra-municipal entities. This measure effectively changes the attributions of the municipalities and curtails the autonomy originally granted to them by the decentralization process. Although municipalities continue to be responsible for guaranteeing the provision of WSS to the population and keep receiving government resources to fund infrastructure works and subsidize the provision of services to the poor, now they have to transfer part of these resources to the departments. It is also expected that municipalities that still run their own WSS will create independent operators, as it was originally foreseen by Law 142. These operators are in charge of the activities of

administration, operation, and maintenance of WSS. More recently, the government launched new policy guidelines to tackle the deficiencies in WSS in rural areas, with the objective of providing an integrated framework for the provision of water supply, sanitation, and cleaning services, articulated with national strategies to solve the problems of rural housing, and funded by the national and regional governments (Colombia, 2014).

Discussion of DESAFIO's research findings relevant for Argentina, Brazil and Colombia

In the light of the regional and country backgrounds discussed in Section 1, we will now summarize some of the key findings emerging from the research, focusing on relevant aspects that may contribute to the ongoing process of democratization in the sector of WSS, particularly in relation to tackling the problems affecting vulnerable communities. The section is organized around the main research questions of the project:

> *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?*

Socio-technical innovations to foster democratization in the WSS sector

Our more general question set the framework for our research, as it demarcated the main objective of the innovations under study: these should be innovations "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" (DESAFIO, 2013: 3). However, it is important to emphasise that the use of the term "innovation" can be misleading for some readers who may tend to associate it with entirely new technological developments and inventions. In addition, in general, the innovations under study were not primarily technological. Although there were important technological elements involved, most technological aspects already pre-existed the innovations studied. Thus, the innovative element in the technological dimension consisted mainly in new assemblages of existing technologies, the re-ordering of technological elements and the re-structuring of their interrelations. In practice, the main innovations in the cases studied took place in the social dimension, broadly speaking as

it incorporates socio-cultural, economic-financial, policy institutional, and political aspects, and in the articulations between social and technological aspects.

With hindsight, this could have been expected, because our study focused on innovations directed at the situation of vulnerable, poor communities. Top-notch technological development and innovation rarely takes place with the vulnerable and poor as their main subjects (some would say customers). Moreover, in the field of WSS technological innovation tends to be rather limited, and even in developing countries many of the materials and technologies in use have been available for decades and in some cases for centuries. Perhaps the notorious exception is the development of advanced wastewater treatment technologies or technological developments applied to the commercial-financial management of WSS. Nevertheless, the innovations covered in the study constitute important contributions because, despite significant differences and diversity between them, they have in common the fact that they were developed with the objective of democratizing key aspects of the provision of essential WSS directed at vulnerable, unserved or poorly served populations. In all cases, a major objective of the innovations was expanding the access to WSS to the unserved. In some cases, the transformations also placed emphasis on making the activities of management, operation and management of WSS more participative and closer to the users, involving them actively in some of these activities. In other cases, the main interventions were aimed at revamping policy-institutional frameworks to make WSS more accountable and subject to the effective democratic control of users and citizens (see Article 1 in this Working Paper).

The emergence of socio-technical innovations in WSS

One the most important issues that we wanted to understand in our study is the process of emergence of these innovations, which was addressed by one of our main research questions:

> *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?*

To answer this question we paid central attention to the context, trying to ascertain the main factors and processes that could be identified as having crucial influence in the emergence of these innovations.

Most innovations studied in DESAFIO emerged in the 1980s and early 1990s (Figure N° 1).[15] As discussed in Section 1, this period was marked by a conjunction of transformations that had far-reaching implications for the provision of essential WSS in the three countries under study. The return to democratic rule after the long years of the civic-military dictatorships in Argentina (1983) and Brazil (1985) opened a new stage in

[15] The main exceptions are the community-managed spring sources dating back to the 1950s studied in D2.3 (Britto et. al., 2015), and the interventions implemented during the project's life addressed in D4.1 (de Pádua et. al., 2015) and D4.3 (Portapila et. al., 2015).

the process of democratization, which strengthened initiatives to decentralize the State and empower local authorities. The results were particularly noticeable in Brazil, where a new Constitution passed in 1988 granted significant autonomy to municipalities in relation to essential public services. Although the circumstances in Colombia were very different, and the country continued to be severely affected by the protracted civil war dating back to the 1950s, 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. However, counteracting these forces of democratization, mainstream neoliberal and neoconservative policies introduced since the late 1980s contributed to the weakening and dismantling of the State's capacity to regulate and directly provide essential public services, including WSS. These policies found a fertile ground because in the three countries there was much appetite for decentralization of powerful State monopolies, which for decades had been perceived as a source of inequality and injustice. The evidence showed that the lack of State action was largely responsible for the high degree of inequality in the access to essential WSS affecting vulnerable communities both in urban and rural areas. However, neoliberal decentralization, 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. In fact, a major objective of these policies was to free the State from such responsibilities, and make the poor take responsibility for their own needs.

