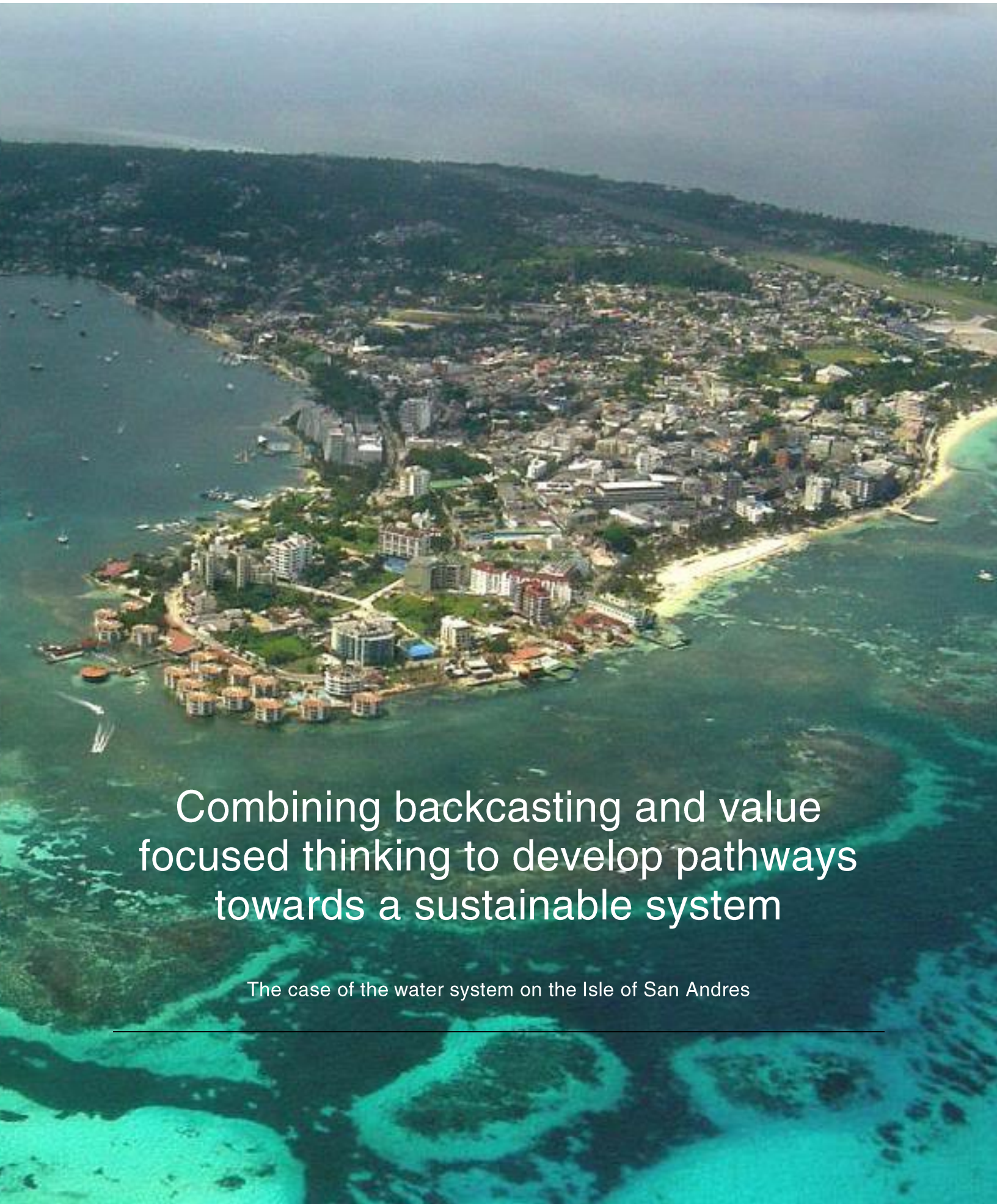

Combining backcasting and value focused thinking to develop pathways towards a sustainable system

The case of the water system on the Isle of San Andres

Colophon

Pathway towards a sustainable water system for the island San Andres in 2030

Combining value focused thinking actor analysis and back casting for creating path ways towards a sustainable water system for San Andres in 2030.

This master thesis is the result of the research conducted for the completion of the master Systems Engineering, Policy Analysis and Management (SEPAM) of Chris Dingemanse at the faculty of Technical Policy and Management at the Delft University of Technology.

The research is done within the company Elemental water makers

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PREFACE

This thesis is the final result of my graduation project for the study Systems Engineering, Policy Analysis and Management (SEPAM) at the Delft University of Technology.

Through windsurfing and kite surfing my interest in clean technology has been settled a long time ago. These sports use wind for acceleration of fun and my wish was to translate this clean empowerment into society. This dream continued when I started to search for a graduation project. My best friend (Toine de Klerk) inspired me to graduate on an island.

Next to the likable conditions that an island has to offer during your stay, Islands are facing problems nowadays that the world will face in 20 years. High energy prices, water scarcity and raising sea level emerge the need for sustainable planning. Therefore islands are the excellent way to explore and experience the problems and solutions for the world in the future.

The company Elemental water makers offered a research on the island of San Andres. However, the money required for the mobility was not available in a start-up. The search for mobility funds led me towards the Climate KIC. The Climate-KIC is Europe's largest public-private innovation partnership, working together to address the challenge of climate change and emerge successful businesses in Europe around climate mitigation and/or change.

The climate KIC demanded participation in the Climate KIC winter journey, for which I travelled to Budapest, Prague and eventually Poland to meet other entrepreneurial students and write business plans about sustainable opportunities.

The mobility funds from the Climate KIC enabled this research and I constructed a framework that could enable a sustainable water management for the island of San Andres in 2030. The framework included backcasting and value focused thinking that had to be constructed into one applicable framework.

This turned out to be quite a voyage passing by many scientific disciplines and great thinkers, which all provide useful insights for this multi-disciplinary topic. Luckily the constructed framework could be put into practise afterwards.

The interviews with experts have provided me with a wealth of information about the actual state and problems in the water system of San Andres. Furthermore, the company EEDAS with their great network enabled me to invite all the participants. 13 out of 15 invited stakeholders showed up and a session emerged, where learning and future planning were executed between the participants.

First of all, I would like to thank all the respondents and participants for spending some of their valuable time to share their insights, expertise and personal experiences. There are a lot of people that somehow contributed to my research. I am very grateful that I have gotten the opportunity to work at Elemental water makers, where Reinoud and Sid provided me with a pleasant entrepreneurial environment. I would like to thank my supervisors for their time, comments and motivating attitude: Especially Telli for her guidance in the first months in finding the right direction in a labyrinth of theories; Jaco for his guidance in the interesting backcasting literature and precise comments and Paulien for her inspiring project proposals that enabled me to do this study.

Furthermore, I would like to express a special word towards my father and mother and also to the loving community in the company EEDAS (electricity company San Andres) that provided contacts and feedback. Next, the owners of the hostel were I stayed during my time in San Andres, were amazing to me. Ilse and Bernard thanks for being my second mam and dad and for the Caribbean vibes during my stay! This graduation project was definitely the icing on the cake of my study time!

Chris Dingemanse. Delft, 4 September 2013

EXECUTIVE SUMMARY

Transition towards sustainable water management

Newly build pathways are needed to speed up the transition towards sustainable water management. Especially in Island conditions the change needs to happen before natural resources like the aquifer are depleted. The sea is an infinite water supplier, but due to high salinity the desalination process will always require considerable amounts of energy. Fossil fuel powered desalination contributes to climate change, which, in turn, affects the water cycle, leads to a high water price and intensifies the original problem that desalination was intending to solve. Safeguarding of a common pool resource necessitates good governance and structured long term planning. However, due to deep seated corruption in the government of Small Islands Voice areas, sustainable planning of natural resources, such as water fails. Furthermore, local stakeholders are willing to enable the transition and are aware of the future problems, but the question is how to merge these different requirements into one clear future vision and planning. Therefore, the research seeks an answer towards the following question:

How can San Andres develop a supported pathway towards a sustainable water system for the island in 2030?

Research methodology

Economic issues are not the only problem that prohibits a more sustainable water system. Impacts at various levels of the socio-technological environment affect planning and decisions, like ecological, cultural, social and institutional issues. Therefore this research aims to develop a method that allows the inclusion of key values and emerge supported pathway towards a sustainable system. To assemble these requirements, backcasting and value focused thinking were selected as starting point. The backcasting methodology meets the constraints, but also causes a loose end that could be resolved by adding value-focused thinking. The combination of the 2 leads to a methodological approach, that takes into account technological, economic, cultural, institutional, organizational and spatial aspects.

With the main objective: *design a practically usable and generically applicable framework for emerging supported pathway towards a sustainable water system*, a preliminary framework was proposed, executed, appropriately refined and thoroughly discussed on the use of theory and quality of the framework

Results

The tangible (hard) results are stated first, where after the intangible (soft) results are presented. The case study started with interviews that harvested the values of the participants and displayed that the local stakeholders are aware of future problems, but that due to deeply formed corruption and disbelief in the local government no common action was executed. Next, a value driven brainstorm generated four visions:

- Rainwater harvesting
- Recycling
- Smart Use(r)
- Renewables energy systems (RES)

During the workshop day, these visions were elaborated upon in groups by first drawing a desired system, identification of barriers and generation of solutions to overcome these barriers.

The backcasting process established a set of outcomes that were translated into clear decision objectives. This translation emerges the possibility to score the objectives on the values of the participants. The result of this process is a value driven assessment on the

various strategic objectives. Strategic objectives with a low added value are removed, because no social or stakeholder support exists in realizing that objective. The government and/or participants could use this list of supported objectives for decision making in the future.

The supported strategic objectives are back casted by the participants to overcome the barriers. However, the plans need to be elaborated in more detail to create a clear implementation agenda. Therefore, the analyst merges his insights with the most supported outcomes in a five point's kick-starter plan. Next, parties need to take responsibility and form coalitions in a proposed second workshop.

Furthermore, two coalitions were formed in the actual workshop. The company that facilitated the analyst (EEDAS) searched for a social responsible investment in order to increase the social credibility of the company. Through contact with the researcher and attendance in the workshop the aerodizilinador was selected as an opportunity to install and the contracts were assembled to create this possible business deal. Currently, EEDAS is searching for the best spot to install the aerodizilinador.

The research also resulted in intangible (soft) results: the framework succeeded in putting attractive future visions or normative scenarios on the agenda of relevant societal and political arenas. The participants represented 75 % of the important people in the water business and society in San Andres and therefore can be concluded that agenda setting of this group is quite successful.

Also, a follow-up agenda containing activities for different groups of stakeholders contributing to the pathway was generated. During the workshop groups were assembled following the key values of stakeholders, which allows for congenial groups that work together instead of having arguments. For example, Coralina employees were teamed up with commercial water producing companies. The stakeholders decided to team up and create a workgroup that enables the transparency of the aquifer towards the users.

Finally, a survey under the participants displayed that stakeholder awareness and learning with respect to the options, the consequences, and the opinions of other stakeholders occurred. Various questions were asked by the participants and learning occurred from understanding the situation towards learning about future developments that could solve the problem.

Conclusions

The participatory nature of the framework created the opportunity to disconnect participants from business as usual and get them into the next paradigm. Next, the methodological framework enabled the comparison and structuring of the outcomes of the backcasting session. Furthermore, the multidisciplinary nature of the problem is echoed by the theory because the social, technological and institutional mechanisms are addressed.

The framework emerges supported value driven strategic objectives, which are clear in nature, but need to be elaborated upon in more detail in a second workshop session to generate a full plan with parties that take their responsibility for certain parts. Therefore, the analyst provided a short plan to kick-start the implementation workshop. The framework fails in emerging clear and detailed plans towards the future.

On the other hand, the framework succeeds in:

- Learning about other participants values
- Emerging normative visions
- Agenda building for relevant parties
- Coalition building

Furthermore, the framework is highly transferrable towards other islands.

Recommendations for San Andres

First off all, the Providence Foundation should host a second workshop were the results of this report are discussed, coalitions are build and detailed plans with responsibilities are formed. Furthermore, the advice towards the stakeholders is cooperating with authorities and emerge a “water committee or foundation”, where local stakeholders meet every two months and discuss the situation regarding water management and aquifer behaviour.

Recommendations for future use of framework

First off all, the framework is guidance towards certain planning activities that only activate participants desires and needs for a future system. In retrospect, the framework is as rich as the participant’s creativity and thoughts. Therefore the framework is largely dependent on the selection of the participants and this should be executed by the analyst with great devotion and thoroughness. Also the choice of an entrepreneurial analyst that is independent from stakeholders in the process is highly recommended. Finally, the transmission system operator (TSO) in San Andres asked for the execution of the framework on the electricity system of San Andres. The opportunity is already there, sent an email if you are interested and willing to develop this island towards a more sustainable way.

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1. INTRODUCTION

1.1 Water planning for small islands

The world water crisis is one of the largest public health issues of our time. One in eight people (884 million people) lack access to safe water(Gourbesville et al., 2008). Numerous areas in the world are gradually developing towards cleaning of brackish or sea water in order to cope with the increasing demand of water. The trend is intensified by climate change, which seems to be already affecting the water cycle resulting in long periods of drought. The sea is an infinite water supplier, but due to high salinity the water cleaning processes will always require considerable amounts of energy (Fairmond and Kaye, 2011).
Fossil fuel powered desalination contributes to climate change, which, in turn, affects the water cycle and intensifies the original problem that desalination was intending to solve. (UNESCO, 2012). The development of the water treatment and distribution systems has been acknowledged as one of the greatest engineering challenges of the 20th century by the US National Academy of engineering(Wulf, 2000). Due to the shortage of fresh water from rivers or lakes, high dependency of fossil fuels in water production, abundance of renewable energy resources in water production, changing rain patterns caused by climate change and el Niño phenomenon, deep vested corruption and lack of economies of scale in energy production, islands face the largest costs providing water to inhabitants and are therefore considered the most vulnerable areas (UNESCO, 2012).

The Small Islands Voice (SIV) is a group of 13 islands that share similar characteristics related to water management. The combination of above mentioned factors make water production not only expensive but also bears health risks in the long term(Council, 1996). The shortage of fresh water, growth of living standards and decreasing rain drive the inhabitants to fossil fuel powered desalination process. The main problem is twofold: (1) Due to rising energy prices and reliance on imported fuel the water produced is expensive and (2) Due to rising water demand, depletion of aquifers can intensify above mentioned problem and endanger the eco system. Interestingly, all the SIV are located in areas with high solar radiation and large wind availability, so harvesting these renewables resources is an opportunity to lower the dependency on fossil fuels and lower the cost of water per cubic meter. The exploitation of these resources is crucial to safeguard the accessibility of the basic need of water (Weisser, 2004). The aquifer is a common pool resource. Safeguarding of a common pool resource requires good governance and long term planning (Ostrom, 1990). However, due to deep seated corruption in the centralized government of SIV areas, sustainable planning of natural resources often fails. (Robbins, 2000).

FIGURE 1 SAN ANDRES ISLAND

1.2 The Isle of San Andres

San Andres is one such a remote island (see figure 1). It is situated 750 km from the Colombian main land and about 230 km east of Nicaragua in the UNESCO Biosphere reserve “sea flower”. Biosphere reserves are sites established to safeguard conservation of biological and cultural diversity and economic and social development through partnerships between people and nature (UNESCO, 1996). The island has an area of 26 km² with a resident population of 75.000 official inhabitants, which is

equivalent to more than 3000 inhabitants/km² and is therefore the most densely populated island of the Caribbean (Estadística), 2005). The residents, commercial buildings, offices and an average of 475.000 tourists per year cause a demand of 15.200 m³ water per day (Atkinson, 2005). This demand is for 66.6 % caused due to domestic users and for the other 33.3 % by the commercial users. The source for supply is for 75 % the aquifer, 20 % rainwater and 5 % imported (see figure 2)

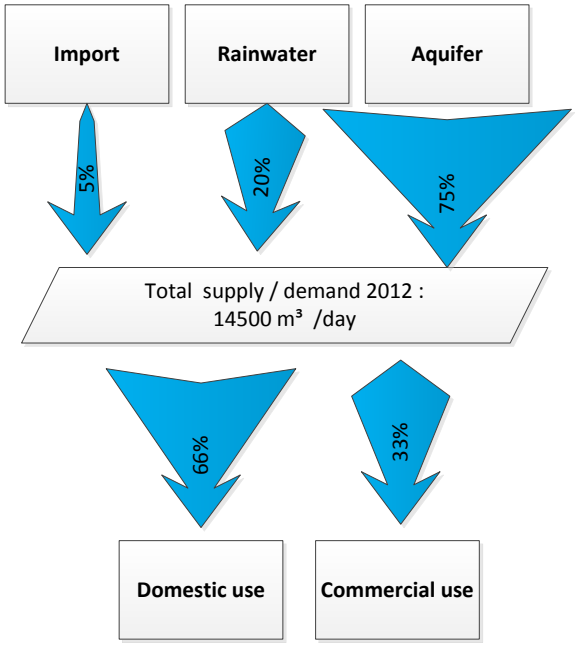


FIGURE 2 WATER FLOW SAN ANDRES

San Andres's development is closely related to its geographical situation, energy production and water management (Chen et al., 2007, Duic et al., 2008). Insular and remote regions such as islands present unequivocal problems related to the isolation, the small size of the energy market and therefore the lack of large scale conventional utility supply (Kristoferson et al., 1985). Interestingly, San Andres has the potential to produce water through renewable energy sources which, as indigenous resources, do not require costly fossil fuel usage (Weisser, 2004). San Andres has with more than 2600 sun hours annually ,an average wind speed of 5 m/s a high degree of solar and wind penetration (A.R. Jimenez, 2011). Next to that San Andres has an annual average rainfall of 1800 mm. Rainwater harvesting and renewable energy can play a role in the safeguarding of affordable water prices, safeguarding of the level of the aquifer and the supply of water on the insular island (Connolly et al., 2010).

San Andres has 32 water wells, but only 17 wells are allowed by the environmental department of the government (Coralina) to be used for exploitation of water (Atkinson, 2005). The private water utility company Pro Activa and other distributors of water are restricted in tapping water from the other 15 the wells by Coralina through water quota. The central water supply system in san Andres consists of a network of pipes and a desalination plant. The system of the water company Pro Activa produces 2074 m3 potable water per day. This covers 30% of the total potable water demand (Atkinson, 2005). The other 70% needs to be imported through bottled water, produced through desalination techniques by other private parties or be solved by rainwater harvesting on San Andres. The combination of high costs for transportation or production of the fossil fuels and lack of economies of scale makes water supply on San Andres expensive.

Next to the dependency on fossil fuels for the production and transport of potable water San Andres is highly dependent on the aquifer. 75% of all the water used on the island is extracted from groundwater (Taylor, 2000)(see figure 2). The pressure on the level of the aquifer is

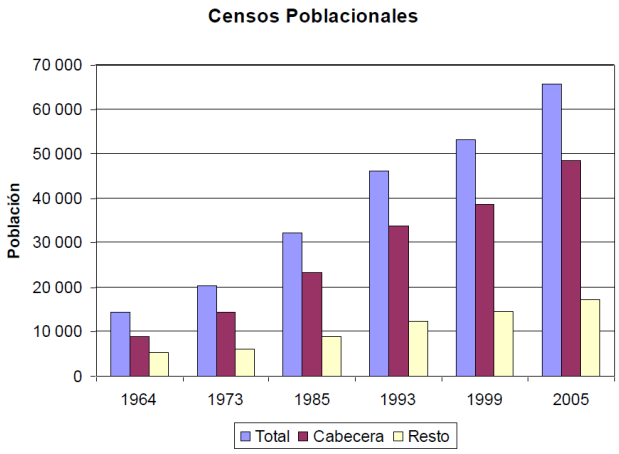


FIGURE 3 POPULATION ON SAN ANDRES (1964-2005)(GUERRERO, 2010)

growing by a combination of (1) population growth (see figure 3), exponential growing range of tourists visiting the island (see figure 4) and (2) the growing water usage of the consumers of the system(Guerrero, 2010).

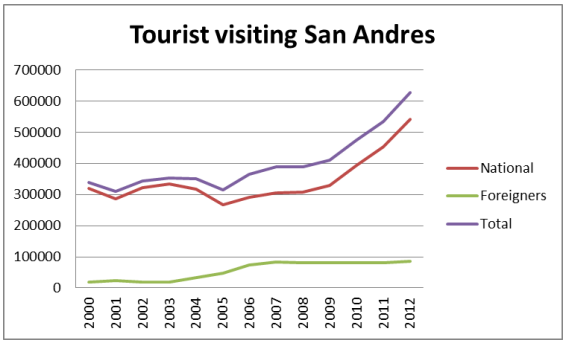


FIGURE 4 TOURIST VISTING SAN ANDRES 2000-2012 (OFFICINA DU TOURISMO, 2013)

The island aquifers are underground floating bodies surrounded by seawater. These aquifers can change through adjustments in sea level or by altering climate parameters, such as precipitation and temperature. At the physical level the Island of San Andres aquifer presents complex features of anisotropy and heterogeneity due to ground conditions (Guerrero, 2010). Aquifer-sea interface adds complexity to the phenomenon, given the differences in density between the two fluids: freshwater-saltwater. Climate variations affect the quality of groundwater, saline intrusion, and the amount, by reducing the total rainfall and average temperature increase, with consequent increase in evapotranspiration, which may cause decrease in recharge volumes.

From all mentioned above the aquifers are difficult to monitor and manage by the controlling agency. The level of the aquifer is “controlled” through a permitting system by Coralina. Since inhabitants do not need a permit for personal use, almost all households have a well. This results in an estimated 5000 uncontrolled domestic wells(Atkinson, 2005). The level of the aquifer has shown a steady decrease in the last years (Guerrero, 2010). Through this depletion of the aquifer salt intrusion happens and the sea water causes higher salt gradients in the aquifer.

Water is never re-used in San Andres. The waste water that is collected is pumped directly into the sea where a submarine construction elevates the water at a depth of 19,5 meter (Atkinson, 2005). According to Coralina, the sea then takes care of the cleaning of the waste water before it enters the UNESCO biosphere reserve “Sea Flower”. The rest is put in septic tanks where sand takes care for the “cleaning” of the waste water. After this cleaning the contaminated waste water flows back into the aquifer.

To meet the standards of the Millennium development goals, the government of Colombia decided to invest in a large scale water distribution system for all the inhabitants of San Andres in 2005. The system entails storage tanks and water pipes through the whole island, which connects 70% of the inhabitants to the desalination plant of Pro Activa. Pro Activa is the owner of the distribution system. A share of the profits of Pro Activa was expected to maintain and enlarge the water distribution system. Through the disability of many inhabitants to pay the bill for the water utility, the majority got disconnected and saddled with huge debts. The attraction of the water distribution system declined further by illegal distraction of water and leaks in the system that together take care for 70 % of the total distributed water. This emerges that the 30 % of the consumers that are registered to receive water, pay 100 % of the water bill. This enhances more customers switch to the big scale water distribution trucks, which are heavy polluting the street views and the air of San Andres.

In addition to population and demand aquifer pressures, climate change will probably further exacerbate the groundwater problem on San Andres. The Intergovernmental Panel on Climate Change (IPCC) predicts between a 0.18 to 0.59 meter sea level rise by 2100(Pachauri and Reisinger, 2007). Rising sea level will increase groundwater salinization, which enhances the need of more energy to fabricate clean water. Furthermore, in 2050 water resources on Caribbean islands might be insufficient to meet

demand during low rainfall periods(Pachauri and Reisinger, 2007). To change the above described situation the government of San Andres has set up a research group with the National University of Medellin, to which the Providence Foundation signed an inter-administrative agreement for the development of scientific, technological and policymaking activities in this field (E. Perez, 2012). The mission of the focal owner and host for the research, Providence foundation is written down below and her mission on water management is displayed in a means to and end diagram (appendix II).