Nevertheless, the contextual conditions of the 1980s and 1990s also nurtured alternative innovations predicated on principles and objectives completely different from those of the neoliberal project. These innovations actually contributed to challenge the prevailing socio-political and economic-financial mindset, and became expressions of the resistance to the neoliberal policy framework that was promoted in the WSS sector. These innovations were fostered by the social and political forces that sought to democratize and decentralize the State but rejected the neoliberal model that promoted the withdrawal of the State and the transfer of responsibility for essential services to private actors or the users themselves. These forces included citizen organizations, social movements, community organizations, progressive sectors of the Catholic Church, among other actors. Although the long-standing traditions of solidarity and reciprocity characterizing Latin American and Caribbean cultures became often entangled with the neoliberal programmes owing to the instrumental approach to these traditions adopted by governments, IFIs, and aid agencies, these traditions provided powerful elements for the development of alternatives to the neoliberal project and inspired the work of the social actors opposing it. 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. Therefore, rather than freeing the State from responsibility for the provision of essential WSS, these forces sough 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.

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, 2015a), the Integrated Rural Sanitation System (SISAR) (Freitas et. al., 2015; Brown, 2015; 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., 2015a,b), and the Integrated Sanitation system (Castro and Ferreira, 2015b), in different degrees, **all borne characteristics inherited from the prevailing conditions of the period**. This is a summary of the key characteristics of these innovations:

- All the innovations studied were designed to tackle the deficit in coverage of WSS **affecting vulnerable populations**.
- Most of the innovations involved **decentralized management and operation** with **user participation** at the local level, in the understanding that it would promote
    - **autonomy from centralized bureaucratic structures** and **empowerment** of the users
    - a **simplification and reduction of the scale** of the systems in urban areas, facilitating the operations and **reducing the impact of system failures**
- Most of these innovations promoted the adoption of **small-scale technologies, and local management** taking inspiration from the appropriate technology approach.
- The innovations implemented in Colombia's rural areas, in addition to the above, focused on the **use of local sources of energy, raw materials, and labour**, taking a step further in following the principles of the appropriate technology approach.

Key principles and objectives derived from the neoliberal and neoconservative framework that predominated in the period were apparent in most of the innovations studied. In particular, some of the innovations were grounded on, or at least strongly marked by the assumptions that

- the **State cannot afford** the investments needed to provide these services to the poor
- **users should take responsibility** for the provision and long-term management and maintenance of their WSS
    i. In different forms and degrees, these innovations **involved vulnerable communities in the funding, construction, and long-term management** of the systems
        - This allowed a **significant reduction of costs** for the State, whether in the construction and maintenance or in the overall management of the systems (up to 70% in the case of the Condominial System; Castro and Ferreira, 2015a)

However, some characteristics of the innovations diverged substantially in relation to the neoliberal/neoconservative framework prevailing at the time. The alternative innovations that emerged from the resistance to the neoliberal approach, such as the Integrated Sanitation system in Brazil (Castro and Ferreira, 2015b), shared some characteristics, such as the role of decentralization in the democratization of WSS, but had radically different assumptions. These alternative innovations assumed that:

- The State was the **only actor with the financial and technical capacity, and the political legitimacy** to achieve the universalization of WSS
- The approach to solve the deficit of service coverage in vulnerable communities should not be based on **piecemeal, partial, sector-bound interventions**, but must be based on **sound long-term planning** that takes into account the **complex character of the vulnerability** affecting these communities
    - Interventions **should not focus on a single aspect or dimension** of the vulnerability affecting the communities (e.g. water supply or sewerage), disconnected from the rest. Therefore, the interventions **must tackle simultaneously as many dimensions as possible**: in addition to providing water or sanitation, attention must be paid to the quality of housing (including adequate in-house sanitary installations), the safety of the environment, and related aspects
- The State **should not transfer responsibility** for these interventions to the users, especially the most vulnerable, and needs to **take full responsibility** for the provision of these services
    - In particular, the State should abstain from passing the cost for the interventions to the poor and should **make provision for the funding of the interventions and the long-term maintenance of the systems**
- Rather than weakening and dismantling the State capacity for direct provision of WSS, it is required to strengthen the State and at the same time creating the institutional mechanisms to allow common citizens to exercise **democratic social control over the whole process**, from political decision making to implementation, management, and maintenance of WSS

Although it is possible to establish clear differences between the innovations studied along the lines of these characteristics, **the evidence does not allow us to pigeonhole these experiences mechanically**. Clearly though, the Integrated Sanitation system (Castro and Ferreira, 2015b) is an example of an alternative approach that **fully rejected the neoliberal principles**, as it actually emerged to contest the implementation of neoliberal WSS policies. However, despite the stated policy objectives of neoliberal policies, **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 these policies, owing to the influence of the local context and the interplay between local actors in the ground, or because their success prompted the upscaling and diversification of their original objectives. As discussed later, the evolution over time of the Condominial Sanitation system and the SISAR system in Brazil, or the community-

managed WSS studied in Colombia, adopted very complex configurations that **cannot be interpreted as being the result of the neoliberal prescriptions for WSS policy**.

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. We identified some specific **factors and processes** operating within or resulting from the contextual conditions that acted as **triggers for the emergence of the innovations**.

a) Ground-breaking **institutional changes** resulting from the political process that provided new avenues for meaningful citizen participation, fostered the democratisation process, and promoted decentralization transferring greater responsibilities to local governments
    i. The **1988 National Constitution in Brazil**, passed shortly after the country's return to democratic rule in 1985 after two decades of dictatorship. The Constitution **strengthened the role of local authorities** in the provision of basic services. This was a period of high social mobilization and the **improvement of living conditions** was a core demand of the population.
    ii. The **1987 decentralization policies and the 1991 National Constitution in Colombia**, which fostered citizen participation in monitoring public management.
b) Popular mobilization owing to the very high **inequality in the access to essential WSS**, both between and within urban and rural areas., and to the **prevalence of water-related diseases** in vulnerable communities affected by unsafe or inexistent WSS (Recife, Brazil)
c) **Environmental pollution** caused by lack of sanitation and wastewater treatment leading to the **collapse of local tourism and the consequent loss of family income** in a small community (Peña et. al., 2015a)
d) Widespread **popular resistance to neoliberal policies** in the WSS sector, seeking the democratization of WSS and rejecting the privatization of public utilities (all countries studied, but more effectively in Argentina and Brazil)
e) **Structural financial crises** reducing the investment capacity of the State to extend WSS to the unserved population (all countries studied)
f) **Specific policy reforms** induced and funded by the IFIs and other international actors (i.e. donors, development agencies, etc.) promoting the withdrawal of the State from direct provision of essential services (all countries studied)
g) **Practical interventions** induced and funded by the same actors to foster decentralized WSS designed to become fully self-sufficient over time, funded and run by users, especially in rural areas (Ceará, Brazil; Recife, Brazil; Cali, Colombia)
h) **Initiatives from a range of social actors** to develop innovative solutions for the provision of WSS in vulnerable communities that **break with the status quo based on the construction of large-scale infrastructures** that are focused on service provision in standard urban areas

   i. alternative technological designs developed by universities (Cali, Colombia; Belo Horizonte, Brazil), public utilities (State of Ceará and Recife, Brazil), or independent consultants (Recife, Brazil)

i) **Strong leadership by individuals or groups**, with long-term commitment to the achieve success in the implementation of the innovations (the clearest examples are the SISAR system and the Condominial Sanitation system in Brazil; and the community-managed WSS in Colombia)
j) Long-standing **traditions of solidarity and reciprocity** characteristic of LA&C, that during the period covered by the study often took the form of **popular mobilization and organization to get access to and regularize land ownership, and secure access to essential public services** (all three countries)
k) **Changes in the political context** resulting from the electoral process that
   i. **brought to power non-traditional actors** (e.g. President Lula da Silva in Brazil) with policy agendas focused on **tackling extreme poverty and giving the State a leading role** in the process (Argentina and Brazil since 2003)
   ii. gave an unique opportunity to designers of socio-technical innovations who came to occupy **positions in government** (elected city mayor; provincial secretary of public works; municipal secretary of water and sanitation) and were able to introduce **official policies** to implement the interventions (Recife, Brazil)
l) **Disasters** like the 1994 earthquake that triggered the innovation implemented in Mondomo, Colombia (Peña et. al., 2015b). The earthquake destroyed the water supply infrastructure in the town, which helped the community to attract the attention of a **broad alliance of public, private and social actors**. Despite the prevailing framework of the time that supported a retreat of the State from the provision of WSS, there was **strong government support** that provided 85% of the funding needed to build a new water system and treatment plant.