To manage, protect and restore the environment of the island of San Andres by applying appropriate technologies aimed at knowledge of the supply and demand of renewable natural resources, tending for sustainable human development and involving the community and companies so that in a concerted supported way improves the quality of life of the region.

The Providence Foundation is a part time driven Non-Governmental Organization that searches for external researchers to solve regional problems. The opportunity for this research was created in combination with clean tech start-up Elemental Water Makers and the Climate KIC programme that financed the required funds for the research.

Finally, San Andres is located in a UNESCO Biosphere reserve, which is established to safeguard conservation of biological and cultural diversity and economic and social development through partnerships between people and nature(UNESCO, 1996). The reserves are quintessence to test and demonstrate innovative approaches to sustainable development from local to international scale, where the United Nations develops sites of excellence. Furthermore, the reserves are optimal practices to manage nature and human activities. These are tested and demonstrated, which creates an excellent place for testing new pathways towards a sustainable water management.

1.3 Problem introduction

Transition in the water system is needed to solve above problems mentioned problems and realize a change towards a sustainable system. When performing such a research it is imperative to take on a multi-disciplinary approach, because potable water is an essential service to society (Finger et al., 2006). Future studies enable transitions by implementing combinations of technological, cultural, social, institutional and organizational changes, which cause effects on many stakeholders when executing these plans into society and emerge complex social change in the long term(Quist and Vergragt, 2006).

The literature of future studies distinguishes between likely futures, possible futures and desirable futures. "The majority and first group of forecasting approaches concentrates on likely futures and are projective in nature, using, for instance, trend extrapolation and quantitative historical data" (Quist, 2007). Ttraditional forecasting is only reliable in the case of well-defined systems like existing markets and in the short term (De Laat, 1998) cited in (Quist, 2007). As dominant trends build on forecasting methods, it is unlikely that the generated solutions incriminate revolutions in the problem areas (Dreborg, 1996). The second group of future studies focusses on possible futures or scenario building methods. Famous examples are the shell scenario method(Cornelius et al., 2005) and the reports on technical and socio-economic information produced worldwide relevant to the understanding of climate change on behalf of the Intergovernmental Panel on Climate Change (IPCC) (Girod et al., 2009). The final group focusses on the desirable futures and is the least wide applied (Quist, 2007). Backcasting is a well-known example of this approach (Vergragt and Quist, 2011, Robinson, 2001).

Various hypotheses have been proposed to cope with complex problem to identify attractive and

desirable system changes (Quist and Vergragt, 2006). The question of how to involve different stakeholder groups in exploration, starting and implementing these changes is far from straightforward. According to (Quist et al., 2002) bringing about system innovations requires new integrated approaches that should at least combine:

- Involving a broad range of stakeholders and actors from different societal groups including government, companies, public interest groups and knowledge bodies, not only when defining the problem, but also when searching for solutions and conditions and developing shared visions.
- Incorporating not only the environmental component of sustainability, but also its economic and social components.
- Taking into account the demand side and the supply chain as related production and consumption systems.

The transition towards a sustainable water system requires future visions and revolutionary change, which automatically points at members of the desirable futures group. In this group the backcasting methodology is the best suited option to comply with the inherent uncertainty and non-existing market of sustainable water supply.

Whereas much has been engraved and explained on the theoretical values of the backcasting methodologies, such as the ability to freely discuss problems with stakeholders who have conflicting interests and that content and process is integrated in a practical approach, the method has also his drawback. Most of the methodologies of back casting are largely silent on the issue of identifying interventions in the present (Wilson, 2006). The method lacks the attention towards to how interventions are identified(Dreborg, 1996, Holmberg, 1998, Quist 2003).

In contradiction to above statement, the applications of the backcasting methodology in the Sustainable Technology Development (STD) project focussed on the interventions and follow up of the process(Quist, 2007). Also the Natural Step (TNS) backcasting approach stresses the implementation of the outcomes. Therefore, these approaches of this methodology are taken as a starting point in this research. In contradiction to the TNS methodology, the research is executed in a multi actor setting, which requires new solutions. Therefore, the report elaborates on the problems of the backcasting methodology in a multi actor environment and searches for synergy with the Value focused thinking methodology to solve above mentioned problem and emerge a new policy building methodology that is applicable towards sustainable utility planning for remote areas.

1.4 Goal

The multi-actor context emerges multiple goals. In order to develop a clear shared goal, a high level goal is set in collaboration with the director of the providence foundation, the focal owner of the research:

> *Construct a supported vision and pathway towards a sustainable water system for the island of San Andres in 2030.*

The search towards the supported policy building method entails the components of the future are characterizations of different technologies, social changes and institutions that together enable the transformation of the water system into a sustainable system.

Technological

The conditions towards innovation in a mostly public-private owned market are conservative. Therefore the technological innovation is somehow predictable by including inventions and state of the art start-ups in the research.

Social- Economical

A social goal positions itself in involving a broad range of stakeholders and actors from different societal groups including government, companies, public interest groups and knowledge bodies, not only when defining the problem, but also when searching for solutions and conditions and developing shared visions(Quist, 2006). Furthermore, the research tries to emerge a learning effect between stakeholders about perspectives and mutual recognition of the problems faced. An economical goal is to safeguard the affordability of the water costs towards the various sorts of consumers.

Regulatory

The water supply system is associated with a change of regulation and rules. The identification of current regulations and requirements concerning water supply for consumers must be assessed on the possible barriers for the process.

Research goals integrated view

When all of the above mentioned factors are clear, possible conclusions and recommendations can be given on the implementation of a sustainable water system for San Andres from an integrated view. If for example sustainable drink water supply is technically possible and the social and regulatory environment poses barriers, conclusions and recommendations can be given on what steps should be takes in order to overcome the barriers. These conclusions and recommendations will be presented in a pathway towards sustainable water system in San Andres. Furthermore, the identification of barriers could be used as a starting ground for further research towards a sustainable system in San Andres in 2030.

1.5 Research questions

The methodological framework that is constructed is put onwards the scientific discussion as an addition and a refinement of the policy building methods towards sustainable systems. From the above description of the problem and the research goals, the main research question is formulated. To be able to answer the main research question, several sub-questions have been developed. The questions are stated below and derived through the combination of back casting and value focused thinking (see appendix V).

Main research question:

How can San Andres develop a supported pathway towards a sustainable water system for the island in 2030?

Sub-research questions:

Descriptive theory

1. How can back casting and value focused thinking actor analysis be integrated into one methodological framework?

Pre-assessment scan of water systems

2. a) What is the current situation regarding the water system in San Andres?
   b) What are the current developments concerning sustainable water systems? (potentials)

Solution space / Case specific analyses

3. What are desirable visions for achieving a sustainable water system on San Andres in 2030?
4. Which interventions and actions can be identified to develop a supported policy towards a sustainable water system for San Andres in 2030?

Synthesis/ conclusion/generalization

5. To what extent is the framework of back casting and value focused thinking applicable to grade and develop pathways towards supported pathways towards sustainable planning?

1.6 Research scope and system boundaries

The geographical as well as the institutional and technical demarcation is characterized by the San Andres water system. Furthermore figure 4 shows the water system and flows taken into account in the system.

The demarcation includes all water flows to domestic and commercial consumers. In San Andres almost all houses have access to a rainwater harvesting system to partly solve the needs of the sanitarian system (toilet, shower, washing machine and to water the garden). These flows are excluded because these systems are already renewable driven energy systems. The energy necessary to power these systems is triggered by gravity to flow the water from the cistern tanks towards the usage source.

Agricultural and use of water is not identified in San Andres and therefore not displayed in figure 5. Furthermore, commercial use of water includes use by the following parties: Hotels, shops and offices. Therefore, industrial use of water is marginal, but taken into account while analysing the system.

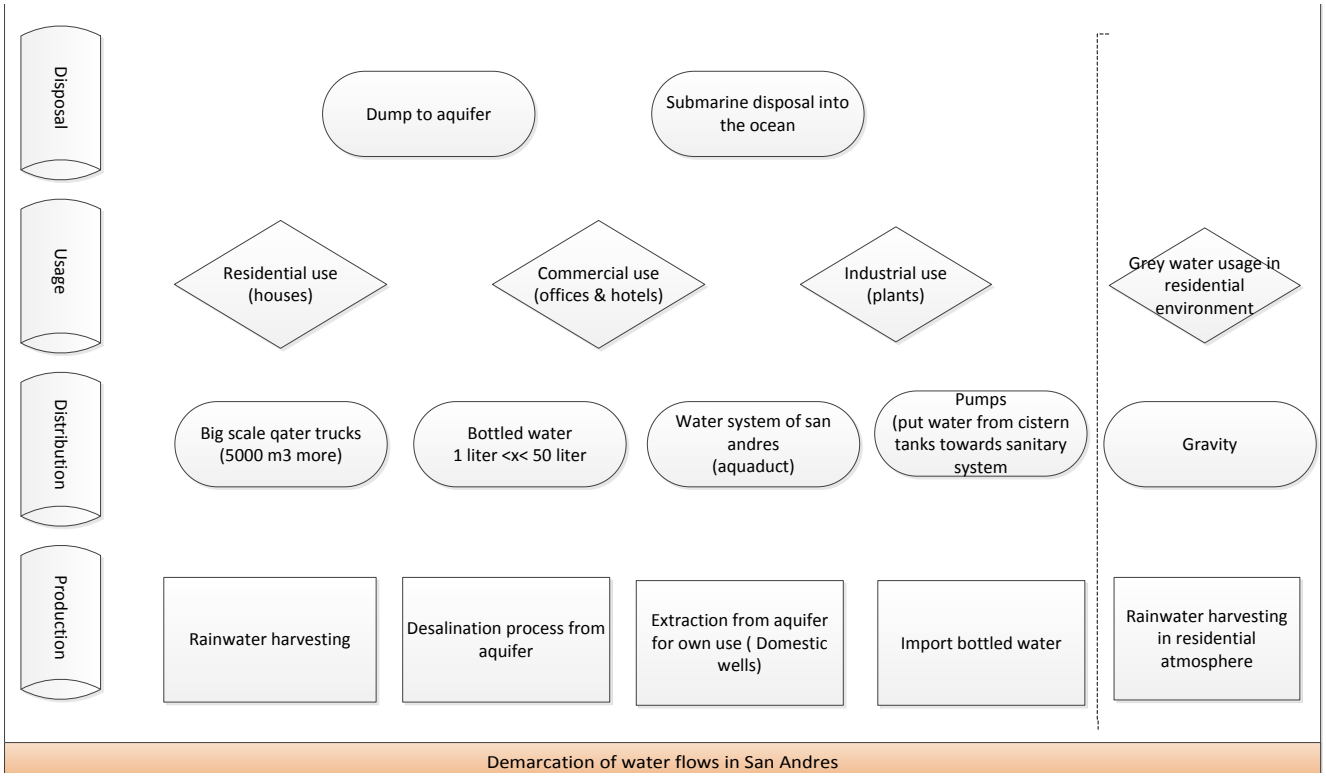


FIGURE 5 DEMARCATION OF THE WATER FLOWS

1.7 Approach

This paragraph shows the approach of the study (see figure 6).Chapter 1 displays a first rough image of the problem by assessing existing knowledge from reports derived from the Providence Foundation. This assessment leads to the research question. In order to answer the research question the research is performed in five chapters. Chapter 2 will focus on the theoretical foundations of the future planning methods. This results in a proper understanding of the research problem and the proposal of a conceptual methodological framework. Chapter 3 entails the application of the theoretical part to emerge a supported policy towards a sustainable water system for San Andres in 2030. Including the case study, where interviews and the workshop take place.

Chapter 4 entails the evaluation of the instrument based on the requirements and goals that are set in the literature study. Based on the results of the case study, the framework is evaluated and suggestions for improvements and further research are formulated. Finally, chapter 5 shows the conclusions and recommendations for possible future use of the framework.

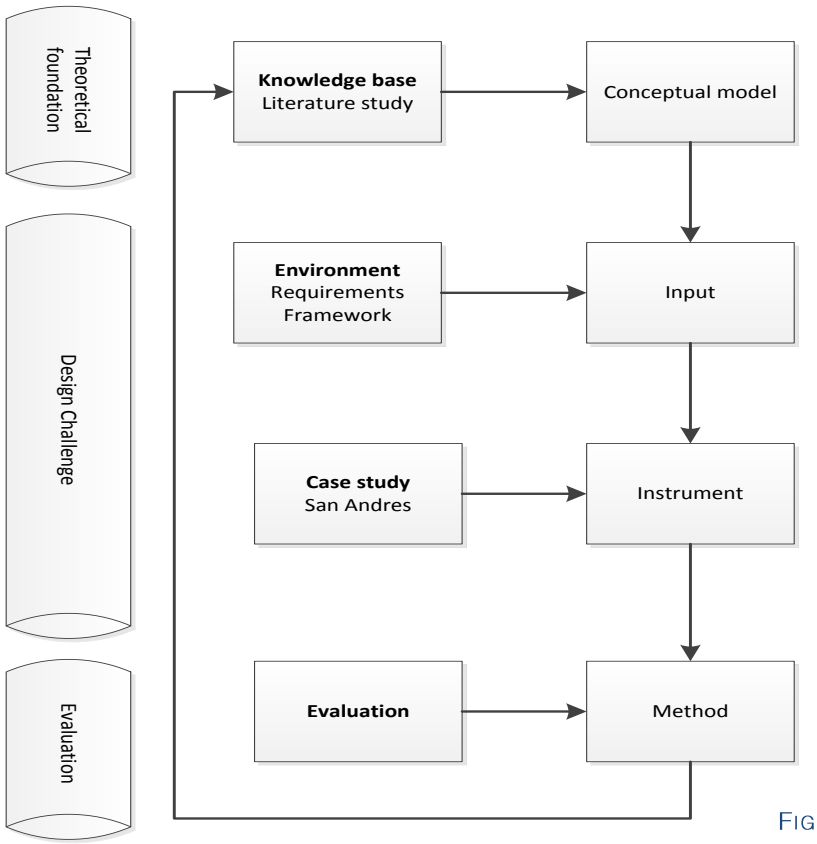


FIGURE 6 RESEARCH APPROACH

2. METHODOLOGICAL FRAMEWORK

2.1 Backcasting

Chapter 2 introduces the backcasting methodology and schematizes all the different backcasting methodologies in order to create a good insight in the building blocks and methodologies that exist in the literature. Backcasting enhances the generation of a desirable future vision, where after the methodology provides a path towards the present (see figure 6.)

Backcasting methodology originated in the 1970s in energy studies and evolved into a methodological framework for system innovations towards sustainability by means of normative and desirable futures(Quist and Vergragt, 2006).

According to Dreborg (1996) backcasting is especially useful in situations of complex societal problems when there is need for major changes and horizons tolerate future alternatives that need years to mature. Backcasting can be described as the development and assessment of the relative feasibility of alternative futures(Robinson, 1990) or as generating a desirable future, and then looking backwards from that future to the present in order to strategize and to plan how it could be achieved (Lovins, 1976). “The analysis is framed by a problem context in which current problems are resolved in the future through choice rather than one in which solutions are constrained by dominant current trends” (Robinson, 1988, Dreborg, 1996).

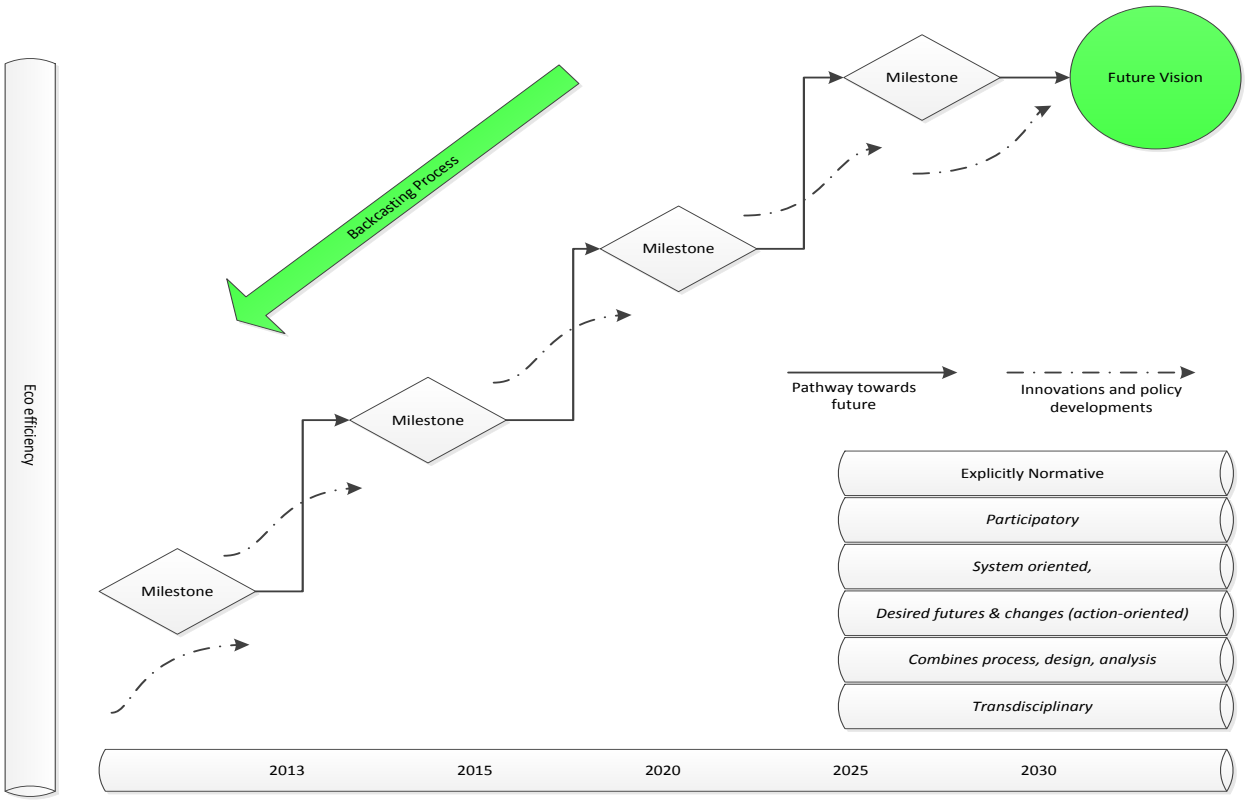


FIGURE 7 GENERAL PRINCIPLE OF BACKCASTING PROCESS

Quist (2007) analysed and described four different backcasting approaches:

- The backcasting approach of Robinson(Robinson, 1982).
- The Natural Step backcasting methodology, as reported by Holmberg and Robert (Holmberg, 1998).
- The STD backcasting approach(Weaver et al., 2000).
- The participatory backcasting methodology applied in the international Sustainable Households project (Green and Vergragt, 2002, Vergragt, 2005)

2.1.1 Backcasting approach of Robinson

John B. Robinson proposed and introduced the term backcasting into the world and created the first schematic diagram about the back casting process (see figure 3). Robinson has always accentuated that the purpose of backcasting was not to yield precise proposals, but to show the relative feasibility and diverse social, environmental and political implications of different energy futures(Robinson, 1990). Furthermore, Robinson worked out the principles defined by Lovins (1998) into a sequential six-step methodology for energy and electricity futures (see figure 8). The methodology does not include a certain set of tools to safeguard the process, but various groups of methods are mentioned: scenario impact analyses, modelling and scenario approaches.

Especially the modelling part is one of the key elements in defining effects in the change of parameters over a period of 50 year (see step 6 figure 8). This process where Robinson tries to simulate future effects of decisions is surrounded by uncertainty and the need of large data sets. During the Georgia Basin Futures Project (GBFP), preferences and beliefs with expert knowledge produced future scenarios of the Georgia Basin region of western Canada. With the impact analysis the core of the GBFB project hosts the QUEST modelling system, a computer-based, interactive scenario generation tool collected contributions from participants in order to produce future scenarios that are then explored in terms of the social, environmental, and economic impacts of user(Robinson, 2001). After this impact analysis the implementation requirements are set who provide a political push towards new objectives.

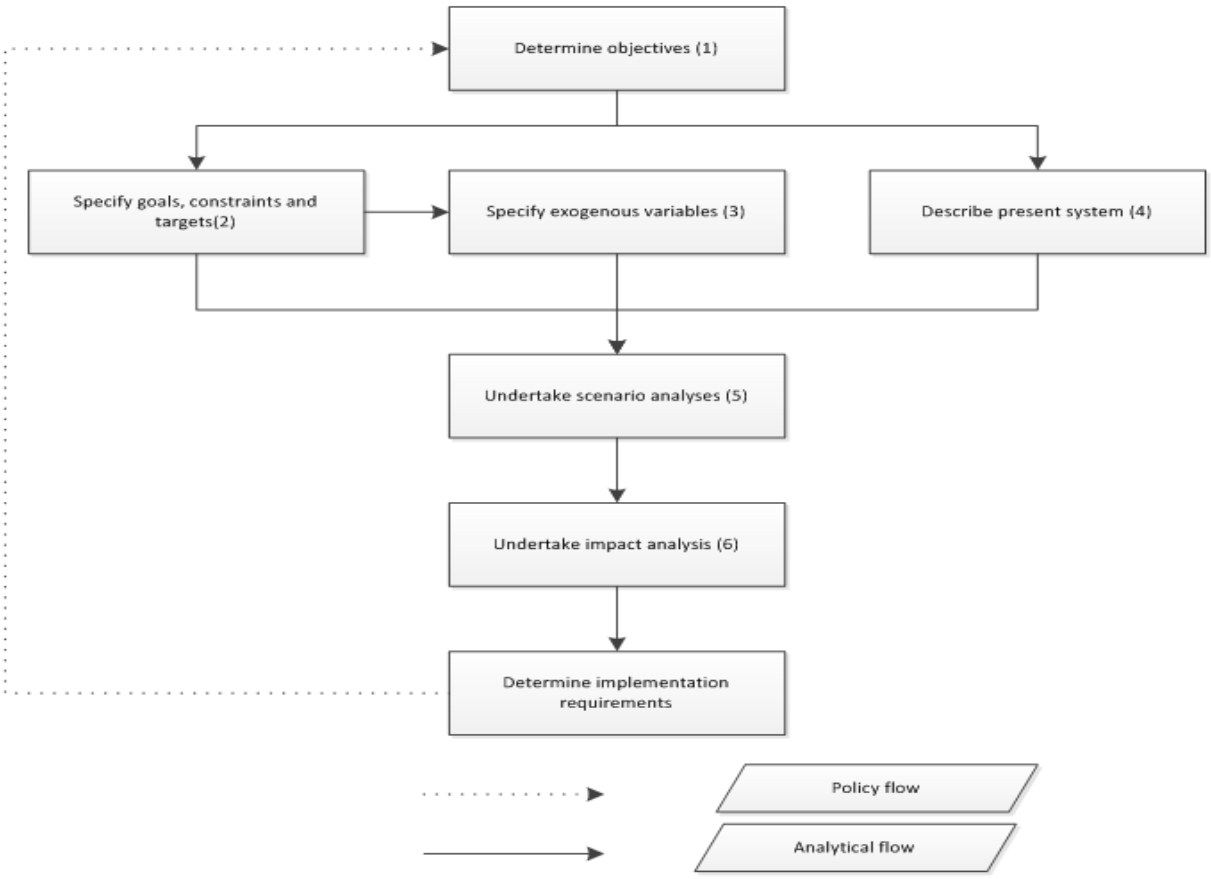


FIGURE 8 SCHEMATIC REPRESENTATION OF BACKCASTING (ROBINSON, 1990)

2.1.2 The natural step backcasting methodology

The natural step (TNS) backcasting methodology was defined by Holmberg in 1998. The pillars of the backcasting methodology are found in the decrease of depletion of natural resources, the safeguarding of eco systems and fair and efficient usage of resources in line with the equity principle(Holmberg, 1998). The methodology entails four steps (see figure 8). The first step is to delineate the framework for sustainability at the hand of above mentioned key assumptions. The second step entails a description of the current situation, the present situation and the supply and consumption chain of the entity. This identifies possible sustainability bottlenecks. The third step entails the creation of future visions with the aid of employees, for which creativity techniques can be applied (Holmberg, 1998). These future visions are thoroughly discussed in the organizations and new activities can emerge out of this discussion. Finally, the fourth step takes care of the milestones and the process that guide the present towards the future situation.