It is important to remark here that, although the socio-political and economic-financial structural conditions that provided the context and some of the triggers mentioned 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 also 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.

Critical success factors for socio-technical innovations in WSS

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?*

As already discussed, the innovations studied were focused on the **democratization** of WSS to tackle the situations affecting vulnerable communities. Many of the factors and processes discussed above in relation to the emergence of the innovations also had a significant role in their success and replicability.

Local community involvement. In all cases, although in different ways and to different degrees, a fundamental requirement for the emergence and long-term success of the innovations was the **involvement of the communities**. In some cases, this was possible owing to a strong record of **pre-existing community organization and leadership**, while in others community involvement was mostly **induced by external interventions**. However, community involvement was addressed differently in the various innovations studied, which has an impact on their long-term success and replicability. For instance, in the community-managed WSS implemented in Mondomo, Colombia, there was a **long track record of community organization, with strong, legitimate leaders** (Peña et. al., 2015b). This was also the case in the implementation of the Condominial and Integrated Sanitation systems in Brazil (Castro and Ferreira, 2015a,b). In the latter, there was a strong tradition of **social and political engagement** of the community with a range of political parties and progressive sectors of the Catholic Church that helped to develop a broad alliance that became fundamental in the process. Also, in the Brazilian state of Ceará there is a **long standing tradition of community associations** that facilitated the implementation of the SISAR system of rural sanitation, which requires an important degree of community participation (Cortez, 2015; Alves, 2015).

Nevertheless, in all cases the **induction from outside** of particular forms of involvement was required to achieve success, firstly during the implementation phase and later for the long-term maintenance and management of the systems. For example,

a) In the two Colombian cases, 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**.
b) In the case of the SISAR system implemented in rural communities of Ceará, Brazil, the approach adopted includes the **training of the local community to take charge of the system** after its construction; there is also a **formal agreement** signed by the local community association and SISAR.
c) In the case of the Condominial Sanitation system as implemented in Recife, Brazil, the involvement of the community was formally circumscribed to

i. **Accepting the implementation of the system** in their neighbourhood by signing a "Condominial Agreement" with the municipality or public provider; this agreement involved a **commitment by the community** to contribute with funds, labour, or materials for the **construction and maintenance** of the system over time

d) The Integrated Sanitation system also implemented in Recife, Brazil, addressed community involvement with a more radical approach: 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.

e) In the intervention implemented in the Quilombola community of Lagedo (de Pádua et. al., 2015), although the local community is actively mobilized around crucial issues such as the regularization of land ownership, the involvement in relation to the development of a water filtration system as envisaged in DESAFIOs case study (de Pádua et. al., 2015) **was fully induced by the university through 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.

f) Similarly, in the intervention implemented in Santa Fe, Argentina (Portapila et. al, 2015), community involvement is **fully induced by the university 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 public policies in the sector of WSS.

There are several cases where the success of the innovation is clearly related to the **high degree of community involvement** that goes beyond 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.

Nevertheless, although community involvement is clearly a crucial factor, **sustained and meaningful external support**, particularly from the State, has been identified as a deciding factor in the sustainability of all the innovations studied over time. 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.

a) As already stated, in the two Colombian cases **the university 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., 2015a,b). The success of these two cases suggests that the model has **significant potential for replication**.

b) In the case of the SISAR system of rural sanitation in Brazil, although the original goal has been that the local systems achieve self-sufficiency, over time it came to be accepted that they **could not succeed without the strong support from the provincial public authority CAGECE** (a consortium partner in DESAFIO). CAGECE has created a special management unit to support all SISAR systems (see Cortez, 2015; Alves, 2015; Melo [CVS], 2015; Sobreira, 2015). As a result, the 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**. SISAR's managers have been already invited to provide advice on the implementation of similar systems across Latin America and in some African countries (Cortez, 2015). Also, the Brazilian government is considering the possibility of adopting SISAR as one of the **policy options for rural sanitation** in the country (DESAFIO, 2015b).