``Although Holmberg (1998) does not elaborate on particular methods of participation, he refers to employee involvement, discussing the results widely within organizations, creativity techniques, developing relevant sustainability criteria, strategy development, training and consulting employees, and translating the outcomes into the organization's activities and policies``(Quist, 2007). The tools used in the TNS backcasting methodology are not explicitly stated. The methodology refers to a" scientifically rigorous framework" that gives organisations the tools to perform a gap analysis using the lens of sustainability, and then work toward closing the gap. Furthermore, the framework refers to strategic sustainable development complements other sustainability tools and methodologies, such as life cycle analysis or environmental management systems, by providing the context and strategic vision that makes them more effective (Holmberg, 1998).

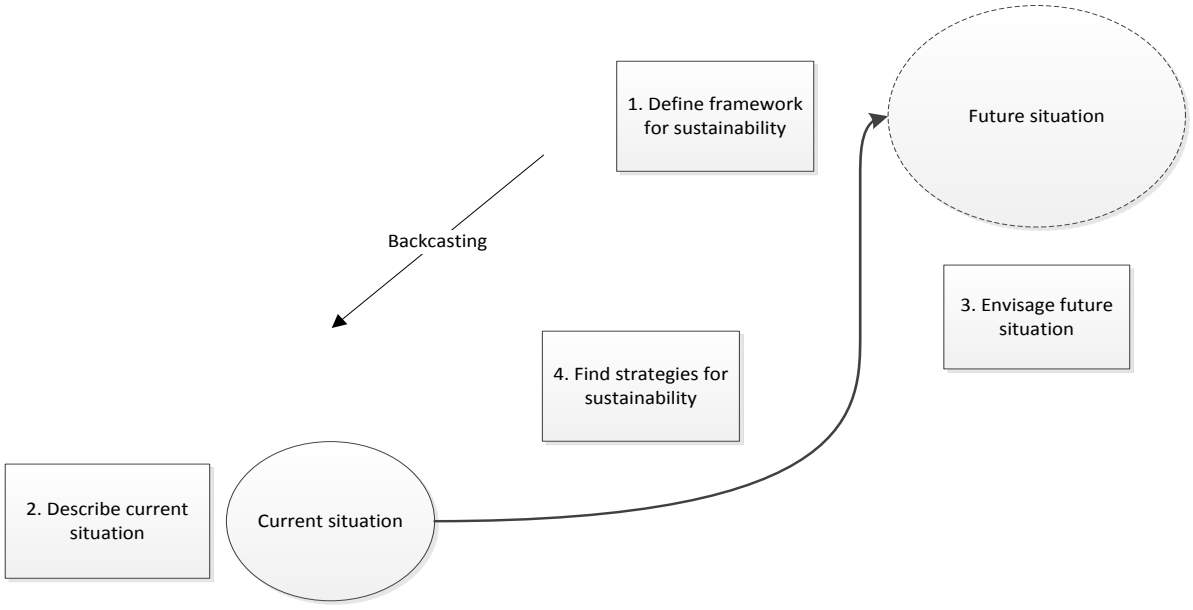


FIGURE 9 THE NATURAL STEP METHOD (HOLMBERG, 1998)

2.1.3 The STD backcasting approach

The STD backcasting approach originated during a Dutch Government program for Sustainable Technology Development that run from 1993 to 2001(Quist, 2007). The main focus was to achieve sustainable fulfilment of needs in the far future, through the use of a backcasting methodology that comprised widespread stakeholder input and future vision development. The STD backcasting approach was described by (Weaver et al., 2000) and entails 3 phases that together consists of 7 steps (see figure 10). The first phase consists of 3 steps and involves the long term vision development. In phase 2 the short term vision development is realized through the exploration of options and the choice and clarification of short term actions. The last phase (step 6&7), deals with implementation, facilitating stakeholder cooperation and realizing the action agenda(Quist, 2007).

The idea is that the involved stakeholders set up cooperation empowering the follow-up agendas. The STD backcasting methodology permits an iterative process wherein there is room for dynamic step behaviour(Quist, 2007).

The methodology focusses on the implementation of follow up and agenda setting, while taking into account that technology development is restricted by cultural and structural conditions. The method that are used in this backcasting approach to develop future visions are essays by experts, the TvC methodology, creativity workshops, the Delphi method and the significance of visualization and communication(Aarts, 2000).

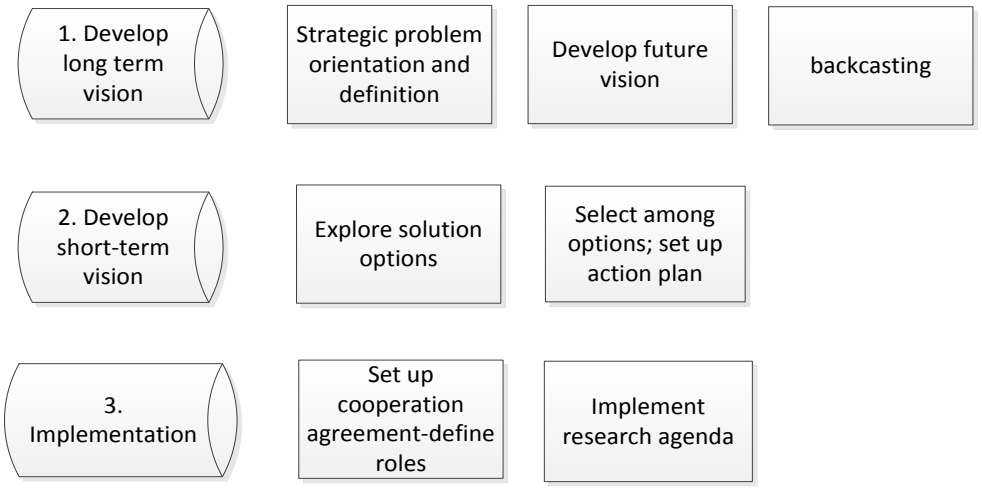


FIGURE 10 STD BACKCASTING APPROACH (WEAVER ET AL., 2000)

2.1.4 Participatory backcasting method

In 1988 Boulding and Ziegler started future visioning workshops with participatory elements by the invitation of 100 persons towards envision aging a more peaceful world 20-50 years hence. The question: "Think about what it is like in this peaceful world" emerged into a shared vision and marginal backcasting process(Boulding and Ziegler, 1988). In the 1990s participatory backcasting methodology developed in mainly the Netherlands, Canada and Sweden (Vergragt and Jansen, 1993, Dreborg, 1996, Holmberg, 1998). Furthermore, the participatory backcasting methodology was used in other domains (e.g.) for households (Green and Vergragt, 2002), industrial coatings (Partidario and Vergragt, 2002) and hydrogen economy planning (Hisschemöller et al., 2006). Furthermost of these projects are related towards sustainability or a systematic societal change that was needed to attain a sustainable system. During the Sushouse project the goal was to involve stakeholders in activities aimed at bringing their cities/towns into line with sustainable development has long been considered to be particularly important for achieving the long-term goals of sustainability adopted by many nations(Carlsson-Kanyama et al., 2008). One of the pilots in the backcasting methodology was the involvement of local actors. The participants discussed sustainability topics linked to everyday life. The purpose of this part of the project was to mature and test a tool in participative backcasting for the involvement of local stakeholders.

Participatory backcasting involves stakeholders in developing, assessing, discussing and adjusting future visions. This arouses a learning process, which may also lead to spin-off and follow up, as was shown for some backcasting studies in the Netherlands(Quist, 2007).

A substantial variety exists in participatory backcasting methodology, but out of literature review Quist en Vergragt emerged a comprehensive methodological framework for participatory backcasting(Quist and Vergragt, 2006). The methodological framework entails five steps and the outline is as shown in figure 11.

Key values in the process are stakeholder participation, first and higher order learning process for the stakeholders and emerging visions(Quist and Vergragt, 2006). "The underlying backcasting approach of the framework is both inter-disciplinary (combining and integrating tools, methods and results from different disciplines) and trans-disciplinary in nature, as it involves stakeholders, stakeholder knowledge and stakeholder values"(Quist and Vergragt, 2006). To engage the stakeholders the following stages and the corresponding toolbox is presented

The first group consists of participatory tools and methods that contain tools and methods that are valuable for the engagement and the interactivity between stakeholders. The second group entails design tools and methods. The third group involves analytical tools and methods. Finally, participatory backcasting obliges a management structure to safeguard the process of backcasting and implementation.

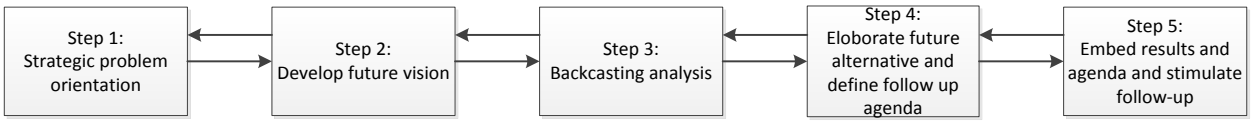


FIGURE 11 PARTICIPATORY BACKCASTING APPROACH (QUIST AND VERGRAGT, 2006)

Participatory backcasting explicates three types of demands: (1) normative demands; (2) process demands; (3) knowledge demands. Normative demands reveal the goal related requirements for the future vision together with the definition of sustainability is drawn into criteria that future visions envisage. Process demands fulfil the needs towards the engagement of stakeholders, the level of influence of stakeholders and how the potential solutions are framed in the backcasting study. Knowledge demands can be defined as the separation between the scientific and the contextual knowledge goals and how these are valued(Quist and Vergragt, 2006). "Interdisciplinary knowledge of the participants does not meet regular disciplinary academic standards, but is crucial for the process"(Quist and Vergragt, 2006). The requirements need to be clear in the start of the backcasting study. This can be created through early stakeholder engagement, but can also be stated by the organizers(Vergragt and Quist, 2011).

Whereas much has been engraved and explained on the theoretical values of the backcasting methodology the method has also his drawback. Most of the methodologies of back casting are largely silent on the issue of identifying interventions in the present (Wilson, 2006). The method lacks the attention towards to how interventions are identified(Dreborg, 1996, Holmberg, 1998, Quist 2003). This partly owes to the application of the backcasting methodology towards exploratory processes of visioning, value elicitation or revelation, and social or institutional learning (Robinson, 2003). According to Dreborg (1996) visions of a desirable future are considered useful starting points for policy-makers, determining the freedom of action in a policy sense, rather than as a detailed structuring device for formulating specific interventions. Backcasting is therefore not the utopian instrument for system planning and includes a loose end. The problem was recognized by Wilson et al (2006).He proposed to add he Value Focused Thinking (VFT) method in the same paper.

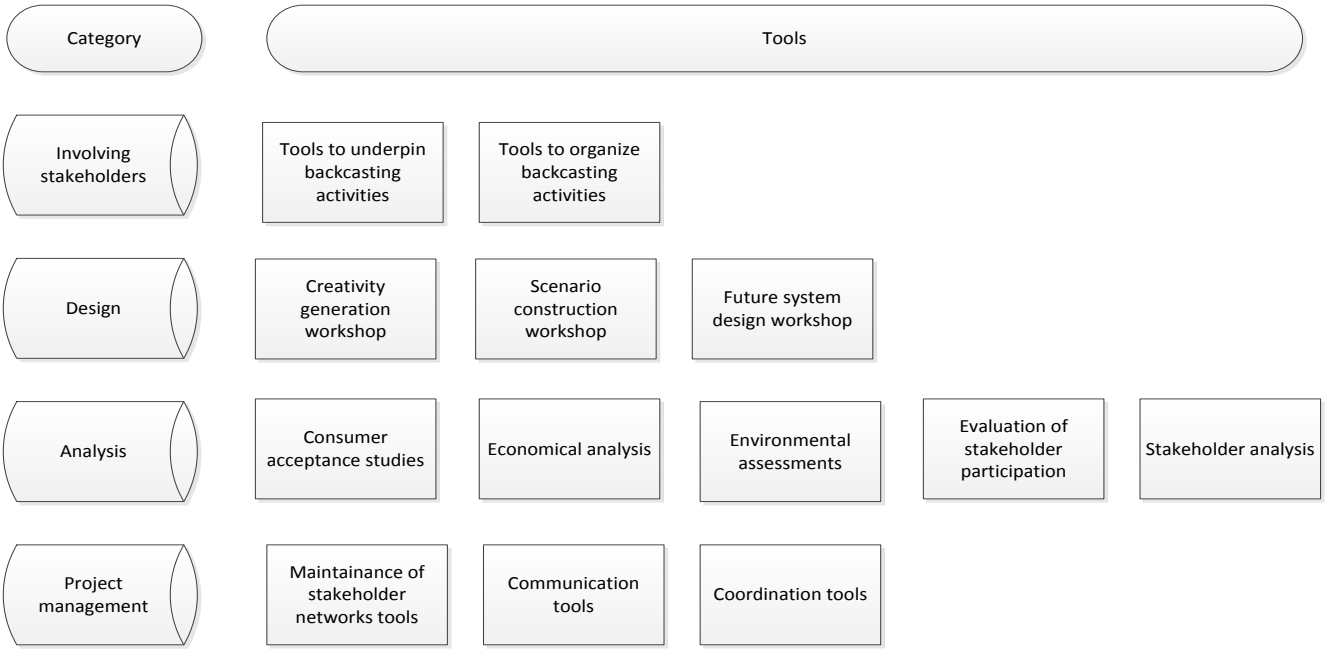


FIGURE 12 TOOLBOX FOR PARTICIPATORY BACKCASTING (QUIST AND VERGRAGT, 2006)

2.2 Value focused thinking

Value focused thinking (VFT) is a member of the family of decision analytic processes. " Value-focused thinking advocates thinking about values first and then evaluating the alternatives present that achieve those values" (Keeney, 1992). Keeney refers to value-focused thinking as an iterative approach between expressing values and choosing alternatives; however, the principle is "values first". According to Keeney (1998) there are multiple uses of value-focused thinking, such as uncovering hidden objectives, guiding information collection, interconnecting decisions, guiding strategic thinking, evaluating alternatives etc. Value focused thinking provides a structured way to think about decisions and develop and support subjective judgments that are critical for good decisions. Value is an ambiguous term. In order to tackle this problem at her roots the definition of values is written down

> *Values are defined as fundamental objectives to characterize an essential reason for interest in the decision situation(Keeney, 1992).*

The decision context is meant to solve the decision problem. The objectives for the decision are categorized into means and end objectives. Fundamental objectives characterize an essential reason for interest in the decision situation(Keeney and McDaniels, 2001). Means objectives are of interest in a decision context because they are a means to achieving fundamental objectives. "For example, lower rent may appear to be an important objective, but it may be seen important only because it would allow a person to improve her living standard, to pursue activities that represent fundamental interests"(Keeney, 1992). Thus, low rent could be seen as a means objective and increase living standard as fundamental objective. Therefore, ends and means objectives can be structured in a hierarchy. Strategic objectives can be in-between fundamental objectives and means objectives. These are evaluated against assessment criteria, which are based on the fundamental objective. The alternative which performs best overall against the decision criteria is selected. "The stepwise process is iterative, allowing for improvement where analysis reveals omissions or misrepresentations" (Hammond et al., 1999).

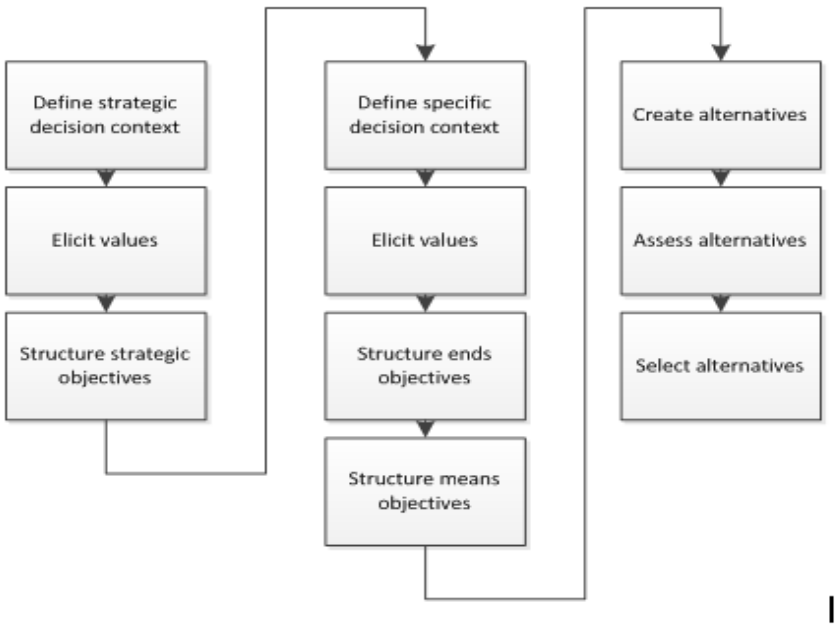


FIGURE 13 VALUE FOCUSED THINKING (KEENEY, 1992)

"The VFT approach is a prescriptive methodology for making decisions in a structured and systematic way"(Keeney, 1992). The proposed methodology applies to structured value-focused decision processes in general. According to Keeney (1992) value-focused thinking helps compared with unstructured methodologies in which values are used as criteria for evaluating a limited set of alternatives; Adopted from: (Keeney, 1992)

1. Make values explicit from the outset ensuring that the reasons behind the ultimate objectives for the decision are clearly understood, both individually and in relation to each other.
2. Focus the decision context on what is important for the decision (objectives) rather than what the options might be (alternatives).
3. Avoid the anchoring of alternatives on pre-identified or self-evident options within a narrow decision context, overcoming decision heuristics which constrain creativity and bias outcomes towards information-rich, familiar or initially-considered alternatives (Kahneman and Tversky, 1982).
4. Provide an overall decision framework to encourage careful thinking and to structure relevant information which makes complex problems more **r**eadily understood (Arvai et al., 2001).
5. Evaluation of alternatives. A more clearly defined value model allows a more precise evaluation of the alternatives (Carenini and Poole, 2003).

The first step of VFT entails a general description of the problem area (see figure 13). The second step identifies the objectives through several techniques. Keeney (1992) introduced 9 principles that facilitate the value elicitation process. These 9 principles are used in the interview to harvest the values of the participants. To safeguard the completeness of the value set the value elicitation takes place on an individual interview. This will also endorse thinking by every individual, instead of anchoring the stakeholders in the direction of the first speaker. Second, these objectives are categorized as means or end objectives and logically structured. The process of structuring the objectives results in a deeper and clearer understanding of the values in the problem situation (Timmermans, 2004). Furthermore, the definition of the fundamental objective is safeguarded. In figure 14 an example of a fundamental objective tree is shown. This value tree clearly displays the hierarchy in the maximization of safety. The tree is divided into clear subparts that lead towards the fundamental value.

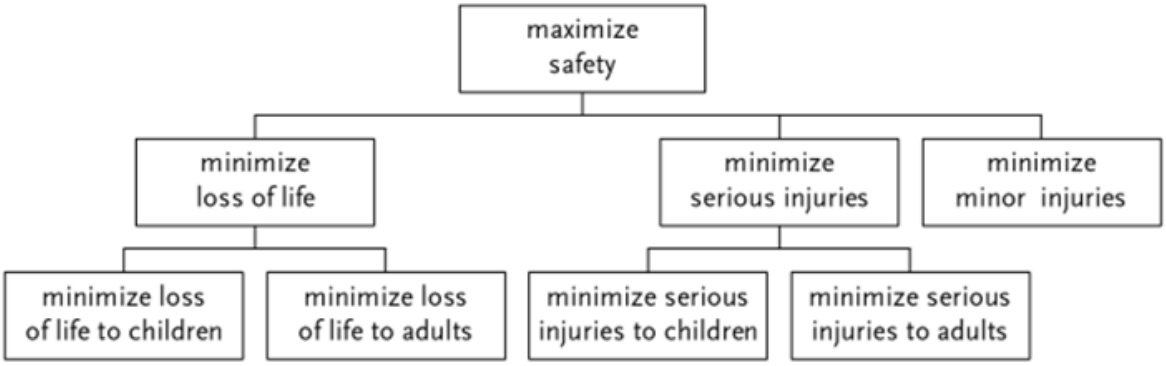


FIGURE 14 OBJECTIVE HIERARCHY AS ADAPTED FROM KEENEY (1992)

Third, several procedures assist in using the objectives to create alternatives. One of the key points in VFT methodology is the opportunity to brainstorm with starting point the values of the stakeholders, enabling a solution for the problem that is widely supported. Finally, the values and the objective tree is used to assess and identify worthwhile decision opportunities"(Keeney, 1992). The VFT is widely used for actor analysis, can bring stakeholders together on the same perspective, create a shared understanding about barriers to tackle and create clear demarcated future options(Wilson, 2006). The valuation of different alternatives is executed by modeling in a spread sheet. Before going into technical modeling terms, the thesis should make use of precise technical language to define key decision-analysis terms and concepts in order to create a readable and workable framework. Therefore, the different terms are explicated:

The eminent theory of utility function establishes the main core of the VFT approach. "A multi-attribute utility function can structure complex environmental decision problems by taking into account several objectives at the same time"(Hassan, 2004). This assists the analyst to formulate goals, weight them and making them operational.

According to (Parnell, 2004), objectives and information about utility functions can come from different sources; Derived from strategy documents (platinum standard), interviews with senior leaders, or workshops/interviews with stakeholders(golden standard) (or stakeholders' representatives) (silver standard). Furthermore, the model has to capture the values of the decision makers and stakeholders, validating the qualitative value model and incorporating their comments is critical to ensuring the stakeholders will "buy" the analysis results(Parnell, 2004).

End objective/Fundamental objective. The most basic objective we're trying to achieve. Example: Create a sustainable water system for San Andres

Strategic objective: Preference statement about an evaluation consideration. Example: maximize renewables production or minimize emission to air.

Means objective: Lower level strategic objective. Strategic objective broken down into goals on timeline

Adopted from (Parnell, 2004)

2.3 Previous proposed combination

According to Wilson et al., (2006) combining these methods may lead to a research methodology, which provides tools and methods that could take into account technological, economic, cultural, institutional, organizational and spatial aspects. The identified loose end of some of the backcasting methodologies could be avoided by adding value-focused thinking, which allows for alternatives to be evaluated against clearly stated but competing objectives in a transparent and systematic manner through facilitating constructive engagement in the process by participants(Keeney, 1992). Furthermore, the development of a clearly stated decision problem confers a number of advantages over unstructured alternatives thinking discussions(Wilson, 2006). For example: clearity, development of unambiguous objectives and clear directions in objectives)

The framework proposed by Wilson et al., (2006) (figure 15) "Integrating participatory backcasting & decision analytic approaches to policy formulation: A conceptual framework" integrates back casting and value-focused thinking. The proposed framework applies a tried-and-tested decision analytic method to help face back casting outcomes towards real interventions for the application of desirable futures(Wilson, 2006). This framework is never tested or implemented in an actual case. Furthermore the proposed framework is never validated or refined through other scientific work. Finally the framework could be more explicit about where the 2 methodologies complement each other and make this explicit. Therefore, this thesis focusses on the further development of a theory combining backcasting and value-focused thinking initiated by Wilson et al 2006. (Figure 15). This research proposes a contribution towards the theory through firstly desk research and afterwards the empirical research in a case study on the way towards a renewable driven water supply system in San Andres. Finally a new framework for developing pathways for utility planning in remote areas will emerge. The possibilities that from the backcasting methodology and the VFT approach evolve are crossed and selected onwards the limited time and resources that will be available for the research. Furthermore, they are crossed with the possible added value that the marginal addition brings towards the policy building area. In this way is decided which possibilities that occur are feasible to integrate into the framework given time and available resources.

Example given, the VFT approach can provide tools for the value elicitation process in the second step of backcasting in the methodology of Wilson et al, (2006). Furthermore, the scan has to be made if the participatory backcasting approach by Quist & Vergragt (2006) (figure 15) can contribute towards the framework given the time restraints of the situation in San Andres. The stakeholder creativity workshop is given the time needed possibly an element that would not

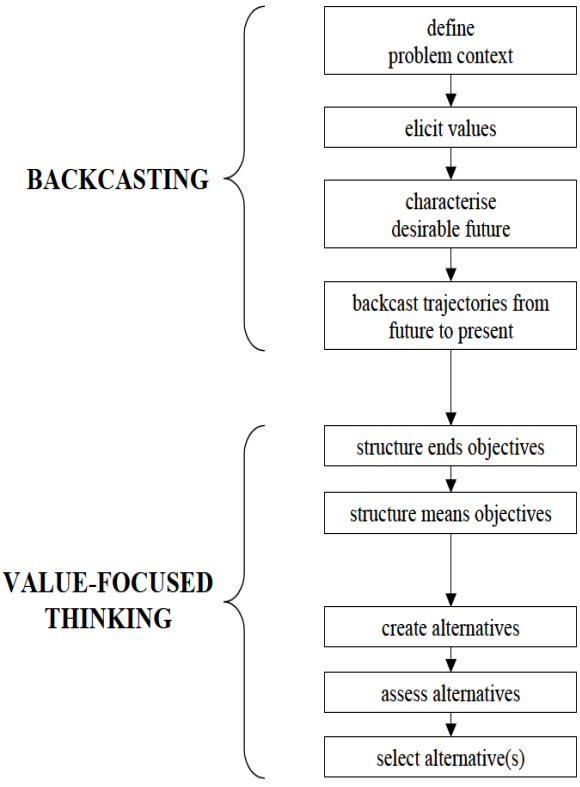


FIGURE 15 CONCEPTUAL FRAMEWORK BACKCASTING AND VALUE FOCUSED THINKING. (WILSON ET AL., 2006)

be integrated in the final framework, but the scenario construction workshop could possibly be a good instrument to reach one of the goals and could be integrated in the framework. The rest of the addition (e.g involvement of local actors (Carlsson-Kanyama et al., 2008) of the final framework is assessed case by case on the feasibility in the case study in san andres in section 2.5. Finally, the erected values of the VFT approach assess the emerged visions on their feasability and possible stakeholders support. According to Vergragt (2005) backcasting should facilitate 2 processes in order to brig about system innovation:

1. The safeguarding of strategic goals and consensus by including the most important societal stakeholders, which states the general direction of the process.
2. The realization of practical goals by involvement of entrepreneurs and consumers/ users around certain specific issues to introduce the innovation towards the market. This may lead to innovations (new products, services, subsystems, infrastructures, and behaviour) that may eventually evolutionary start the overall system innovation.

These processes are dependent on one another. The high level thinking about system innovation needs to emerge into entrepreneurial thinking in order to implement the innovation (Vergragt, 2005). “Bottlenecks for system innovation towards a sustainable society are the separation of networks, short term thinking, the dominance of short-term thinking in financial circles, and risk-averseness of social actors” (Vergragt, 2005). The barriers towards system innovation are numerous and therefore need to be taken into account when creating a framework for system innovation through the combination of VFT and the backcasting methodology.

This research proposes further development and refinement of the theory through empirical research in a case study in San Andres. This synthesis applies backcasting outcomes towards concrete interventions for the implementation of desirable futures. The framework is evaluated on multiple criteria in order to create a clear picture about the addition to the backcasting process. In the following paragraph the demands of the case in San Andres and the demands towards the users of the technology are set, whereafter in paragraph 2.5 the methodological framework is constructed.

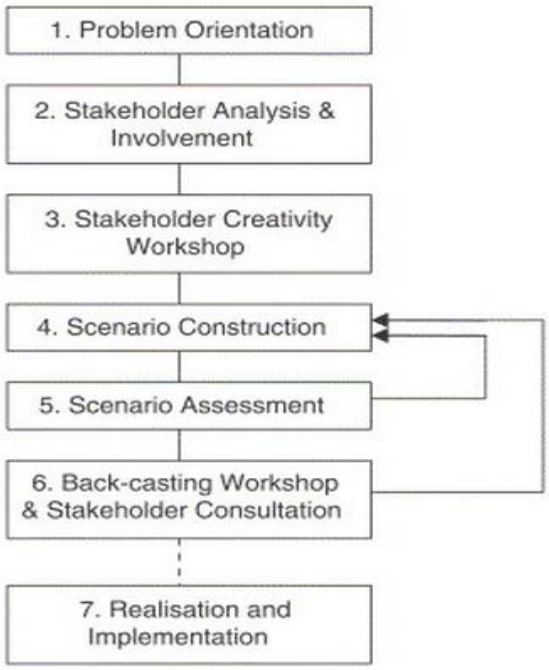


FIGURE 16 PARTICIPATORY BACKCASTING PROCESS (QUIST AND VERGRAGT, 2006)

2.4 Requirements for the methodological framework

To start with the objectives for the methodological framework are set. The only person that has evaluated outcomes of back casting studies and therefore authority on this issue is J. Quist. Therefore, the methodological framework will be evaluated on the following criteria as set by (Quist, 2007). An additive requirement towards the framework is the applicability for sustainable utility planning in other remote areas. Therefore, the methodological framework should be built without focus towards the water problem in San Andres, but rather generally applicable for utility planning in remote zones. Generalization of these criteria is shown in criteria number six.

To what extent did the process in San Andres generate

1. Generation of normative options for the future and analysing these on their environmental improvement.
2. Putting attractive future visions or normative scenarios on the agenda of relevant societal and political arenas
3. A follow-up agenda containing activities for different groups of stakeholders contributing to bringing about the desirable future
4. Stakeholder awareness and learning with respect to the options, the consequences, and the opinions of other stakeholders
5. Stakeholder support and commitment with respect to vision, designs, analysis, and commitment to the follow-up agenda
6. Applicability of the newly build framework towards utility planning activities in remote areas.

The criteria mentioned above should be maximized in the refined framework. The mentioned criteria are not explicated in operational values. Before operationalization a quick scan is made if the criteria fit the case study in which it will be described. The case study describes the methodological framework, which is set up in San Andres and delivers some constraints to the building of the framework. The timespan for the study is 2 months and restricted financial resources are available. Due to business as usual, cultural behaviour and other tasks, stakeholders can lack or cancel their appointments. The methodological framework is therefore based on half a day workshop setting and not demanding a week to week gathering with all the stakeholders involved. According to Quist (2007) the stakeholder participation and influence level can be categorized as medium. In this research is the second criterion is doubtful, because the agenda setting in relevant societal and political areas does not emerge in 2 months. VFT could play a role in safeguarding and handing tools towards the operationalization of these criteria. The operationalization of the criteria emerges out of the first Value Focused Thinking Process in the thesis.

The criteria and the evaluation of the framework could possibly serve as data for the first benchmarking study made on the internal process and short impacts <1 month of the backcasting methodology. According to Quist (2007) the only impact measurement study done and the internal workability and short impacts of backcasting are never published or shown. The goal is therefore to create a framework which is suitable for the participants and creates optimal outcome of the process.

2.5 Integration Value focused thinking and Backcasting

Before developing the framework it is essential to return towards the goal of this research: *Creating supported visions & pathways towards a sustainable water supply system in San Andres in 2030.* In this research the vision is already set: The Providence foundation desires to develop the island towards a sustainable system. The framework develops the components of the future vision that are characterisations of different technological, social and institutional changes, which together emerge a sustainable water system for San Andres in 2030. As described in paragraph 2.1, the backcasting methodology is suitable to develop the way towards such visions and Value Focused Thinking methodology advantages the methodological framework. The methodology is used to identify technological, social and institutional clusters which may be required to achieve the future vision. When using backcasting methodology, different methods can be applied and it is allowed to combine different methods(Quist, 2007). Therefore, the four backcasting methodologies can be unravelled, derived in building blocks and combined into a new framework with VFT approach.

To create a workable situation the thesis selects a starting point in a prominent backcasting methodology through reasoning. The study entails a decision making process towards a pathway for sustainability. Through literature review the following study came forward; Through the exhaustive review of 386 decisions taken everywhere from the Millennium Dome in London to the Denver International Airport half of all decisions failed and the implementation rate for multi criteria decision-making efforts is even worse(Nutt, 1999). Furthermore, Nutt (2004) argues that despite prominent presence in business schools lectures participation is used in 1 out of 5 decision making processes. Out of all decision making tactics, intervention and participation tactics had a much better track record than e.g. edict and persuasion(Nutt, 2004). Moreover, the 5 steps of the participatory backcasting stresses the importance of designing an operational plan and not end into ambiguous long term planning(Quist et al., 2011). Both participation and intervention push implementation to a position early in the decision making process in order to manage and identify stakeholder interests and commitments. Taken into account the statements above and in the meanwhile create a robust line of reasoning in the research towards the methodological framework, the building blocks of participatory backcasting methodology (PBM) are selected as the prominent blocks to integrate with the VFT approach. PBM includes demands on three areas as elaborated upon in paragraph 2.1 (1) normative demands; (2) process demands; (3) knowledge demands. The requirements need to be clear in the start of the backcasting study. These demands are stated and validated with the participants in the first interview.

Other methods serve as supplements and building block by building block is selected on (1) the marginal added value on the criteria mentioned in paragraph 2.4 and (2) the limited timespan and resources available in the case study in San Andres. The combination of PBM and VFT results in 5 prominent building blocks, which have their own sub processes (see table 1). In the strategic problem orientation there is some overlap in the steps, but moreover the 2 approaches bear scant resemblance. The method is proposed in this chapter and reviewed and refined after the case study.

To merge the two methodologies the research starts with schematizing the building blocks of the participatory backcasting approach and the VFT approach into one table (see table 2). As shown in the table the two methods bear scant resemblance.

TABLE 2 COMBINATION PBM (QUIST AND VERGRAGT, 2006) AND VFT (KEENEY, 1992)

1. Strategic problem orientation	VFT	Participatory Backcasting
Demarcation, specification goals and definition of demands towards participants		x
Analyze present water supply system	x	x
Identify renewable potentials		x
Identify stakeholders		x
Elicit Values	x	
2. Develop future visions		
Definition normative requirements		x
(Brainstorm) alternatives from values and develop detailed future vision	x	
3. Backcasting analyses		
What? Define social, institutional and economical barriers		x
What ?Define social, institutional and economical milestones		x
How? Overall strategy choice		x
Who? Stakeholder analysis for succes project.		x
4. Elaborate future alternative and define follow up agenda		
Select the strategic objectives	x	
Formulating specific interventions (strategic - fundamental)	x	
Define necessary changes		x
5. Embed results and agenda & stimulate follow up.		
Construct follow up agenda		x

TABLE 1 ADDITIVE ELEMETNS OF OTHER BACKCASTING METHODOLOGIES

Added value in methods					
1. Strategic problem orientation	Robinson	Natural Step method	STD approach	added value framework	Feasibility
Define exogenous variables	x		x	1	3
Define framework for sustainability		x		3	3
Gap analysis current situaton to sustainable framework		x		2	3
2. Develop future visions					
3. Backcasting analyses					
4. Elaborate future alternative and define follow up agenda					
Undertake impact analysis	x			3	1
decide on priorities		x		3	3
5. Embed results and agenda & stimulate follow up.					
Implement stakeholder cooperation plan			x	3	1

The basis for the methodological framework is constructed out of the 2 prominent methodologies. The 3 other backcasting methodologies could be beneficial towards the criteria presented in paragraph 2.4. These possibilities are by building block assessed on their marginal added value and feasibility towards the criteria (table 2). The additions are made based on criteria which are elaborated upon under figure 15.

During the search for other building blocks that can contribute towards the added value of the framework the following possible contributions came up. The possible contributions are graded on 2 scales(see table 2). The added value of the framework is graded from (1) no added value (2) average added value (3) maximal added value. The feasibility is graded (1) Not feasible (2) average feasible (3) Feasible. The scores are awarded through a logical intellectual estimation and elaborated upon in the following paragraph.

Strategic problem orientation. The area of the strategic problem orientation contains 3 potential supplements. According to Robinson (1990) the definition and elicitation of exogenous values act as a kind of projective frame for the scenario analyses. The trade-off that is created through putting exogenous variables outside of the scenario analyses safeguards the scenario building towards the future vision(Robinson, 1990). The marginal value on the end criteria scored low added value, because the framework gets more complex through the trade-off of exogenous values in the framework between the scenario analyses and exogenous values. The next variable is the definition of the framework for sustainability, which is the first step of the Natural Step Methodology. The definition of the framework and criteria for sustainability is demanded in the specification of goals that is part of the basic framework as well as in the normative demands for the PBM methodology. Furthermore, the title of this research and main goal is to develop a sustainable water supply system for San Andres. Therefore the Natural step criteria for sustainability will be explicated in the framework to safeguard the sustainability guidelines. The gap analysis towards the sustainability criterion is part of the backcasting process and therefore awarded low added value and excluded from the list.

Elaborate future alternative and define follow up agenda According to Robinson (1990) the backcasting process is iterative with a feedback loop that measures the impact of the interventions on the different scenarios, where after the goals and constrains of the starting phase refined. This process was categorized as added high added value. Feedback loops keep the process and the stakeholders awake. The iterativeness of the process is already safeguarded in participatory backcasting methodology(Quist and Vergragt, 2006), so therefore not taken into account for the main framework. The building blocks decision on priorities emerges out of the Natural step process and functions exactly the same as the addition of VFT. It touches the heart of this research and is therefore graded maximum added value to this research. The building block is however already integrated by adding VFT towards participatory backcasting and therefore not selected to integrate in the main framework.

Embed results and agenda & stimulate follow up. The STD backcasting methodology stresses short term planning that elaborates about the implementation and stimulation of follow up. Moreover, it implies a as well as to methods for organising and managing projects on options that originates from the backcasting analysis and the future vision(Quist, 2007). The integration of stakeholder cooperation matrix can be useful in the phase of operationalization of the framework and is therefore awarded a place in the methodological framework.

The adaptions towards the original methodological framework emerge into the final framework (see figure 16). This framework is divided into 4 different parts of research. The first part is work done at the office. This part is best executed in presence of structured literature, but utility planning and presence of data regarding utility is not very easy to reach about remote locations. Therefore, the analyst should try to get

these data before starting the second step of the framework. The second part of the research entails the interviews with the stakeholders. This part safeguards the completeness of the analyses of the current situation and harvests the values of the participants. The third part is the workshop. The value based brainstorm towards a detailed future vision balances between the interview and the workshop part. After the workshop the research returns towards the desk, where it is finalized.

Selection of participatory backcasting as prominent building block entails demands: Participatory backcasting explicates three types of demands: (1) normative demands; (2) process demands; (3) knowledge demands (for elaboration see paragraph 2.1). The requirements need to be clear in the start of the backcasting study. This can be created through early stakeholder engagement, but can also be stated by the organizers(Vergragt and Quist, 2011). Early stakeholder involvement is critical in the project and the requirements for all participants are partly developed in the interview stage. Regarding the normative demands the vision of sustainability is drawn in the interviews. The process demands are shaped by the combination of the analyst and the Providence foundation. Finally, the knowledge demands are stated by the analyst to create a solid basis for the cases study and a shared understanding through all the participants about the process.

The conceptual framework is in place, the headline requirements are stated and the specification of different tools and methods to successfully guide the process can be tailored towards the case study in San Andres. The tools are selected through the review of detailed backcasting descriptions (Quist, 2012, To be update Quist, 2007, Svenfelt et al., 2011) and the review of combinations with other methodologies made with backcasting literature examples (van der Voorn et al., 2012, Ricken, 2012).

2.6 Framework and methodologies

The framework is presented below (see table 4) is an overview of all the methods used during the backcasting study in San Andres. The research stated that the participatory backcasting methodology is used as a ground pillar the framework. Therefore, the different choices for the integration of participatory methodology and the choice for other methodologies are elaborated upon in separate subparagraphs (see table 3.

TABLE 3 FINAL FRAMEWORK

1. Strategic problem orientation	Method
Define demarcation and level analysis, set goals	Analyses : System analysis following: (Enserink et al., 2010)
Analyze institutional situation	Analyses: Four layer model (Williamson, 1998)
Identify stakeholders	Stakeholder analysis. Enserink et al., 2010)
Define sustainability values	Analyses: Desk survey Following the Natural step method (Holmberg (1998)
Identify renewable potentials	Analyses: Desk survey
Elicit Values	Interview all stakeholders.
Create (un)shared values map	Mapping and creating value tree
2. Develop future visions	
Definition normative requirements	Definition of trends, definition requirements of future visions and preconditions
(Brainstorm) alternatives from values and develop value based future vision	Workshop format with "feel free to join invitation" , desk work
3. Backcasting workshop	
Disconnect stakeholders from business as usual	Present analyses of current situation and present value based future vision
What ?Define social, institutional and economical milestones	Backcasting workshop format following sustainable technology development (STD) format. Distinction is made between (1) technological, social and institutional milestones
How? Overall strategy choice	
4. Elaborate future alternative and define follow up agenda	
Formulating specific interventions (strategic - fundamental)	Build a schematic version of visions.
Select the strategic objectives	Select the optimal building blocks of different visions based on values stakeholders
Develop plan to reach objectives	Construct plan towards reaching the objectives in 2030
5. Embed results and agenda & stimulate follow up.	
Implement stakeholder dependancy matrix	Project managament tools. Construction of stakeholder responsibilites and dependancy matrix.
Construct follow up agenda	Identify possibilities for further workshops or actions that need to be exectuted in order to create follow up.
review process	Survey after workshop about follow up agenda with testing of goals study
Participatory block	Non participatory block

2.6.1 Strategic problem orientation

The strategic problem orientation is the first step of the framework and enables the analyst to become familiar with the problem situation and unravel the complex situation into clear manageable parts. Next, the institutional arena is mapped and involved stakeholders identified. The outcomes from the system orientation are checked with regards to the four principles for sustainability and gaps may appear. The method displays possible solutions for this gap by presenting state of the art technology to deal with these gaps, where after the selected participants are interviewed and the result (including the values of all participants) of the interview is shared among all participants.

Firstly, System analysis is used to explore the problem and the goal of the process is defined with the focal owner (see table 4). In order to avoid complex models and ambiguity the system analysis is executed from the view of the focal owner. Systems analysis is the approach that evolved in the 1950s and 1960s from the field of operations research, relating scientific and often mathematical methods to analyse large and complex systems (Enserink et al., 2010). When applied as part of policy analysis processes, the system under study is typically a certain policy domain, seen from the perspective of a policy maker or the focal owner(Findeisen and Quade, 1985). The acknowledged restraint of systems analysis is that it is inherently incomplete. This is not only because of practical restrictions in terms of money, time or human labour, but also because it cannot study all attentions that may be significant (Miser and Quade, 1985). This means that the analyst has to make choices about what to consider, what to include as part of the analysis, and what aspects are left outside the scope of analysis. As a result, uncertainties endure. They increase are even more when we take into account that many policy decisions apply for long periods of time.

The backcasting study involves a trajectory of 17 years and is therefore vulnerable to uncertainties. The system under study is the water supply system in San Andres. This question describes the steps and corresponding methodologies that will be used in this research. First the characteristics of the water supply system of San Andres will be described by means of a system analysis of the complete value chain of electricity on the island (resource, distribution network, end users). The system analysis is made through the method as identified in the chapter 3 of the book Policy Analysis of Multi-Actor Systems by (Enserink et al., 2010). The following steps need to be taken:

1. Set the initial problem demarcation and level of analysis.
2. Describe current system
3. Specify objectives and criteria (outcomes of interest)
4. Identify potential means and map the main causal relations and their influence on the outcomes of interest.
5. Provide an overview of the problem area using a system diagram.

Taken together, these steps should help to develop a first system diagram and to perform a first, qualitative systems analysis, supporting a sound problem formulation. To create an integrated view the institutions are mapped. Institutions and politics are critical enablers or constraints to technical and policy change and often forgotten in future studies (Nilsson et al., 2011). To identify and clearly display the institutions the four layer model of Williamson (1998) is used.

Secondly a stakeholder analysis is conducted. According to Enserink et al (2010) the following steps are needed for a full stakeholder analysis:

1. Formulation of a problem as a point of departure;
2. *Inventory of the actors involved;*
3. *Exhibiting the formal chart: the formal tasks, authorities, and relations of actors and the current legislation;*
4. *Determining the interests, objectives and problem perceptions of actors;*
5. Mapping out the interdependencies between actors by making inventories of

resources and the subjective involvement of actors with the problem;
6. Determining the consequences of these findings with regard to the problem formulation

The system analyses formulated a sound problem formulation, which makes step 1 superfluous. Furthermore, the methodology only searches for identification of stakeholders and a fast mapping of interests, objectives and problem perceptions. Therefore, step 5 and 6 of the proposed stakeholder analysis are not executed.

The analyst can select one of the seven stakeholder identification approaches (Enserink et al., 2010). This research selects the reputational approach, which uses key informants related to the policy problem and asks them to identify important actors. The resulting list of actors may be further expanded by asking each of the actors on the list to nominate additional actors. The latter technique is known as 'snowballing' (Wasserman and Faust, 1994)

The addition to stakeholder analyses is the selection of the participants towards the interviews and workshop. To enable system innovation the coalitions between five types of stakeholders are needed: Government, Companies, Knowledge infrastructure and advice, Intermediates, and Citizens/ Consumers (Vergragt, 2005). Furthermore, successful implementation of a strategic sustainability perspective depends on the involvement of investors in an early stage of policy making (Hallstedt et al., 2013). Therefore the investor is added towards the coalition and integrated as necessary to the framework. Moreover, the framework requires an equal participation of various sorts of stakeholders. An equal participation of consumers, commercial parties and non-commercial parties enables an honest view of values towards the fundamental objective. Next, the participants are selected on having a degree in science and lectured in the situation of the system and future possibilities. The list of stakeholders is crossed with the above stated required parties and if necessary third parties are invited towards the process to complete the requirements to engage them early in the process to enable the system innovation.

Thirdly, the concept of the Natural Step Method is used in order to safeguard and explicit the principles of sustainability. The current developments in sustainable systems that could possibly contribute towards the process are mapped and shown before the backcasting workshop to inspire and educate the participants.

Fourth, the value elicitation of the participants takes place through interviews. Values are long term strategic objectives of participants. The interview (see appendix I) consists of questions that enable the analyst to build a proper value model and guides the weights given to the different criteria in the end of the process. The interview consists of 2 parts; the first part is constructed to validate the stakeholder analysis; the second part emerges the key values of the stakeholders and generates pathways towards the future vision. To create structure in the interviews, but not limit creativity; the open-ended interview is selected as interview method. Participants are always asked identical questions, but the questions are worded so that responses are open-ended. Although the data provided by participants are rich with qualitative data, it can be a more awkward and time consuming process for the researcher to fully and precisely combine the different responses into one clear answer (Turner D, 2010). To minimize the burden of administration process and maximize the outcome the interview is structured in the following way (McNamara, 2009) First, choose a setting with little distraction. The interviews are held with senior people in their offices which safeguards this requirement. Second, the purpose of the interview is explained and the terms of confidentiality are mentioned. This leads to stakeholder involvement and commitment in an early stage of the process and safeguards the completeness of the orientation phase.