c) Although as explained below the experience of the Condominial Sanitation system implemented in Recife, the focus of one of the case studies (Castro and Ferreira, 2015a) was a failure, the model has been highly successful elsewhere. As already discussed, the system was originally designed as a low-cost option to tackle the deficit of sanitation coverage in poor neighbourhoods where it was unfeasible to introduce conventional sewerage networks owing to the irregular characteristics of the terrain or the informal patterns of urbanization characteristic of poor areas. However, 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 this system, 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. Another mark of success is that the Condominial system has been also adopted by the current Brazilian government, which in the field of WSS has taken a very different policy approach to that promoted by the neoliberal governments of the 1990s (Castro and Ferreira, 2015a; Brazil, 2015c; Melo [JC], 2014, 2015; Rissoli, 2013, 2015). The system has been also replicated worldwide and has been promoted by the World Bank, the Inter-American Development Bank, and other international agencies.

d) The Integrated Sanitation system implemented in Recife, Brazil, has been very successful in achieving the goal of **transforming the living conditions of poor communities by adopting a holistic approach** that tackles simultaneously different dimensions of their 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 has been a major factor

> in this success, this involvement has been mainly in relation to participation in the design and monitoring of public policy, implementation, and long-term management of the system. In this model, **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, 2015b; Miranda Neto, 2014, 2015). As discussed below, changes in government policies can be a major setback for this system.

Summing up, the research findings show that the main factors to explain the success of the innovations over time and their replicability are fundamentally **socio-cultural, policy-institutional, and political**, something that has been largely confirmed by the technical experts interviewed, many of whom were designers or implementers of the innovations (e.g. Melo [JC], 2014, 2015; Miranda Neto, 2013, 2014; 2015; Montenegro, 2013, 2014a,b). In particular, we can highlight here three main factors: firstly, the **fundamental role of 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 the users (as in the SISAR system, in the community-managed WSS in Colombia, or in the Condominial Sanitation system). 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.

Critical obstacles to the success of socio-technical innovations

The other aspect of the innovations studied that we sought to understand concerned those factors and processes that help to explain failure. Our core question here was:

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

Although understandably there are questions related to improvements needed in techno-infrastructural and operational dimension, the research results suggest that, similarly to the question examined in the previous section related to success and replication, **the factors and processes that help to explain failure are overwhelmingly socio-cultural, policy-institutional, and political**. Even the failures identified in the technological aspects, for instance the inadequate infrastructural performance of the Condominial Sanitation system in Recife (Castro and Ferreira, 2015a) 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 implementation of the Condominial Sanitation system contains important lessons in this regard. According to the critics, important factors of failure would be in-built in the model:

a. The **exclusive focus on sewerage, unconnected from other fundamental infrastructure services**, in particular drainage and paving, but also drinking water and in-house sanitary facilities, proved to be a major reason of the failure of the system in Recife.
b. 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 turn, the experience of the Integrated Sanitation system, also implemented in Recife, Brazil, further confirms the key role of policy-institutional aspects and casts light on the political factors that are at the root of the causes of failure. 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 reforms foreseen by the original project in the policy-institutional and political dimensions **were never implemented and effectively abandoned**, in particular those involving the meaningful participation of the citizenry in the design of public policies for the city as a whole, and in the monitoring of the implementation of the infrastructure works. Also, the provisions made in the original project for long-term institutional arrangements to ensure the accountability of the municipal and provincial authorities and the public utility **were progressively scrapped**. This case demonstrated that merely electoral, tokenistic democracy is not enough to ensure the democratization of the politics and management of WSS. Although there was an effective material democratization with the universalization of coverage and radical infrastructural intervention that turned an insalubrious shantytown into a liveable neighbourhood, the **abandonment of the commitment to introduce substantive political and institutional reforms led to the failure of the original project** that envisaged the empowerment of the local community vis a vis the authorities and the service providers.

The SISAR system of rural sanitation implemented in Brazil also elicited important lessons about factors that pose important obstacles for the democratization process in relation to WSS. This is also a system that has enjoyed much success in relation to the achievement of material democratization, as it has managed to provide access to

drinking water to almost one million people in the state of Ceara's rural areas. However, 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 were it to favour other alternative systems. 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. There are also other obstacles that affect the performance of SISAR as a vehicle for the democratization of WSS. Among other issues, 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**, while the low-density populations characterizing Ceara's rural areas often result in a **fewer number of connections that the minimum required to make the systems economically self-sufficient** (Alves, 2015).