Finally, the analyses are shared with the participants and new insights are included in the study. From these values an (un)shared map of values emerges that is presented and shared with the stakeholders before the backcasting workshop. Next to this the results from the interview are used to feed the mathematical construction of the Multi Objective Decision Analysis (MODA), which is elaborated upon in paragraph 2.7.4 of the framework. Finally, the contact details are exchanged and the whole interview is recorded to safeguard the completeness. During the interview (see appendix I) key questions are asked double, to validate the answer of the participant.

2.6.2 Develop future visions

The strategic problem formulation provides normative requirements for the next part of the study; the development of future visions. The second part of the framework entails the following steps:

According to Quist et al (2011) normative requirements reflect the goal-related requirements for the future vision, as well as how sustainability is defined in the case under study and how this is turned into principles or criteria that future visions should meet. The definition of normative requirements is erected and defined in a presentation before the workshop. The shared map of the goal and the trends (question 12 in interview) is sent by email to all the participants to inform them. Furthermore the selection of the participants is an extremely important topic, because the result of the study heavily depends on them.

Secondly, experts or stakeholders maintain problems disconnecting from the present. (Quist et al., 2011) W. Ascher named this “assumption drag”(Ascher, 1979). Professionals are inevitable connected to their business as usual, thereby carrying the knowledge and problems of the operational situation. The key towards future visioning is to disconnect them from this present paradigm and get them into the next one. In the future vision developing stage the participatory tools to solve this problem are prominent in stock. The participatory backcasting methodology can employ creativity brainstorm techniques, scenario construction workshops and scenario assessment workshops. The connection with VFT methodology serves in this research as connection to the future. The stakeholders are first questioned upon their long term goals (values) and are thereby disconnected from business as usual. The values are harvested in the form of an individual interview to obtain true values from every participant.

Quite often, simply by presenting the true reasons for a decision, the stakeholders can identify ways of finding solutions for the problem that supports one or more objective (Keeney, 1992).

These ways often will be considered “outside the box” alternatives because they are not biased toward the status quo solutions. Therefore, the framework comprises a brainstorm session with “feel free to join invitation”, were stakeholders are invited on (1) the basis of creating a full spectrum and (2) facilitating all parties required for system innovation. The session is held with participants of the process to develop commitment towards the process and possible outcomes.

The shared values map is then used as a pillar for a creative session towards possible solutions for the pathway towards a sustainable water supply system for San Andres. This vision is then later used as starting point for the backcasting analysis workshop to kick start the creative mind of the participants, disconnect them from business as usual and serve as inspiration for the moderator to diverge 4 future visions(see figure 17). Next to the starting point, the results of the brainstorm are also used as an example to guide the participants in the process of designing and putting the ideas towards the paper.

2.6.3 Backcasting workshop

The backcasting part of the process takes place in a backcasting workshop where the selected participants are invited that (1) are necessary to enable system innovation and (2) represent all the different visions stated in the interviews. The backcasting analysis is organized in a workshop format that integrates maximum participatory elements given the resources and time available.

During the backcasting session the following questions will be handled with equal input of the participants. To obtain a clear and workable workshop format the following scheme is followed:

To engage the participants and cut them loose from business as usual the workshop starts with a variant of the human knot game that links a proposal round of all the participants with the multi actor complexity of the problem. After this game the problem is connected to the problems that are faced and the participants are asked towards the learning effects of the game. Possible learning effects can be: group understanding of communication, leadership, problem solving, teamwork, trust, persistence, understanding difficulties of solving complex problems.

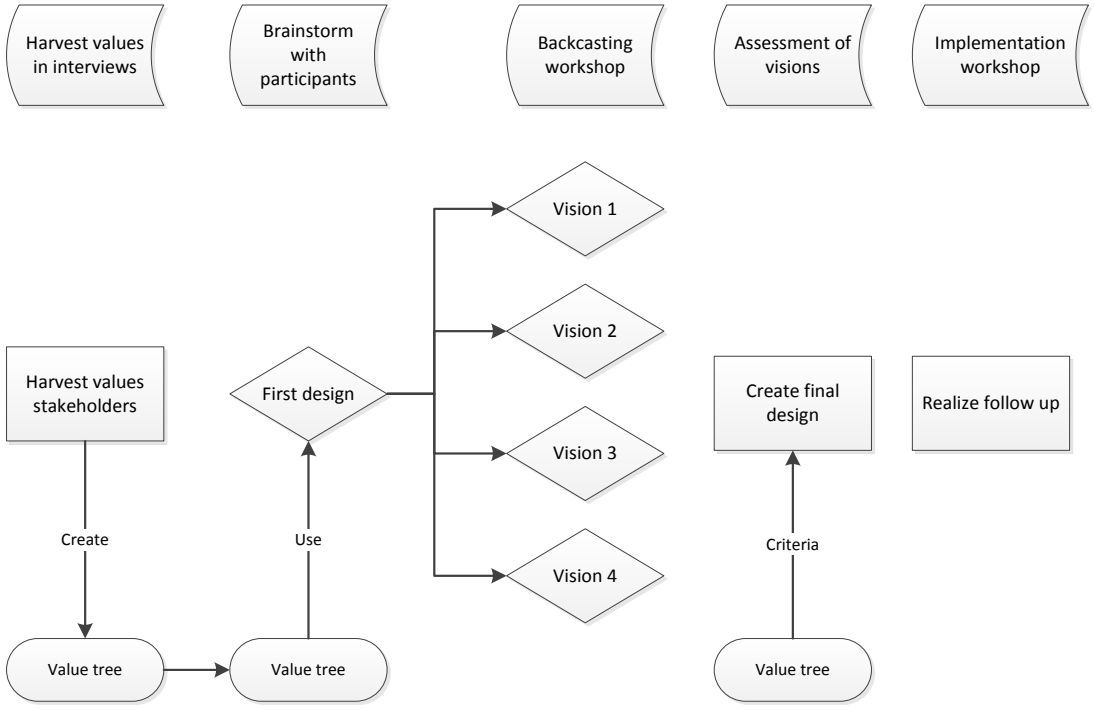


FIGURE 17 USE OF VALUES IN PROCESS OF VISIONING

Future developments in an unchanged situation are presented to further disengage the participants from business as usual. The backcasting process demands openness and all the results of the interview are share among the participants. (Only explicitly asked for information is withheld from the other participants). The presentation includes climate change effects and extrapolation of different trends for the 4 principles of sustainability of the Natural step approach. The argumentative approach states that “stakeholders from policy and science communities are unlikely to improve their understanding of a complex problem if they are faced with factual knowledge(Kerkhof et al., 2001.). Furthermore it states that the lack of underlying assumptions of viewpoints of the other stakeholders create this ignorance. To break this barriers, solve both of them and create fertile ground for policy making the stakeholder analysis together with the shared values is included in the presentation.

The backcasting process starts with the introduction where the overall process and the goals of the session are presented, which is followed by the presentation of the value based design and the 4 extracted visions towards the participants (see figure 18). The participants are scheduled into groups with regards to their vision and focus on the solution of the problem. This emerges 4 groups that create a solution of the future problems with their own focus. The groups are given a certain time limit and the focus to make a design that is presentable in 5 minutes, where after the process starts. Firstly, the groups are asked to create a design of the situation in 2030, with focus on 3 areas:

(1) Social design,
(2) Technological design and
(3) Institutional design.

These designs are after the certain time limit presented to all participants. Secondly, the participants are asked to assess the designs made in the first assignment on the barriers on the 3 areas, where after the participants are asked to focus on the biggest problem to come to their initial designs. This leading problem has to be solved with regards to the time horizon in 2030 and together with the barriers presented to all participants. After this session a short break is initiated, where the participants can share their feelings, solutions and network new ideas and insights among each other. The final element of the workshop is the actual backcasting, where participants create a reverse roadmap towards their initial design covering solutions for the identified barriers on the technological, social and institutional arenas. Through backcasting the strategy choice is applied towards the identified barriers. This result in validated milestones and different interventions presented by all the stakeholders represent on the table. The overall strategy or mechanism that drives innovation leading to the envisaged sustainable system in 2030 is shaped in this question. Strategies on different areas can be included: It may be knowledge development, product development, market launches, institutional changes, policy adaptions, shaping of networks, strategic alliances and public campaigns.

The session ends with the presentation of the roadmaps towards their initial design and the entities needed for the system innovation, which elaborates upon the range of stakeholders needed for the envisaged system innovation. The activities that should be conducted by the different kinds of stakeholders are elaborated upon in the implementation. The stakeholder matrix is extended by asking “who would oppose the required changes and how can this opposition be dealt with?” and the results are integrated in part 5 of the methodology towards a stakeholder dependency matrix with clear intentions to work together on this subject.2.6.4

2.6.4 Elaboration and choice of alternatives

The alternatives from the backcasting process function as the ground pillars for the VFT methodology to put the added value to the table. The framework incorporates the identification of strategic objectives and structures them towards a decision problem. The interventions that come out of the backcasting analyses need to be appropriately structured into clear directional preferences following decision analytic prescriptions and clarified towards all the stakeholders in a scheme. The VFT approach structures the various characterizations of the future vision that emerged in the backcasting process, by adding an object (e.g. amount of connection to hotels) and a direction of preference (e.g. maximize). The developed term "it is imperative for us to stop depleting the aquifer" would be structured as the objective "Minimize SUM (water in –water out) aquifer".

The consistent structure of alternatives safeguards consistency interpretability and clarity(Keeney, 1992). The components of the future visions that are generated are treated as strategic objectives for the decision problem. The strategic objectives are properly structured and placed into a decision problem. I.e. what are the most supported strategic objectives for reaching the fundamental objective?

The backcasting workshop emerges a set of visions that each has their focus. The four visions may contain double strategic objectives. These are merged and the result is taken towards the development of the multi objective plan towards the fundamental objective. The strategic objectives (results) of the backcasting workshop are assessed with regard to the shared value list to decide which of the alternatives harvested in the workshop receives a place in the policy framework towards the main goal (See figure 18).

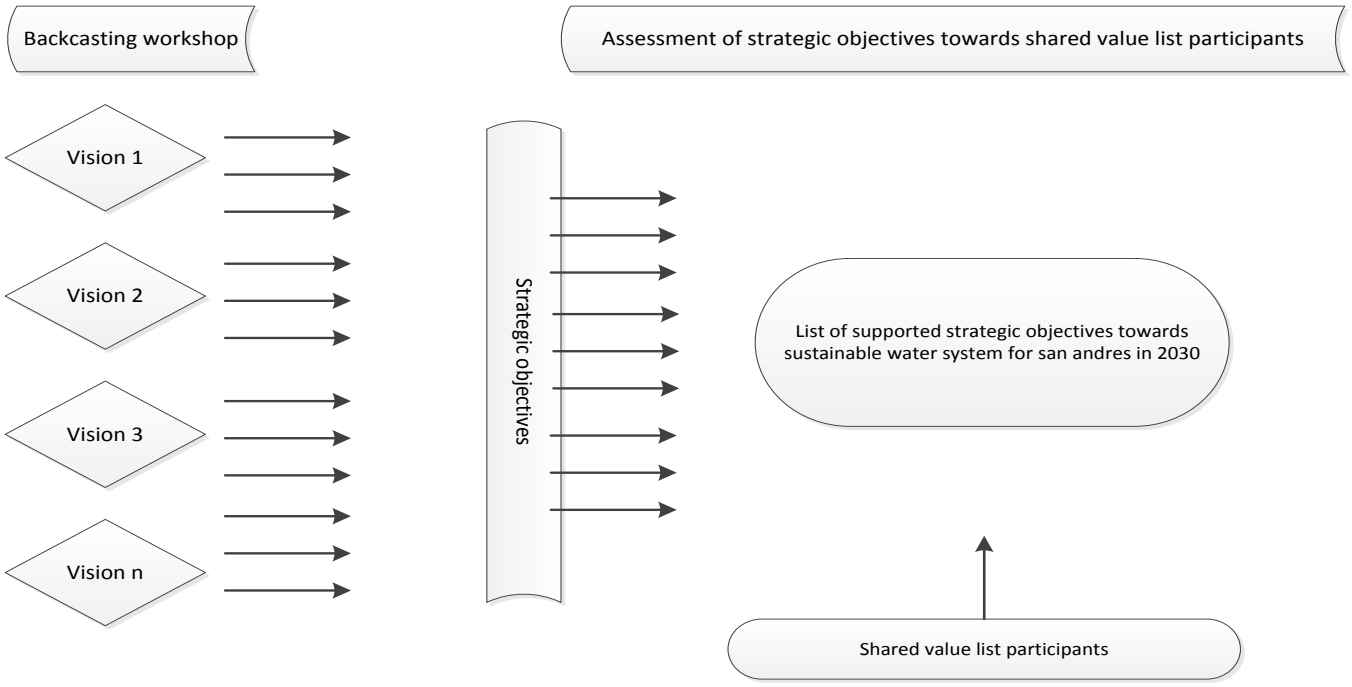


FIGURE 18 ASSESSMENT DIFFERENT STRATEGIC OBJECTIVES

The score of the strategic objectives is constructed by two parameters:

- The Likert scale shown in table 4 enables the analyst to specify the level of agreement or disagreement on a symmetric agree-disagree scale (Burns and Burns, 2008). The analyst captures the intensity and sophistically scores the strategic objective towards the shared value list

Score	0	1	2	3	4
Added value	No added value	Low added value	Medium added value	Medium-high added value	High added value

TABLE 4 OBJECTIVES ASSESSED ON THEIR SCORE TOWARDS THE SHARED VALUES OF THE PARTICIPANTS

- The normative score of the value compared to the rest of the values of the value on the shared value list as assessed by the participants

Next, a spread sheet program that is transparent and understandable towards all participants multiplies the 2 parameters (see appendix IV). The data together create a chart where the analyst can define which strategic objective has a big added value towards the fundamental objective and which strategic values add no value towards the fundamental objective. The list of the total scores is displayed in a clear table.

The strategic objectives that have a total score less than one, which means a low added value, are removed in order to develop a plan that has broad support under the participants. Here after, a clear set of strategic objectives with implementation trajectories remains for elaboration and follow up. Finally, presented above is presented in the subparagraphs to get an oversight of strategic objectives and possible implementation trajectories. For every strategic objective an implementation plan is written down, which includes a stakeholder engagement proposal. This proposal derives possible coalitions and opponents for the required transition from the scores that the participants awarded towards values.

2.6.5 Embedding of results and stimulating follow up.

The amount of strategic objectives and plans that evolve from the methodology are in need of follow up. Therefore, the research aims to develop a shared pathway, where supported strategic objectives are developed into a clear pathway. This figure enables discussion about the implementation of these 5 important objectives.

The stakeholder dependency matrix is developed for the strategic objectives to make the process transparent towards all stakeholders. The objectives are presented with clear coalitions and opponents. Furthermore the opportunities are explored to create follow up. This recommendation for future process is constructed with the focal owner on the island in order to engage them in the follow up of the process.

Finally, a survey is distributed under the participants to conclude on the success or failure of the framework in the goals set in paragraph 2.4. (See appendix VI).

3. EXECUTION OF FRAMEWORK

Before executing the framework it is essential to return towards the goal of this research: *Creating pathways towards a sustainable water system in San Andres in 2030.* The goal requirements for the study are set: The Providence foundation desires to develop the island towards a sustainable system. The framework develops the components of the future vision that are characterisations of different technological, behavioural and institutional changes. The framework furthermore facilitates the framing into a clear decision problem, which enables the value focused choice between the different pathways that optimally emerges a sustainable water system for San Andres in 2030.

3.1 Strategic problem orientation

The framework and methods elaborated upon in paragraph 2.6.1 are executed in this part. The reason to implement the methodology on the case study in san Andres are twofold: (1) To actually improve the situation on the island regarding the water system on all six identified goals (see paragraph 2.4) and (2) empirical research towards pathways for sustainable water planning to improve the framework.

3.1.1 System analysis

The system analysis is executed in the next paragraph following the guidelines as set in paragraph 2.6.1. The analysis starts with the mission statement of the focal, the Providence Foundation:

> *To manage, protect and restore the environment of San Andres and Old Providence by applying appropriate technologies aimed at knowledge of the supply and demand of renewable natural resources, tending for sustainable human development and involving the community so that, in a concerted and participatory , improve the quality of life of the region.*

This statement of the providence foundation is applicable on all areas and very wide in perspective. To focus the research and emerge tangible results the following paragraph elaborates on the system boundaries.

3.1.1.1 Demarcation Research scope and level of analysis

The demarcation of the system is constructed by following the value chain of water system in San Andres (see figure 5).

The chain starts with the production that is facilitated by harvesting of rainwater, the desalination of ground water, the extraction of the aquifer by domestic wells and the import of bottled water. The water is then distributed through the aqua duct, the big scale trucks (carrotanques), transported in 2-5 gallon water bottles (botellon), or pumps that put the water into the cistern of the houses via the private water company Pro Activa.

Next, the water is used by 2 sorts of consumers. Domestic users represent 66% of the water usage. Hotels, shops and offices are named commercial users and represent 33% of the water usage. Industrial use of water is negligible on San Andres and the agricultural sector does not exist. Finally, the disposal of water is either dumped into the soil (aquifer) or processed by the water company Pro Activa through various pump stations towards a submarine disposal system.

In San Andres almost all houses have access to a rainwater harvesting system to partly solve the needs of the sanitarian system (toilet, shower, washing machine and to water the garden). These flows are excluded; because these systems are already sustainable energy systems. The energy necessary to power these systems is triggered by gravity to flow the water from the cistern tanks towards the usage source.

The geographical as well as the institutional and technical demarcation is characterized by the San Andres water system (see figure 19). The map shows the different identified aquifer zones in the map of San Andres(Atkinson, 2005). To clearly state the level of analysis a means to an end diagram is constructed in cooperation with the focal owner of the project, the providence foundation (see figure 25). In the diagram can be seen that the Providence Foundation stated her head goal as “To realize a prosperous San Andres for all inhabitants in 2030. The introduction elaborated upon the different problems the island faces. The island is highly dependent on fossil fuels in water production, energy production and mobility. For each of these problems this framework could be adapted, but after consulting the Providence Foundation the water problems on the island seemed to be the most urgent one to solve.

Therefore the whole water system is chosen as subject of this research. The end objective of this research entails the realization of a sustainable water system for San Andres in 2030. The year 2030 is chosen because the Colombian central and regional governments constrain their policies to the short and medium term planning. The majority of backcasting studies proposes planning of 50 years, but in cooperation with the Providence Foundation the timeline is set towards 2030 to make the planning tangible towards the participants.

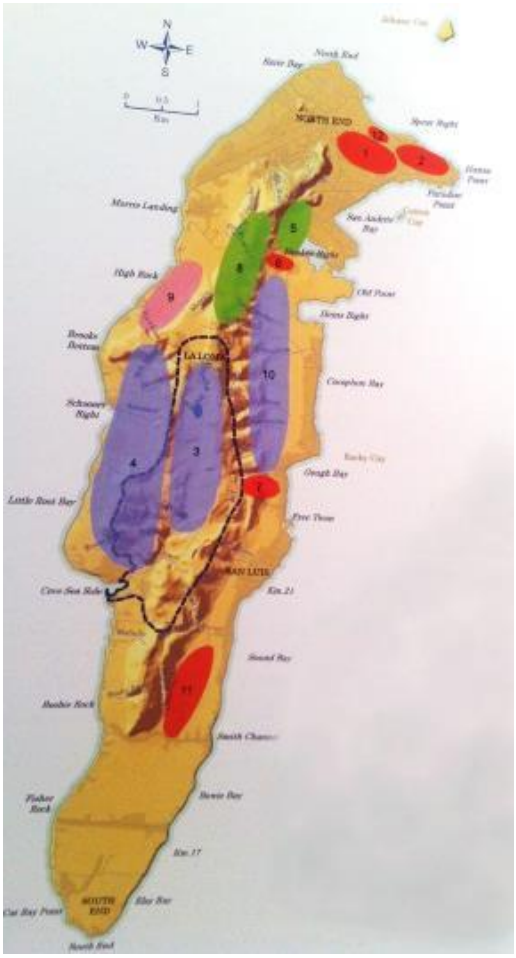


FIGURE 19 SAN ANDRES AQUIFERS

3.1.2 Analyses of the current system

To become familiar with the water system in san Andres the current system is defined. To ensure the completion of the analysis of the current water system in San Andres the value chain is displayed in figure 21 and part by part analysed.

The regulation of the water system is executed by 5 different entities, which all regulate different parts of the system. The ministry of Utilities (MU) is represented by the regional government of San Andres and is responsible for the regulation of the policies that are set up by the Vice Ministry for water and sanitation and departmental plans (VMWSD)(Bowie, 2012). The provided water for sanitation and drinking water is then tested on quality by the Potable Water and Basic Sanitation (PWBS) entity. Colombian municipalities are responsible for ensuring that their inhabitants are given domestic services of water supply and sanitation in an efficient way by public companies(Congreso, 1995). Therefore, public utilities or privately held companies are directly responsible for service provision. Aguas de San Andres tendered a new 20 year water concession in 2009.

The privately held company Pro Activa was awarded the concession which is controlled by Aguas de San Andres(Duffs, 2013). The aqua duct that was constructed in 2005 is public financed by the central government of Colombia, however owned by Pro Activa (see figure 23). The entity that administrates, controls the contract and has decision power on adjustments in the water infrastructure is Aguas de San Andres. Finally, Coralina regulates the environmental permits for drilling wells and other constructions in San Andres. The decision power of the various entities is elaborated upon in a formal chart shown in figure 26.

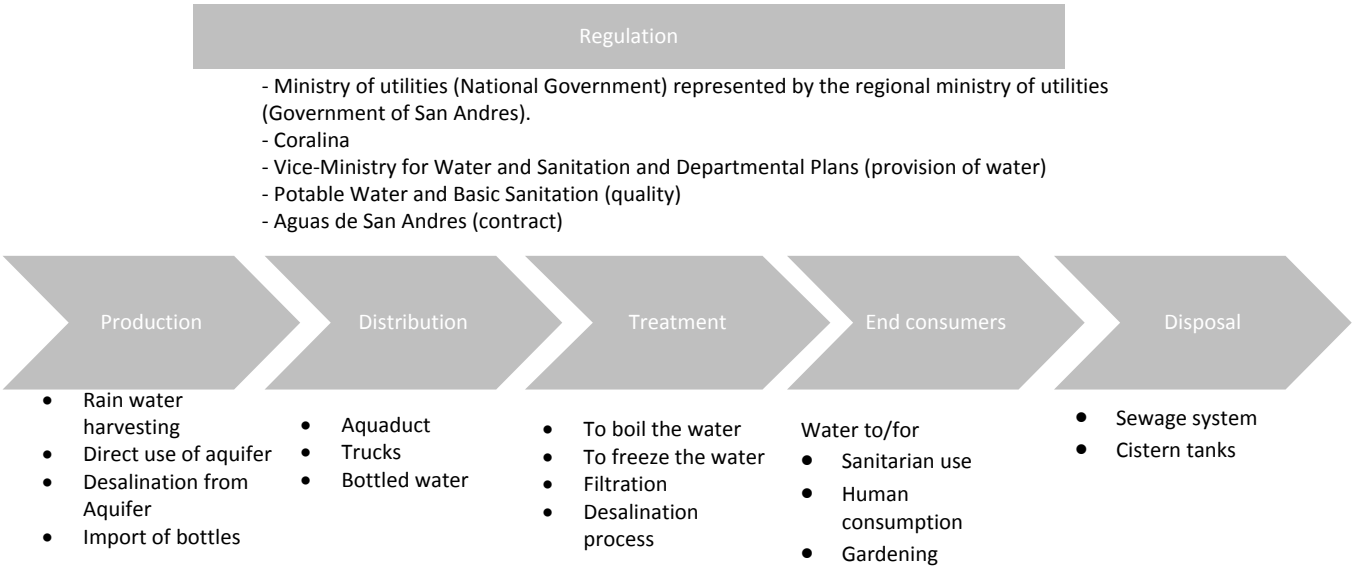


FIGURE 20 VALUE CHAIN WATER SYSTEM SAN ANDRES

Production

The production of water is for 75 % dependent on the aquifers(Guerrero, 2010)(see figure 2). The total water demand is 14500 m³/day, which causes an extraction of 10875 m³/day in the aquifer. Coralina permitted the extraction of the aquifer by permits and the total permitted extraction is regulated at 5800 m3/day(Atkinson, 2005).

Rainwater harvesting secures 20% of the demand (2900 m³/day). Rainwater harvesting is a traditional system used by the Native islanders, whereas the immigrated Colombians do not use the rainwater for their fresh water supply. Less than 40 % of the roofs are prepared for rainwater harvesting(Atkinson, 2005). The quality of the rainwater is excellent, but due to contact with animal excrements and a lack of maintenance of the rooftops the quality of the water decreases. Rainwater is used for cooking, drinking and sanitarian use. Due to the phenomenon El Niño and widely discussed climate change, rain season of the island has changed from August-march (7 months) to September- February (5 months) over the last decade(Guerrero, 2010). During the El Niño periods the average rainfall decreases with 30 %.The rest of the water 5% is imported through bottled water (725m³/day).

Distribution

In 2013 5000 m³ water/day is distributed through the aqua duct which was constructed in 2005 (see figure 21). In 2007 this was 8000 m³ water/day. The loss of distribution in 3 years through the aqua duct is caused by 3 factors: (1) The disconnection and search for other water sources by the wealthy people (class 5&6 see paragraph 3.1.3) in san Andres, (2) The high price for sanitation water asked by Pro Activa compared to big scale trucks and (3) the low amount of days that the water flows through the system (see figure 23)

The water distribution system faces a lot of problems. Due to corruption, illegal distraction and bad maintenance of the water distribution system 75 % of the water does not reach his destination(Duffs, 2013). These developments cause heavy financial losses per year, which cause a disability to invest and maintain the system by Pro Activa. This negative spiral results in unhappy consumers and a difficult position for involved and responsible entities(Duffs, 2013).

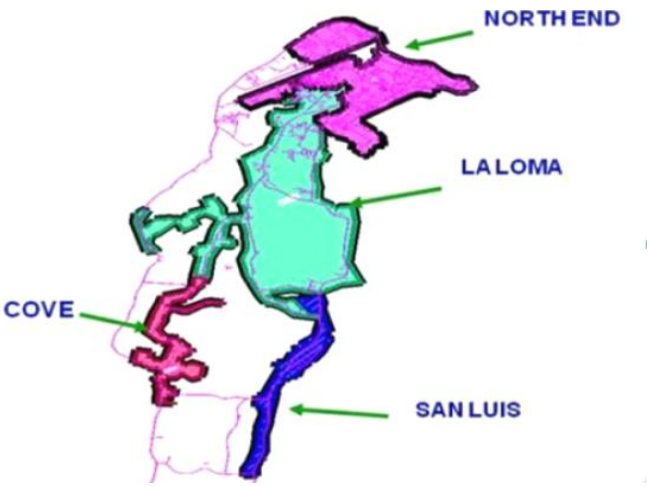


FIGURE 21 AQUA DUCT PRO ACTIVA

The big trucks distribute 1800 m³ water/day and the private 5 gallon bottle distributors another estimated 800 m³ water/day. This leaves 7400 m³ water/day for the categories rainwater harvesting and domestic wells. Rainwater harvesting was estimated on 3000 m³/ day, the import of bottled water at 750 m³ water/day, which causes an extraction through domestic wells of 5075 m³ water/day (see figure 22)

FIGURE 22 DESALINATION PROCESS PRO ACTIVA

Treatment

The treatment of the water is at big scale executed in the desalination plants (see figure 23). The desalination process needs large amounts of energy, which is elaborated upon in paragraph 3.1.5. The domestic treatment of either well water or rainwater is executed by filtration or boiling to make water suitable for drinking purposes.

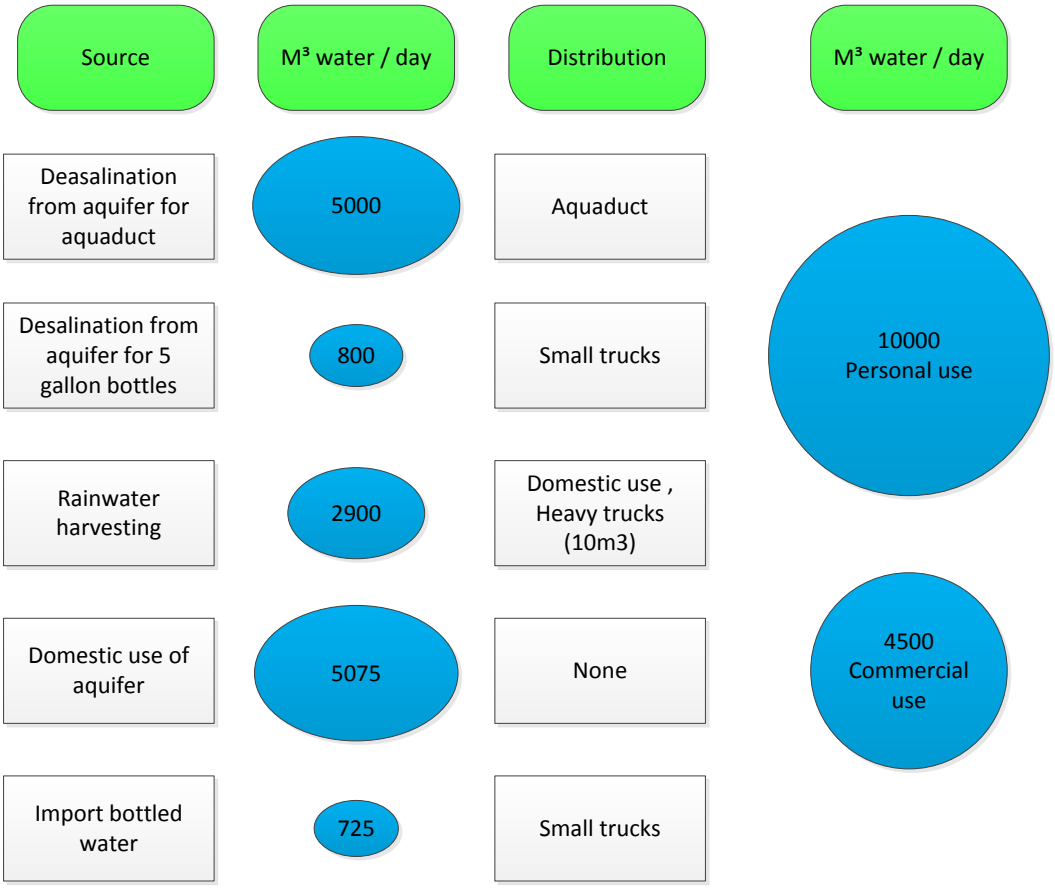


FIGURE 23 WATER FLOWS SAN ANDRES (DUFFS, 2013), (ATKINSON, 2005)

End consumers

San Andres faced a fast population growth and an expansion of hotels in the 1990's. The majority of the public water service is used by residential consumers and hotels (see figure 24). To understand the water consumption in the coming 20 years it is important to get a good understading about how the population and the tourists evolve. Various studies are performed towards the expected population growth of San Andres (see figure 24). Out of the various models that predict poupulation growth, the report selected the average variable to estimate the population (M. Tasa Decreciente). The variable displays an population in 2013 of 87.000 inhabitants that grow till 2030 at 145.000 inhabitants. The other big user of water are the tourists visiting San Andres. Tourism was stable during the crisis in colombia and especially the amount of colombian tourist shows an increase of 90.000 per year over the last 3 years (see fig 2) .The island has a limited number of places to stay so the tourists will not exceed the 1.000.000. The water usage per resident is estimated to be 150 liters/day by international standards. According to the thorough survey by C. Ashbaugh (2012) the island people have culture to save water and use 115 liters per day.

The tourist section uses more then double of the inhabitants and count for 293 liters per day(Guerrero, 2010). Shops consume 200 liters per day and offices consume 3900 liters per day(Guerrero, 2010). This result in a total water use for San andres of allmost 14.500 m3 per day in 2013 to more than 21.000 m3 in 2030(see table 5)

Disposal

The disposal of the water is processed through a system where 4 pompstations pump the water 450 meters from the shore and release the water at 19,5 meters depth (see figure 26). The sewage system is connected to all the households that have a Pro Activa subscription, to buy water and has a capacity of 30.000 m^3 wastewater/day. The households that are not connected to the sewage system put their waste water into septic tanks. This used to be sand puts, but are nowadays towards concrete tanks. The concrete tanks have leakages and this contiminates the aquifer. If the septic tanks are full of waste the big scale trucks suck up the waste and bring it towards a special entry in the submarine disposal system, where after the waste is blown into the sea.

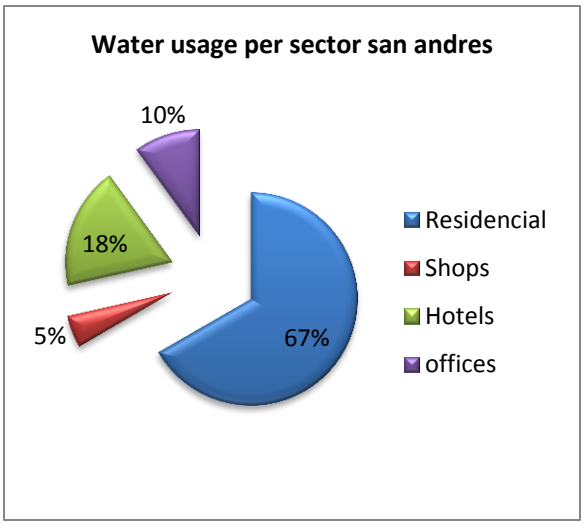


FIGURE 25 WATER USAGE PER SECTOR IN SAN ANDRES

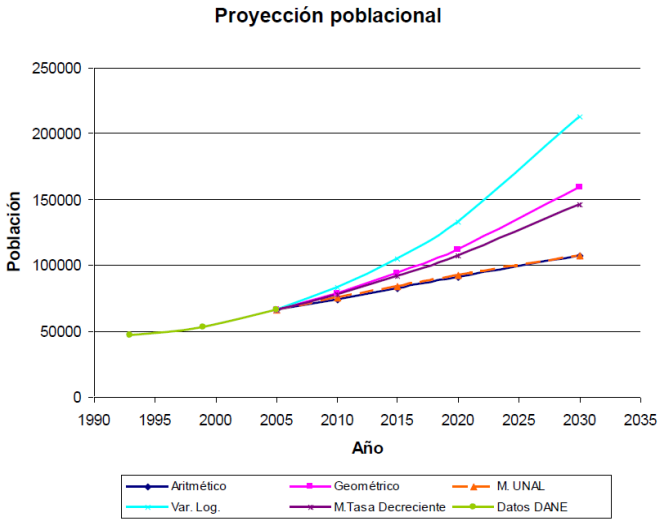


FIGURE 24 POPULATION SAN ANDRES TILL 2030

3.1.1.3 Objectives and criteria

Together with the director of the Providence foundation (A. Bowie) the objectives for the analyses and for the Providence Foundation were explicated by executing a means to and end analysis. The result is shown below (See figure 27). The means to an end analysis provided the objective for the focal owner:

Create supported pathways towards a sustainable water system for the island of San Andres in 2030.

During the session it became apparent that the Providence foundation did not have a clear understanding about her fundamental goal. The definition and explication of the values and objectives were an eye opener for the providence foundation. The means to an end diagram is used in further development for the strategy of the foundation. The means to an end analysis resulted also in a clear delineation of the research area and level of analysis. Next to the formulation of the objectives, the operationalized blocks can be seen as criteria for the focal owner of the project to assess the outcomes of the research.

FIGURE 26 SUBMARINE DISPOSAL SYSTEM

TABLE 5 EXPECTED WATER USE TILL 2030 DERIVED FROM(ASHBAUGH, 2012) (ATKINSON, 2005)

	Water usage m3/day				
year	Residential	Hotels	Shops	Offices	total m3/day
2013	10000	2500	600	1350	14450
2015	10600	3300	620	1480	16000
2020	12100	4000	650	1560	18310
2025	13200	4000	650	1560	19410
2030	15000	4000	650	1560	21210

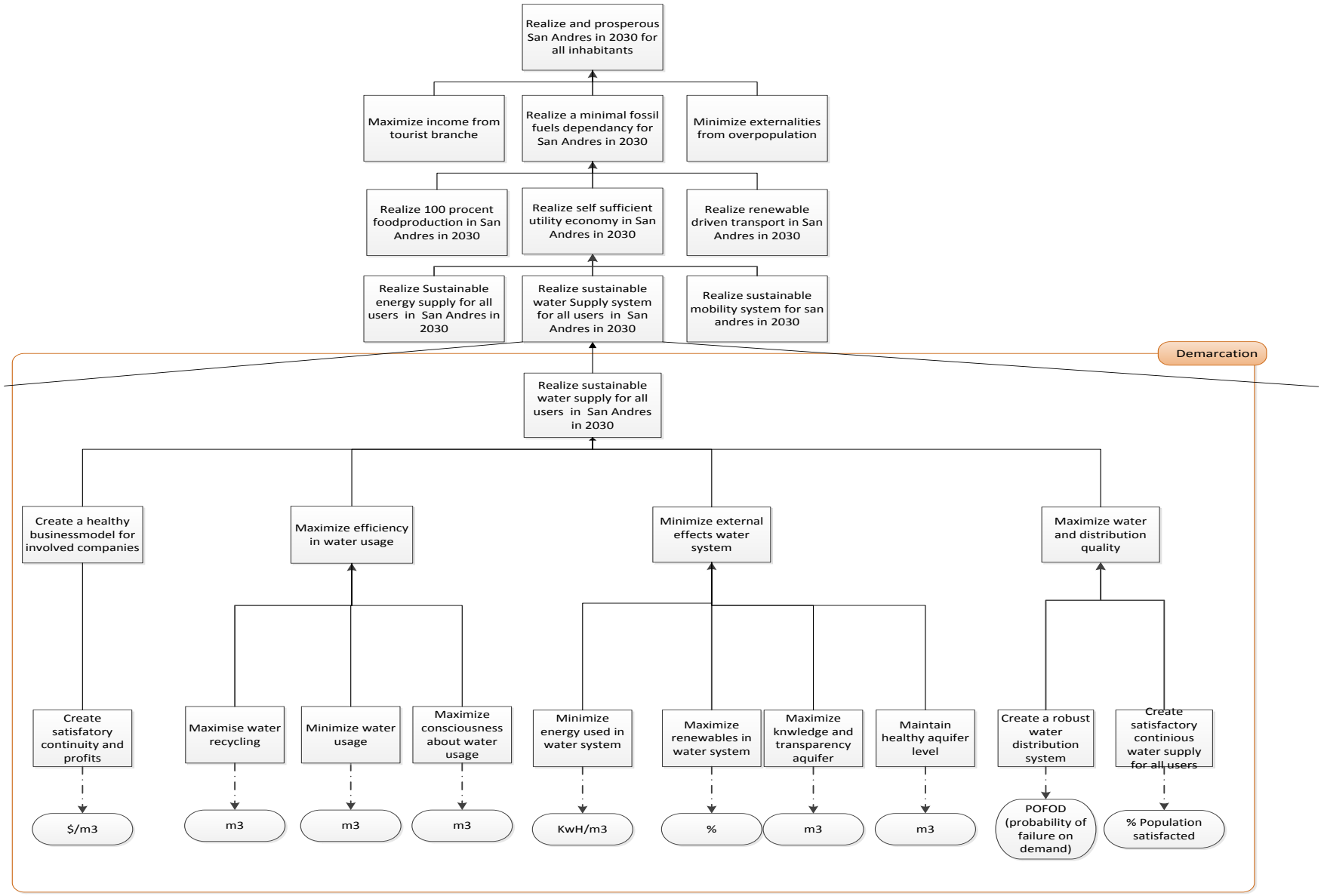


FIGURE 27 MEANS TO AN END DIAGRAM PROVIDENCE FOUNDATION

3.1.1.4 Provide an overview of the problem area using a system diagram

The criteria are set, the decision variables are numerous. To avoid complexity and ambiguous information this paragraph is performed from the view of the focal owner of the project, the Providence foundation. The system diagram is used to clarify the system by (1) defining its boundaries and (2) defining its organization and the main components and the relationships among them. .

Figure 28 show that the providence foundation lacks any influence in the system. The reason to model from the focal owner is stated above. The problem of lacking influence on the problem situation is solved by stating that his research will include entities that have decision power and are able to influence variables in the model.

The need of other entities to support this research is clearly pointed out. The system analysis clearly develops the goal of the focal owner and therefore also the goal of this project. Therefore the goal of the methodological framework is established:

> *Construct supported pathways towards a sustainable water system for the island of San Andres in 2030.*

The search towards the supported policy building method entails the components of the future are characterizations of different technologies, socio-economic changes and institutions that together enable the transformation of the water system into an integrated sustainable water system.

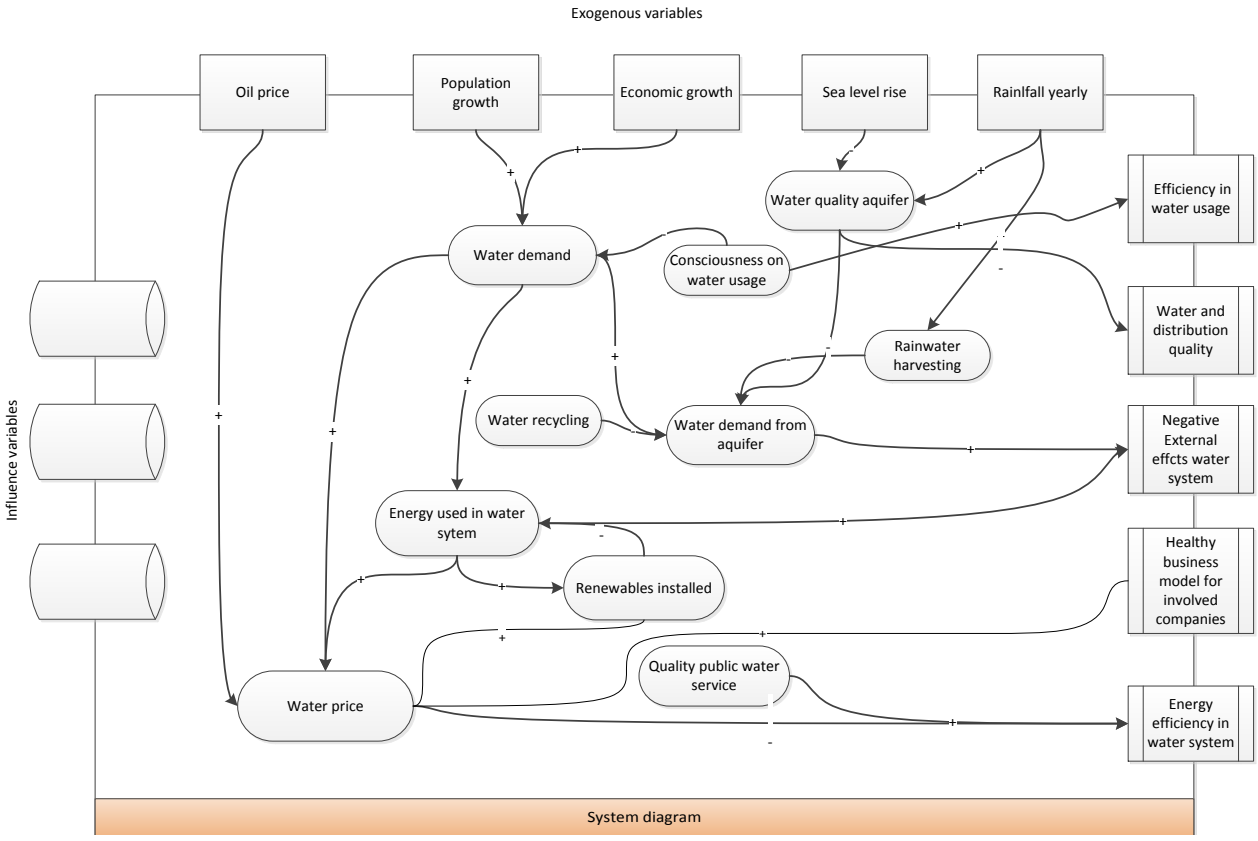


FIGURE 28 SYSTEM DIAGRAM

3.1.3 Analyses of institutions

The method used to unravel the institutions of the water system in San Andres is the four layer model by Williamson (1998) as shown in figure 29. The model is an approach to describe social and institutional arrangements in an integrated view.

The top level is the level of 'social embeddedness'. The cultural components, norms, religion and habits are expressed in this layer. This layer is formed by the cultural behaviour of the Raizales (Anglo African original inhabitants of San Andres). The Raizales were used to take water from the rainwater and private wells and therefore not used to pay in any form for water service. The majority of the Raizales owns land that was given back to their slave's grandparents and they are proud to be free and possess land. The general norm for the Raizales is to pay their bills at short notice because of the pride that they carry with them. Another cultural habit is the corruption in Colombia; Ninety-three % of Colombian company directors that were surveyed reported that bribes are paid in the course of their business activities(Burnett, 2010).

The second level is the 'institutional environment', in which the political behaviour provides the "rules of the game" for the arena where the economic activity is organized. The political arena in San Andres goes hand in hand with bureaucracy. The coupling of business towards politics is visible during the tendering and decision about which company is awarded the tender for the public water service contract. Due to low paid government employees and a deep-seated corruption[1] culture business and politics couples with resources. In 1993 the Colombian government implemented Right to prior consultation/informed consent (Consulta previa), in which Afro-Colombians are guaranteed the right to be consulted about all development projects that may affect their land

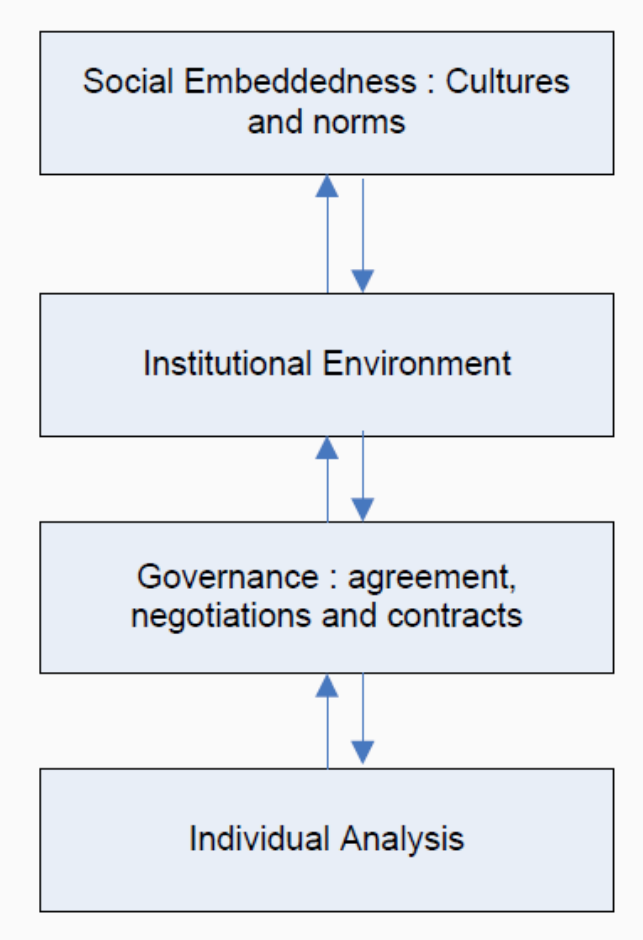


FIGURE 29 FOUR LAYER MODEL (WILLIAMSON, 1998)

use patterns; this right has been consistently abrogated in favour of the interests of agricultural and tourism investors. The Consulta previa entails the consultation and participation of local communities in the design, approval, implementation, and evaluation of development projects that could affect them and their territories. A commission of natives is erected per province to communicate the desire of the local community onwards projects. On the first sight a good tool to involve communities in projects, but due to the deep seated corruption in the country the Consulta Previa soon became a tool for politicians to ask large amounts of money to investors, because they could convince the community about the good or bad effect of the project. Due to ambiguity in the processes of consulting the community, the realization of a 7 MW onshore wind park in San Andres is still on hold. In the 20th Century the Colombian

[1] Colombia listed a score of 36 point (0 is totally corrupt. 100 is corruption free) on the transparency list that is yearly published by transparency international.

government issued to gain knowledge about natural resources and the law and institutions needed to regulate their uses.