The community-managed WSS systems studied in Colombia face obstacles in relation to the democratization process, obstacles that are mainly **concentrated in the policy-institutional and political dimensions** similarly to the other cases. 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. 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. This is 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. Also, like in the other cases, **the decline over time in community participation and commitment** to self-management poses significant challenges to the sustainability of the systems in the mid and long-term.

Summing up, in all cases studied, there is a **pattern of common factors that constitute significant obstacles** for the innovations studied in their character **of vehicles of the process of democratization of politics and management in the WSS**. Discontinuity in the public-policy and institutional dimensions, slow pace or routine cancellation of political reforms oriented at tackling structural social inequality and injustice that are the root of the vulnerabilities affecting poor communities, decline and stagnation of community participation over time, lack of long-term commitment by the authorities to invest and develop adequate planning and policy-institutional frameworks for rural sanitation, policy fragmentation and the corresponding lack of integrated approaches to the provision of essential services including WSS, among other issues. In addition, the replicability of the implementation of the innovations often faces the obstacles presented by the transplantation of models developed in a particular setting to other regions and countries. Although we did not study this aspect, there is evidence of **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). However, there is also evidence that the innovations can **be successfully adapted to different conditions**, even introducing radical modifications of the original model, as has been the case of the implementation of the Condominial Sanitation system in Brasilia or Salvador in Brazil.

Conclusions

This document has presented a synthetic analysis of main project findings that are relevant for the context of the countries participating in the project, Argentina, Brazil, and Colombia. As discussed in the first section, the three countries have made good progress in several areas related to the expansion of access to WSS to vulnerable communities. However, the claims made in relation to the MDGs have be taken with much caution, as the evidence suggests that the progress achieved is less significant than what the official figures present. This is particularly true in relation to the lack of progress in the provision of basic sanitation, but also in relation to safe drinking water. The situation of vulnerable communities, particularly in rural areas but also in urban regions, continues to be a major obstacle for the process of democratization of the politics and management of essential public services, and in consequence, a fundamental obstacle to the democratic process more generally. Providing safe, sustainable basic WSS to vulnerable communities continues to be largely overdue in most developing countries. To deliver these basic services within a democratic framework that prioritizes social efficacy and equality, accountability, and meaningful citizen involvement and participation in monitoring policy decision-making and implementation is more daunting and remains a largely elusive target.

At the time of writing this report, these three countries, and LA&C as whole, are experiencing a new cycle of the recurring economic-political crises that have historically characterized the region. There is a clear historical pattern showing that these crises tend to have a huge impact of the poor and vulnerable sectors of the population, producing the discontinuity of policies directed at tackling the conditions of structural inequality and injustice affecting these sectors and very often reversing the advances achieved during periods of progressive political and economic reform, as those experienced by Argentina and Brazil since 2003. The return of neoliberal policy frameworks predicated on the retreat of the State and the transfer of responsibility for essential services to the poor, complemented with the privatization of commercially attractive public services presents a major threat to the democratization of essential WSS in Brazil and Colombia, and potentially also in Argentina depending of the results of the national elections that take place in late 2015.

In this difficult context, the cases studied by DESAFIO contain very important lessons and provide clear evidence of the enormous potential that socio-technical innovations may have in contributing towards fostering the democratization process. Substantive democratisation in the access, government and management of essential public services such as WSS requires social participation and control over the decision-making process by common citizens and users. This includes the scrutiny and democratic

control of decisions about how water and essential services such as WSS are governed, managed, and distributed, by whom, for whose benefit, etc. This is seldom available to local communities and common citizens, but even the short-lived experience of some innovations like the Integrated Sanitation system implemented in Recife suggest that it is feasible and achievable. Also, a crucial lesson extracted from the study is that the extension of safe essential WSS to the unserved vulnerable population must rely on heavy, long-term State involvement, and particularly on substantial public funding. The State must provide strong and continued support to make these innovations possible, and more importantly, sustainable and replicable. It is unfeasible and undemocratic to require poor, vulnerable communities to become self-sufficient in taking responsibility for the provision of safe WSS. There must be a balance between the promotion of autonomy and substantive citizenship in the communities and the exercise of State responsibility for guaranteeing the provision of essential services.

These and other lessons that the research team will elaborate in more detail in forthcoming publications can make significant contributions to the design and implementation of public policies for the WSS in the three countries addressed in the study.

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