On the third level (the 'governance' layer), the arrangements are described that guide the interaction between individuals. This layer examines (law) property rights, regulation (prices) market relationships from completely equal towards top down relations. From 1995 to 2002 the government launched a program of business modernization to privatize the utility companies, leading to significant developments in the efficiency and quality of the utility services(Blanco, 2008). The government of Álvaro Uribe (2002-2010) rapidly increased coverage, overtaking the United Nations Millennium Development Goals for the water service sector and invested heavily in rural areas, which had the highest requirement of service improvement. This resulted for San Andres in the investment in a 55 km large public water supply and sewage system (aquaduct).The public water system is owned by Pro Activa that was awarded the concession of the public water service. Aguas de San Andres is an administrative entity that controls the concession about the public water service contract and has decision power in the modifications of the public water distribution system. Aguas de San Andres is then controlled by the Central Ministry of Utilities in Bogota. To get a better picture of the stakeholder responsibilities a formal chart is established in figure 32. The control of the water extraction permits that are awarded through market parties is executed by Coralina. The problem is that no environmental fines exist. Once an owner of a big scale truck company is caught with illegal extracted water there is no follow up possible. The rest of the water production and distribution is privately held under normal market conditions. The market conditions are affected by the tariff law. The Colombian tariff system is defined in the Public Services Law from 1995(Congreso, 1995). It is applied to all utilities for cost recovery from the rich to the poor. The base tariff of each service provider has to be adjusted to the socio-economic class of the user, according to

Class	Tariff adjustment factor
1	30%
2	60%
3	85%
4	100%
5	120%
6	120%

FIGURE 31 TARIFF STRUCTURE

adjustment factors that are specified by law. Class 1 represents the lowest income group while class 6 stands for the highest class (see figure 30).Class 1 entails over 2000 connections on San Andres and the total of connections in class 5 and 6 is equal to 1000 connections. The difference that is created is paid by the government(Duffs, 2013).

The fourth layer "operation and management" focusses on the individual analysis. This is the level where the neo-classical economics are pondered. On the assumption of rationality, individuals determine their utility and choose the best option on the basis of prices, services, demand and output (Williamson, 1998). Individual consumers concentrate on receiving the highest utility and therefore shaping the market. This works solely in a market with competitors. In San Andres there are 3 ways to order the water from the market. (1)Private water service Pro Activa, (2) Big scale trucks (5000 litre) and (3) Water bottles 5 gallons (19 litre).The water service of Pro Activa is delivered to the consumers at the quality standards of potable water. The public water service is only continuous for the north end of the island. The rest of the Island receives water at scheduled times (see figure 31).

SUBSECTOR	Día servicio/mes	Frecuencia prestación servicio
Centro hotelero	30	Todos los días
Centro Residencial	8	Cada 4 días
Sarie Bay	30	Todos los días
Almendros	8	Cada 4 días
Natanias	8	
Back Road	8	
Norte	15	Cada 2días
Sur	30	Todos los días
Norte	4	Cada 7 días
Centro	4	
Medio	4	
Sur	4	
Shingle Hill	2	
Hill Can	2	
Court House	2	
Orange Hill	2	

FIGURE 30 PUBLIC WATER SERVICE IN DAYS PER MONTH

The discontinuity of the water service together with culture makes the consumers store the water before using in large cisterns. According to a survey the majority of the consumers have more than 3000 litre installed capacity for water storage(Ashbaugh, 2012). This leads to the situation, where the potable water from the public service is put into cisterns and mixed with the rainwater. This water is used for washing and sanitary purposes.

According to Ashbaugh (2012) the public water service is experienced by the customers as too expensive for the service. This emerges partly from the norm that the inhabitants were not used to pay for water and is partly caused by the costs of water distribution of the public service, which is elaborated upon in paragraph 3.1.1.2. The public water distribution service experiences the heavy losses through leakages and illegal connections. Due to the culture of corruption and the minimal payment of the employees of Pro Activa, the employees are easy to bribe with money to connect customers towards the water system without any form of administration.

3.1.4 Stakeholder analysis

The water system in San Andres involves interdependencies that compete, regulate or cooperate in order to serve the customers. According to Quist en Vergragt (2006) it is important to develop future visions that are endorsed by actors to create a founded policy making process. A stakeholder is a social entity, a person or an organization, able to act on or exert influence on a decision"(Enserink et al., 2010). The stakeholder identification is executed by the reputational approach. Various key stakeholders are approached to identify important other stakeholders, which developed the following list:

Regulation

- National Vice-Ministry for Water and Sanitation and Departmental Plans
- Ministry of Environment, Housing and Territorial Development
- Potable Water and Basic Sanitation Regulation Commission (CRA)
- Superintendence of Residential Public Services (SSPD)
- Aguas de San Andres
- Regional ministry of utilities
- Coralina

Production

- Pro Activa
- Aqua works
- Sweet water
- Blue water
- Aqua Sana

Distribution

- Conty water
- Various other 1 person big scale truck companies
- Pro Activa
- Sweet water
- Blue water
- Aqua Sana

End consumers

- Enormous amount of large scale hotels
- Enormous amount of restaurants
- Huge amount of shops
- Governmental offices
- Native lodging
- Native consumers
- Residential consumers
- Hostels

Disposal

- Pro activa

The amount of stakeholders that is able to participate in the backcasting session is restrained by the size of the workshop room and the amount of specialists that is able to moderate a session (16 people). Next, demands towards the participants as stated in paragraph 2.6.1 are followed in the selection process. The process of election is structured by selecting an equal

participation of consumers, commercial parties and non-commercial parties. This results in a list of 12 participants. To get a sense of the environment in which the whole process is executed the actors are displayed with a photo or logo. Next to this logo the interest of the stakeholder is displayed.

Regulation

Ministry of utilities (National Government) represented by the regional ministry of utilities (Government of San Andres).

Interest: To protect and promote the rights and obligations of users and providers of public services, to contribute to sustainable development of the country and the quality of life of its inhabitants.

Coralina

Interest: Improvement of water management in the Archipelago of San Andres and through action planning, regulation and greater community participation.

Vice-Ministry for Water and Sanitation and Departmental Plans (provision of water)

Interest: Consolidating structural reforms in the drinking water and basic sanitation sector, to achieve a positive impact on the reduction of poverty through actual coverage of water, sewerage, and sanitation services.

Potable Water and Basic Sanitation Regulatory (quality)

Interest: to create and preserve the necessary conditions to provide sanitary services by regulating the organizations and agencies that provide this services, may them be public or private; its duties include establishing criteria for quality towards the users and implementing subsidies to low income users

Aguas de San Andres (contractor and administrator of the water concession)

Interest: Efficient water distribution system with minimal negative effects for the environment in the Department of San Andres.

Production

Pro Activa

Role: Desalination of water. Plant capacity 4500 m3/day

Interests: Profit and Continuity for the shareholders of Pro Activa

Sweet water

Role: Desalination of water. Plant capacity (18m3/day). To bottle the water into the 5 gallons bottles

Interests: Profit and Continuity for the family business

Aqua Works

Role: Desalination of water. Plant capacity (50 m3/day). To bottle the water into the 5 gallons bottles

Interests: Profit and Continuity for the business.

Distribution

Pro Activa

Interest: Connect the whole population of San Andres to the central water system in order to enlarge consumer bases and divide the maintenance and amortization costs over all the participants.

Conty water

Interest: Profit and continuity by supplying entities with big trucks (5000 litre) to serve them of water. Enlarge network of customers by providing 24/7 service.

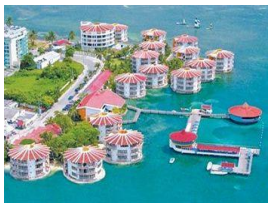
Sweet water, aqua works
Director . sr. Vasquez

Interests: Serve customers daily with up to standards quality potable water distributed in 5 gallon bottles.

Consumers

Residential consumers
Edward Jay, Future consumer

Interest: High quality water for an affordable price in a system that is sustainable and therefore available for the children of my grandchildren.



Commercial consumers
David Pinerez, Director Royal Decameron

Interest: High quality water at a low price in a continuous system over the coming decades to secure the high quality water supply for all our high end hotels.

Native Consumer:
Mrs. Patricia Bowie, owner of native lodging

Interest: High quality water at low price in a continuous flow. Stop the big trucks to avoid pollution of the street and environment.

Disposal

Pro Activa.

Interest: Profit and Continuity for the shareholders of Pro Activa Connect as many users a possible towards the disposal system.

To enable system innovation the framework proposes coalitions between six types of stakeholders: Government, Companies, Knowledge infrastructure and advice, Intermediates, Citizens/ Consumers and investors. Furthermore an equal mix of consumers, commercial parties and non-commercial parties is required. These stakeholders could be either part of the value chain of the researched topic, or from a complete different background to emerge new ideas. To comply with this requirement four parties are invited to the process:

Miscellaneous

University of Colombia

Interests: The University's purpose is to increase the knowledge through investigation, to pass on knowledge through education, learning and interaction processes that are related to new national realities.

Elemental water makers

Interest: Install a commercial renewable driven desalination system for drinking water production in San Andres. With rising energy prices and increasing freshwater scarcity, there is a growing need for renewable driven desalination. Elemental Water Makers has developed an innovative desalination system that only uses solar and/or wind energy in an efficient and costs effective way.

Providence foundation

Interest: To manage, protect and restore the water system on the island of San Andres by applying appropriate technologies aimed at knowledge of the supply and demand of renewable natural resources, tending for sustainable human development and involving the community and companies so that in a concerted supported way improves the quality of life of the region.

Inter american development bank

Interest: At the Inter-American Development Bank we are convinced that countries in Latin America and the Caribbean can close the coverage gap in water and sanitation services in the near future. To reach that goal, the Water and Sanitation Initiative offers a new set of tools and flexible financing.

The required stakeholders are identified and categorized. The parties required for system innovation are identified and the mix between consumers (4) commercial parties (5) and non-commercial parties (4) is safeguarded (see table 5).

TABLE 6 STAKEHOLDERS

Consumer	Commercial	Non commercial
Future consumer	Pro activa	Ministeria da vivienda
Royal Decameron	Sweet water	CRA
Universidad Nacional	Aqua works	Providence foundation
Native Consumer	Inter-American development bank	Aguas de San Andres
	Elemental water makers	

The second step of the actor analysis entails the exhibition of the formal chart: the formal tasks, authorities and relations in the system. Stakeholders and interdependencies between actors have a formal and an informal adjacent. Knowledge about both subjects is important in order to understand the behaviour of stakeholders and their environments (Enserink et al., 2010). The analysis is executed on the basis of government documents and verified with Aguas de San Andres in the interview that was held 10-4-2013. The formal chart is shown in figure 32. The diagram below shows the most important formal relations between the actors. It should be noted that the informal influence relations are not included. As a result of this, the non-governmental actors may seem less connected or less influential than they actually may be. The top down approach of the Colombian institutions is clearly visible in the chart. The National Ministries communicate the laws responsible towards the regional Government.

The department mental government provides the legal entity Coralina with the regulation of aquifer and the sewage on the island. The entities who produce water receive regulation from Coralina about the possible extraction from the aquifer and water quality standards of the Potable water and basic sanitation entity. The requirements of the sewage system are regulated by Coralina. The public water service is tendered by Aguas de San Andres for a 20 years concession towards Pro Activa. Aguas de San Andres is in control of the contract and reports to the regional department of utilities t in San Andres. The four entities on the outside line are not part of the formal responsibilities, but influence the system with knowledge, investments and research.

The last part of the stakeholder analysis entails the definition of the problems, objectives and overall strategy to administrate these issues. These are derived from the interviews that took place with each stakeholder as part of the future vision development and value elicitation process and are displayed in appendix III.

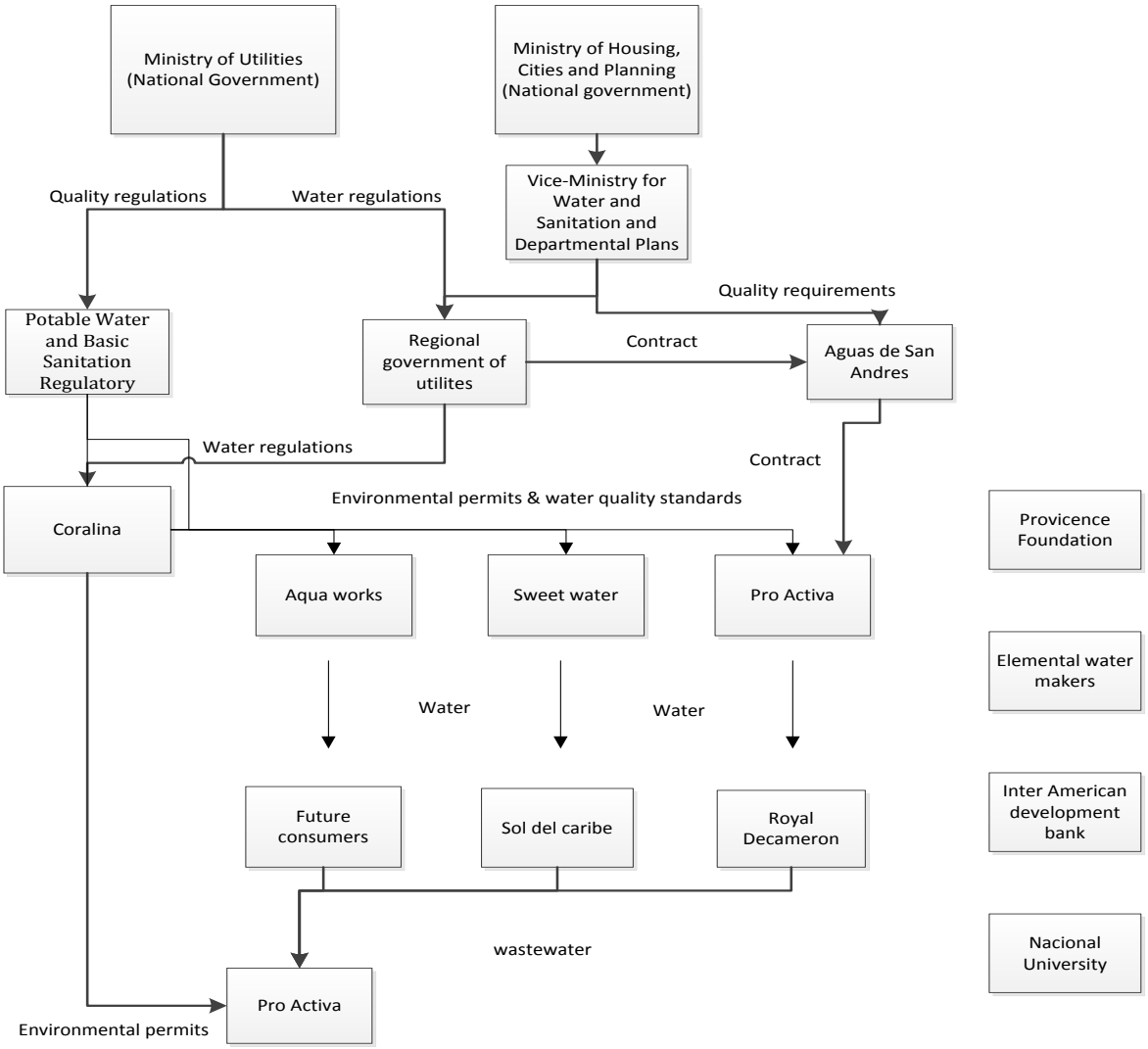


FIGURE 32 FORMAL CHART WATER SYSTEM

3.1.5 Definition of sustainability framework

This paragraph elaborates upon the requirements needed for a sustainable water system. Firstly, the conditions for a sustainable system are presented, where after the major gaps are indicated. The Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC)report presents the following definition of sustainability: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”(Pachauri and Reisinger, 2007). This definition is widely accepted, but ambiguous in operational values and therefore difficult to make the sustainability criteria explicit. The proposed framework includes the operationalization of the sustainable definition through 4 basic sustainability principles. The first three maintain the essential natural resources, structures and functions that sustain human society. The final principle acknowledges that human action is the primary cause of the rapid change we see in nature and focuses on the social and economic considerations that drive those actions and the capacity of human beings to meet their basic needs (see figure 34).

The application of the natural step framework is executed following the guidelines and the sustainability principles are shown per area. The current situation is crossed with the principal conditions for sustainability, which results in gaps. The gaps are shown together with brief solutions to inspire the participants in their imagination.

1. **Concentrations of substances extracted from the earth's crust**	The systematic increase of concentrations of substances extracted from the Earth's crust (for example, heavy metals and fossil fuels)
2. **Concentrations of substances produced by society**	The systematic increase of concentrations of substances produced by society (for example, dioxins, PCBs, and DDT)
3. **Degradation by physical means**	The systematic physical degradation of nature and natural processes (for example, over harvesting forests and paving over critical wildlife habitat); and
4. **In society people are not subject to conditions that systemically undermine their capacity to meet their needs**	Conditions that systematically undermine people’s capacity to meet their basic human needs (for example, unsafe working conditions and not enough pay to live on)

FIGURE 33 PRINCIPAL CONDITIONS OF SUSTAINABILITY CONDITIONS (HOLMBERG, 1998)

Concentrations of substances extracted from the earth's crust

The total energy consumed in the production and sewage water system in San Andres in 2012 was more than 5 million kilo Watt hours (kWh) (see table 6). The energy is produced through diesel engines that produce 4,5 kWh per litre diesel, which causes in production and sewage a diesel use of more than 1 million litre diesel per year and the emission of more than 4 million kg CO2 per year. The distribution of water through big scale trucks and small scale trucks consumes another 1500 litre of litre per day, which results in 1.6 million litres diesel used per year and an emission of 7.3 million kg CO2 per year into the atmosphere. The needed diesel is derived from fossil fuel and extracted from the earth crust.

Concentrations of substances produced by society

A huge part of the water distribution (1800 m^3 water / day) is processed by the huge trucks that were imported during the 80's. The trucks are mainly of American brands and use v8 powered gasoline engines to transport the water from the wells towards the consumers. The old American engines cause high contamination. There are 12 trucks on the island that transport 10 m3 water for sanitarian use. The trucks have 12 -15 loads per day in dry season and due to the old engines need on average a refill with 40 gallons (120 litre diesel) per 25 trips. Per day are this 12 trucks * 15 trips = 180 trips. The trucks use 5 litre diesel per trip, which means that the system of trucks use 900 litre diesel per day. The emission of the old engines is 65 gram CO and 6 gram NOx per km(Agency, 2011). The total system requires the trucks to drive almost 1 million km per year, which results in 60.000 kg CO2 and more than 5000 kg NOx emitted.

TABLE 7 ENERGY USED IN WATER SYSTEM SAN ANDRES. (JAY, 2013)

Production and sewage	5.659.200	1.061.100	4.600.000,00
Distribution		547.500	2737200
Total		1.608.600	7.337.200

Degradation by physical means

The situation of the aquifer is stressing the importance of the research. To maintain a healthy and sustainable level of the aquifer the average daily charge from the aquifer should be less or equal than the recharge of the system. The aquifer is by average daily charged with 11200 m³(Taylor, 2000). According Taylor (2000), the total water use is for 75 % dependent on the aquifer. In 2013 the total water demand was 14306 m3, which means that the daily extraction is equal to 10700 m3 and therefore ceteris paribus a sustainable situation. In 2020 the total water use of the island rises towards more than18000 m3/day, which creates a pressure on the aquifer of more than 13500 m3/ day. The aquifer is charged with 11200 m3/ day, so the daily loss is in 2020 already 2300 m3/day. The losses towards 2030 are even higher due to a higher demand and this difference keeps rising.

Next to the theme of charge and discharge the aquifer works as a sewage system. Many islanders have a septic tank with leakages towards the aquifer. According to Taylor (2000) 69 % of the aquifer was heavily contaminated, 30 % medium contaminated and only 1 % considered drinking water quality. Since 2007 the sewage system is installed and connects 7000 households and 1200 offices towards the "cleaning" system. An average household in San Andres contains 4 persons, so this means that almost 30000 persons are connected to the sewage system. The other 50000 users are still putting their waste into septic tanks. The sceptic tanks often suffer leakages and contaminate the aquifer.

In society people are not subject to conditions that systemically undermine their capacity to meet their needs

Conditions that systematically undermine people's capacity to meet their basic human needs exist in the payment of the inhabitants towards the water company Pro Activa. The Raizales does not have the money to pay for the water service. If the valves of the system are opened, the population fills up their cisterns and is not able to pay for the service provided. When the government installed the water service system the users were not given a proper education about water costs and water use. This result in large accumulated bills for the water service (4 times the monthly income is not exceptional) and resulted in expropriate of houses and land by credit managing companies.

3.1.6 Analyses of potentials to leapfrog the gap

The analysis in paragraph 3.1.4 clearly states the gap between the current situation and the sustainable situation regarding the waters system in San Andres. The participants of the session are a mix of engineers, social scientists and entrepreneurs. In order to create a basic level of knowledge among the participants regarding inventions in sustainable water systems a showcase of innovative ideas is presented (see appendix IV). This showcase is used to engage and inform the participants about future possibilities of water production through other resources than the aquifer. Firstly, innovations in desalination processes are shown where after large and small scale rainwater harvesting processes are displayed. Finally the innovations in the recycling of water are stated.

The abundance of sea water that surrounds islands demands a deeper look into the possibilities of using this water for drinking and sanitary purposes. Sea water contains dissolved salts having a concentration of 25,000 to 35,000 ppm. This level must be reduced below 500 ppm before it can be used for drinking water purposes. Distillation is the oldest and the most commonly used method of desalination, where sea water is evaporated and vapours then condensed giving clean water. The latent heat of water is about 540 kcal/kg making the process highly energy intensive and conventional distillation columns prove uneconomical for production due to high input energy requirements.

According to M Papetrou (2010) off grid powered seawater reverse osmosis (RO) systems promise the lowest cost (euro/cubic meter drinking water produced (see figure 35). The table displays different prices at various quantities and is also outdated. Therefore, it can only be used as an indication towards future prices of desalination processes.

COMBINATION	COST (€/m³)	ASSUMPTIONS
Off-grid wind powered-seawater RO systems	1.07	• Nominal capacity: 1,000 m³/d • Number of annual operation hours: 5,200 • Specific energy consumption: 3.3 kWh/m³
Seawater PV-OR	11.81	• Nominal capacity: 100 m³/d • Number of annual operation hours: 3,000 • Specific energy consumption: 6 kWh/m³
Brakish water PV-RO	8.29	• Nominal capacity: 100 m³/d • Number of annual operation hours: 3,000 • Specific energy consumption: 1.6 kWh/m³
Brakish water PV-EDR	8.47	• Nominal capacity: 100 m³/d • Number of annual operation hours: 3,000 • Energy consumption: 3.31–3.65 kWh/m³ (depending)
MED + solar pond	1.44	• Nominal capacity: 6,000 m³/d • Number of annual operation hours: 8,320* • Electric consumption: 2.25 kWh/m³
CP solar collectors + biomass-MED	4.84	• Nominal capacity: 6,000 m³/d • Number of annual operation hours: 8,320* • Electric consumption: 2.25 kWh/m³

FIGURE 34 COSTS OF RENWABLES ENERGY DESALINATION SYSTEMS(M. PAPAPETROU, 2010)

3.1.7 Value Elicitation

The goal of the value elicitation is twofold: (1) Focus the decision context on what is important for the decision (objectives) rather than what the options might be (alternatives) and (2) the setting of the weights for the Multi Objective Dimension Analysis (MODA) that is used to evaluate different alternatives crossed with scenarios on their robustness towards the objective. 14 interviews were carried out with the selected participants. The majority of the interviews were done at the office/ workplace of the interviewee and endured roughly 2 hours. The goal was not only to interview the stakeholders in the water project, but also to involve and engage them in the backcasting process. In addition, the interview was meant to obtain data and views on the water system in San Andres to safeguard the completeness of the process. An interesting observation was that all the stakeholders answered that the government was responsible for development and the implementation of a long term plan, but that the actual development and implementation depends on the combination of market parties and environmental organizations.

The participants are asked the following questions:

1. What do you want? What do you value regarding the water system for San Andres?
2. *Consequences.* What has occurred that was good or bad? What might occur that you care about?
3. Different perspectives. What would your competitor or your constituency be concerned about? At some time in the future, what would concern you?
4. *Strategic objectives*. What are your ultimate objectives? What are your values that are absolutely fundamental?
5. *Generic objectives*. What objectives do you have for your customers, your employees, your shareholders, yourself?
6. What environmental, social, economic, or health and safety objectives are important?

These open questions together with the objective tree facilitated the completeness of the value harvesting process. The value tree that was erected is shown in figure 35.

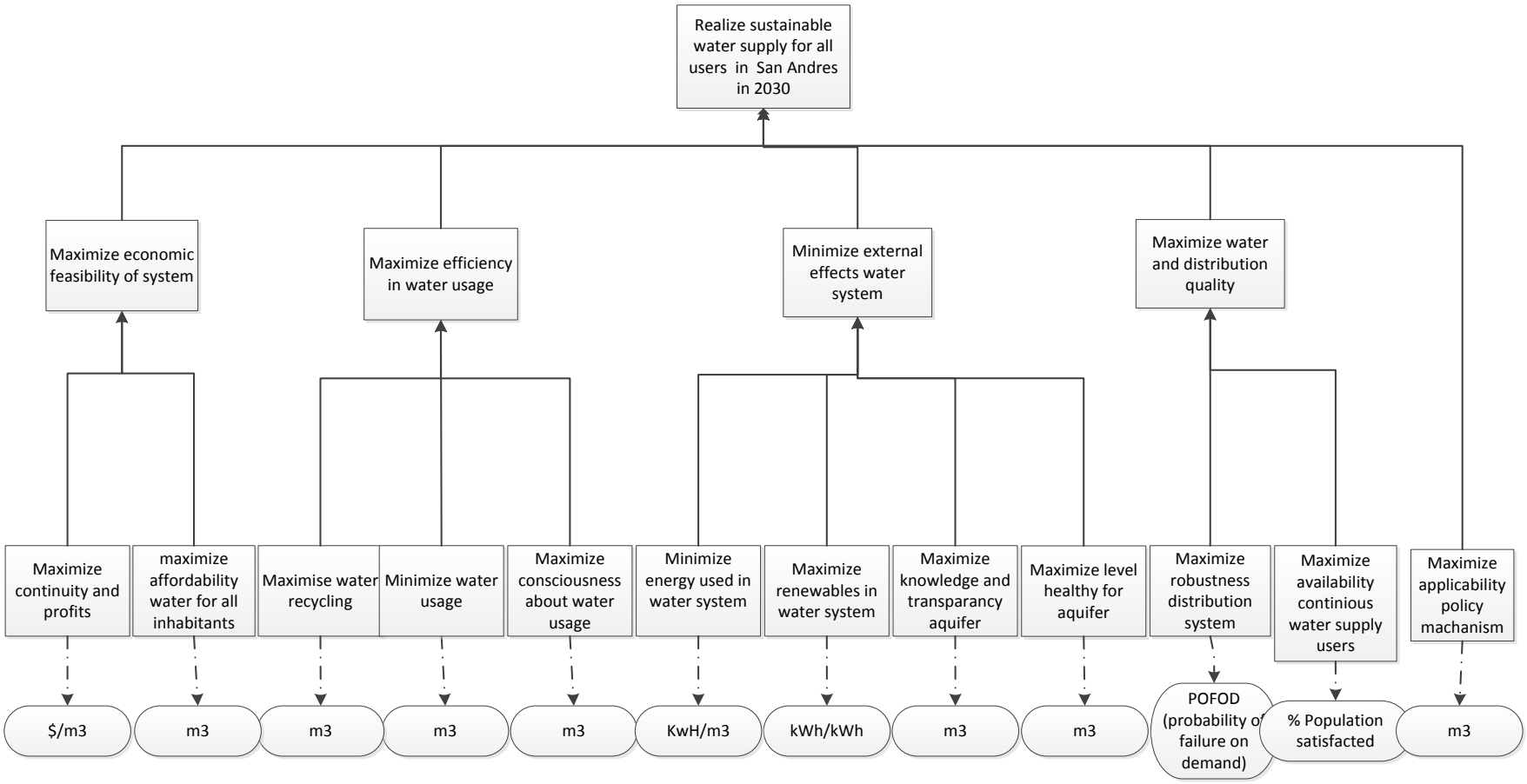


FIGURE 35 SHARED VALUE TREE PARTICIPANTS

After these 6 questions, the participants were asked to divide 100 points over the values to create a weighed value tree. The coupling of the answer towards the value tree results in the following schematic drawing that clearly displays the most important means and fundamental objective(s) in percentage of the total points rewarded towards the value (see figure 36)

3.1.8 (Un) Shared value mapping

The complexity and challenge is the multi actor contest of Value Focused Thinking in the thesis. Values are personal and organizational defined.

The challenge is to create a shared value tree that emerges consensus among the participants. The objectives derived from system analysis are accompanied with 5 boxes to write down other values to create a shared values list among the participants. Over this number of values the participants could share 100 points. The final value list of all the participants is shown in table in figure 34, where the absolute score is divided by the total score, which leads to a comparable importance of the variables.

The values minimize energy used in water system, maximize renewables driven water system and maximize profits are the top 3 identified values. There is a tendency towards renewables energy driven systems on the island. The other 2 top ranking values can easily be explained by the high amount of commercial entities that participated in the research (5/14). This shared value list is later on used as criteria to judge the different visions formed in the following paragraph.

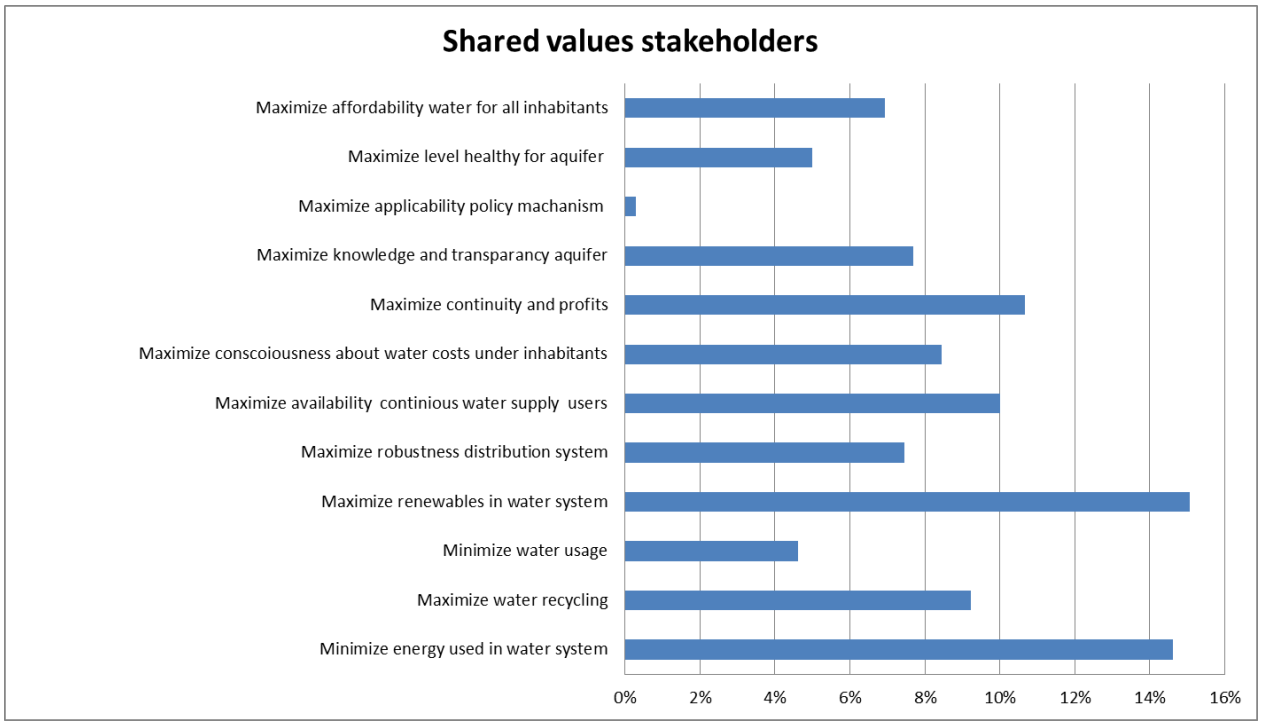


FIGURE 36 SHARED VALUES LIST STAKEHOLDERS

3.2 Develop future visions

The initial part of the future vision development elaborates upon the normative requirements of the study followed by the actual vision development.

Definition normative requirements

The future visions are harvested through the interview and a shared future vision can be generated;

Realize sustainability regarding the water system in San Andres Island involving an integrated water management system, taking into account the socioeconomics aspects of the island inhabitants, the special characteristics as an isolated system and the technical approach all in regarding to the sustainability principles that are established regarding the rules within UNESCO Biosphere reserve.

According to the definition of sustainability for Biosphere reserves of the World Summit on Sustainable Development the provision of clean drinking water and adequate sanitation is necessary to protect human health and the environment(UN, 2002). However, the rules that are set towards sustainability in an UNESCO Biosphere reserve are unambitious and ambiguous. To incentivize a clear sustainability picture the thesis selects the principles from the Natural Step Method (NSM) as sustainability standard. The NSM is described in detail in paragraph 3.1.5 and displays a clear definition of sustainability.

The selection of this group results in the total creativity, experience and clout available to formalize a pathway to deal with future problems. Therefore, the core normative requirement contains the selection of the people that participate in the interviews and workshops. Above mentioned requirements are ambiguous and therefore the participants are selected on a) having a university degree and b) senior position in the company that is represented.This requirements safeguard the experience in strategic thinking, which is needed to develop strong pathways.

(Brainstorm) alternatives from values and develop value based future vision

The next challenge is to disconnect the participants from this paradigm and get the stakeholders in future paradigm. The connection with VFT methodology serves in this research as connection to the future. The stakeholders are first questioned upon their values and strategies and are thereby disconnected from business as usual. These values are harvested in an interview in the case of San Andres and displayed in figure 34. These serve as pillars for the brainstorm session “towards possible solutions for the pathway towards a sustainable water supply system for San Andres”, where every participant can participate. One of the key advantages from value thinking is the possibility to emerge a vision purely based on the values and thus underlying wants of the stakeholders. In the session a group of stakeholders volunteered to contribute towards this shared valued vision. The group contained the following participants:

(1) Future energy consumer Edward Jay
(2) Pro Activa director Elizabeth Young
(3) Elemental water maker’s representative Chris Dingemanse
(4) Coralina representative Tomas Guerrero
(5) Royal Decameron representative Jose Fuentes.

These 5 participants represent government, distributor, environmental agency and start-up in the field of water management. To break the ice, create awareness of the multi actor stakeholder and as general rehearsal for the workshop the human knot game was played, which is elaborated upon in the following paragraph. The brainstorm was then introduced with an analysis of the water system followed by the introduction of the goal of the brainstorm. Firstly, the participants were asked to design a system that is pillared on the shared values as presented in paragraph 3.1.8. The result of the brainstorm is displayed in the following design:

The design is based on the 6 most important values that the participants pointed out in the interviews:

(1) Minimize energy used in water system
(2) Maximize water recycling
(3) Maximize renewables driven water system
(4) Create continuous water supply
(5) Create satisfactory continuity and profits in the water system
(6) Realize monitoring for transparency and information customers of aquifer.

The design should meet the requirements to be presentable in 5 minutes and understandable for all public that has a basic knowledge of the water system in San Andres. The participants came up with the following design; The Island is separated into 2 policy areas, the urban zone and the rural zone. In the urban zone the government rents the rooftops of the inhabitants to harvest rainwater during the dry season. This water is pumped into a great tank that is installed on the hill through solar and wind power. The water flows empowered by gravity into a filtering system, where the water is prepared for drinking purposes. Then it flows through gravity to the consumer, who pays an honest fee for the use of water. The tank is large enough to cover 2 months of dry period. In the other 4 months of dry period a solar power desalination system takes care of the supply for the big tank. A recycling system takes care of the sewage system.

After the recycling the water is pumped into the big tank on the hill. In the rural zone a smaller scale system of the urban zone is installed, without the recycling system. The rural compounds are assessed on water demand and supplied with water tanks paid with government money. Small scale solar powered desalination systems are installed to cope with the demand in the dry season. Finally, it is important to educate all the users in san Andres in continuous water supply and the costs starting 2 years before the start of the newly build system, to avoid overuse, spilling and the disability to pay for the utility bills.

Out of this value based design the four different focus visions were extracted. These 4 different focus visions are shown in figure 37. Rainwater harvesting was the original water resource from the island. Islanders used the water for sanitation and boiled the water for drinking purposes. This vision focusses on restoring the old habits into a new culture. The vision with a focus in recycling attempts to starts this process on San Andres. Nowadays, all the used water is disposed via a submarine system that is located 200 meters offshore. The re use of this water could lead to less energy needed in the whole water cycle. Smart user develops not the exogenous variables, but the user itself in its behaviour. The total water demand can be stabilized by the efficient use of water and complete knowledge about the aquifer as eco system. The last vision focusses on the implementation of renewable energy systems in the water system in San Andres. Through installation of solar PV and wind modules the water production and distribution could be facilitated without the use of fossil fuels.

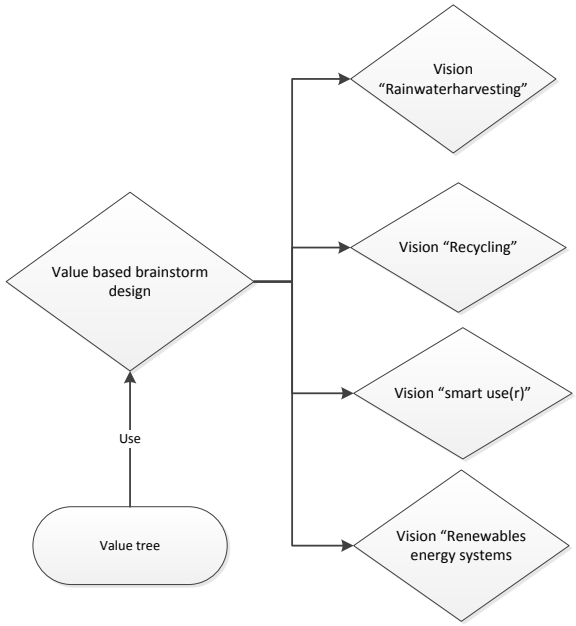


FIGURE 37 VISIONING PROCESS

3.3 Backcasting

The backcasting workshop took place in the meeting room of the company EEADAS on the Wednesday afternoon 24/04/2013. The room that is used for the workshop could comfortably host up to 15 persons, including the moderator. 15 stakeholders were invited and 13 showed up. The only entities that did not attend the workshop were the IADB and Conty water. The rest freed itself from business as usual and engaged into the workshop towards a fruitful future for the water system in San Andres. The conduct and results of the workshop are shown in this paragraph. The workshop started with a variety of the human knot game, which was a true icebreaker and a great success (see figure 38). Human Knot' is a get-to-know-you icebreaker and initial activity for a group which is learning about one another and how to work together in complex situation.

The original human knot game activity involves close physical proximity and touch potentially in sensitive places and therefore the original game was adapted with a rope to avoid cultural or social problems. The participants were beforehand asked to think about the possible learning effects that the game could demonstrate.

Participant Edward Jay (Future Consumer) elaborated after the game on the learning effect with the following phrase: ´The human knot game taught us that the problem we are facing with the water management in San Andres cannot be solved by one entity. In order to solve the problem we have to communicate and cooperate in a structured way´. The game opened up the mind of all the participants and the moderator took the opportunity to couple the game towards the water problem in San Andres. The workshop continued with a presentation (see appendix V) about the status quo of the water system of San Andres.

FIGURE 38 HUMAN KNOT GAME

During the presentation the participants were educated in the definition of a sustainable water system regarding the Natural Step criteria and the gap that was created between the status quo and the desired sustainable system (see appendix V). Especially the rising population and tourist numbers created a lot of questions in the session. The presentation continued with the 4 sustainability principles and the gap elaboration followed by 3 conclusions, stated by the participants:

- Climate Change is a game changer, but San Andres is not the island that could take the leading role in Co2 reduction. This argument was structured by a participant by showing the video Mr President, about the situation of the Maldives. The Maldives is almost at sea level and 25 cm of sea level rise can submarine 75 % of the Island surface. Therefore, the president is fighting for stringent rules and thresholds for C02 reduction at the Rio+20; United Nations Conference on Sustainable Development, but the great emitters United States of America, China and India are blocking stricter contracts about C02 emission.
- Rapid change and structured planning in order to change the diminishing level and quality of the aquifer is needed to save the natural resource from depletion.
- The fourth principle of sustainability, the ability to pay for the basic need of water is not safeguarded at this moment. Inhabitants are expropriated from their house, because they do not have sufficient financial resources to cover the monthly utility expenses.

The workshop continued with the second presentation (see appendix VI) where the interviews and values, harvested in the interview were translated into 4 different visions from which each have their own focus point:

1. Rainwater harvesting
2. Renewables energy systems
3. Energy efficiency + smart user
4. Recycling + closed loop

These 4 visions were presented together with the newest innovations on that focus area. The innovations presented can be found in the appendix IV.

The participants were sorted into the 4 subclasses according to their initial vision and asked to work in small groups. The first assignment was to design a water system for 2030 according to the focus that was allocated to the group, meeting the 4 principles of sustainability stated in the presentation. The design should clearly define the requirements in the 3 subcategories;

(1) Technological design,
(2) Social design and
(3) Institutional design.

These designs are after 45 minutes presented to all participants in a 5 minute window.

To kick start the process and creativity of the participants, the design of the brainstorm was shown to educate the participants in the requirements of the drawing and statements. The report shows one design (to indicate the process and the outcomes. The other 3 designs, barriers and solutions towards 2030 are summarized and shown in detail in appendix VII.

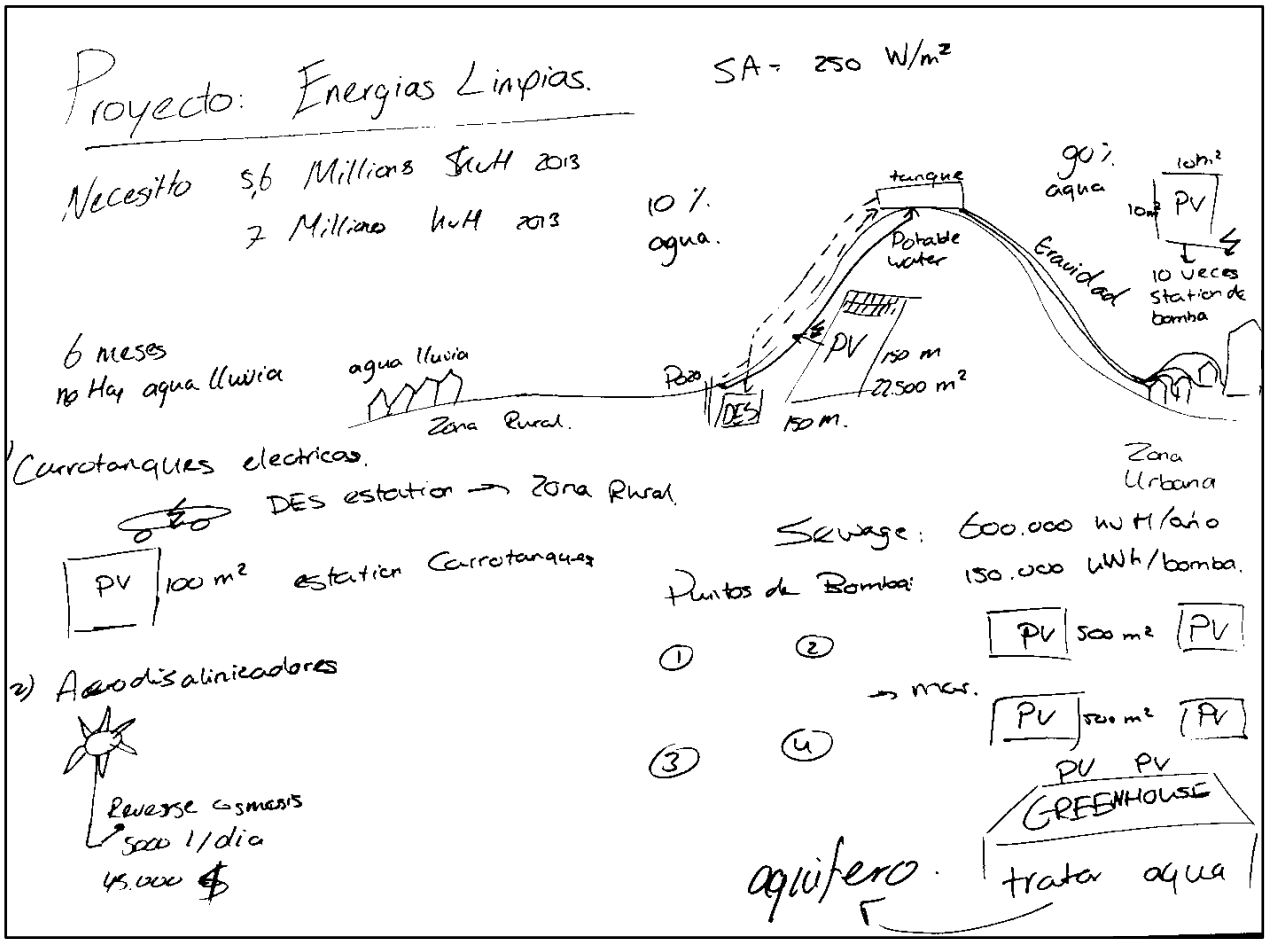
3.3.1 Backcasting "Renewables energy systems"

The island of San Andres displays excellent values of wind parameters and solar radiation. These excellent preconditions however have not taken care of the installation of any of these renewable resources. There is no wind turbine installed and the amount of solar panels is negligible. The water production in San Andres uses large quantities of energy and this vision focusses on producing this need by clean energy producing facilities.

The design starts with a clear drawing of San Andres and the energy necessities of the different water production and distribution systems. The total energy needed for the whole system is 7 million kWh in 2013.

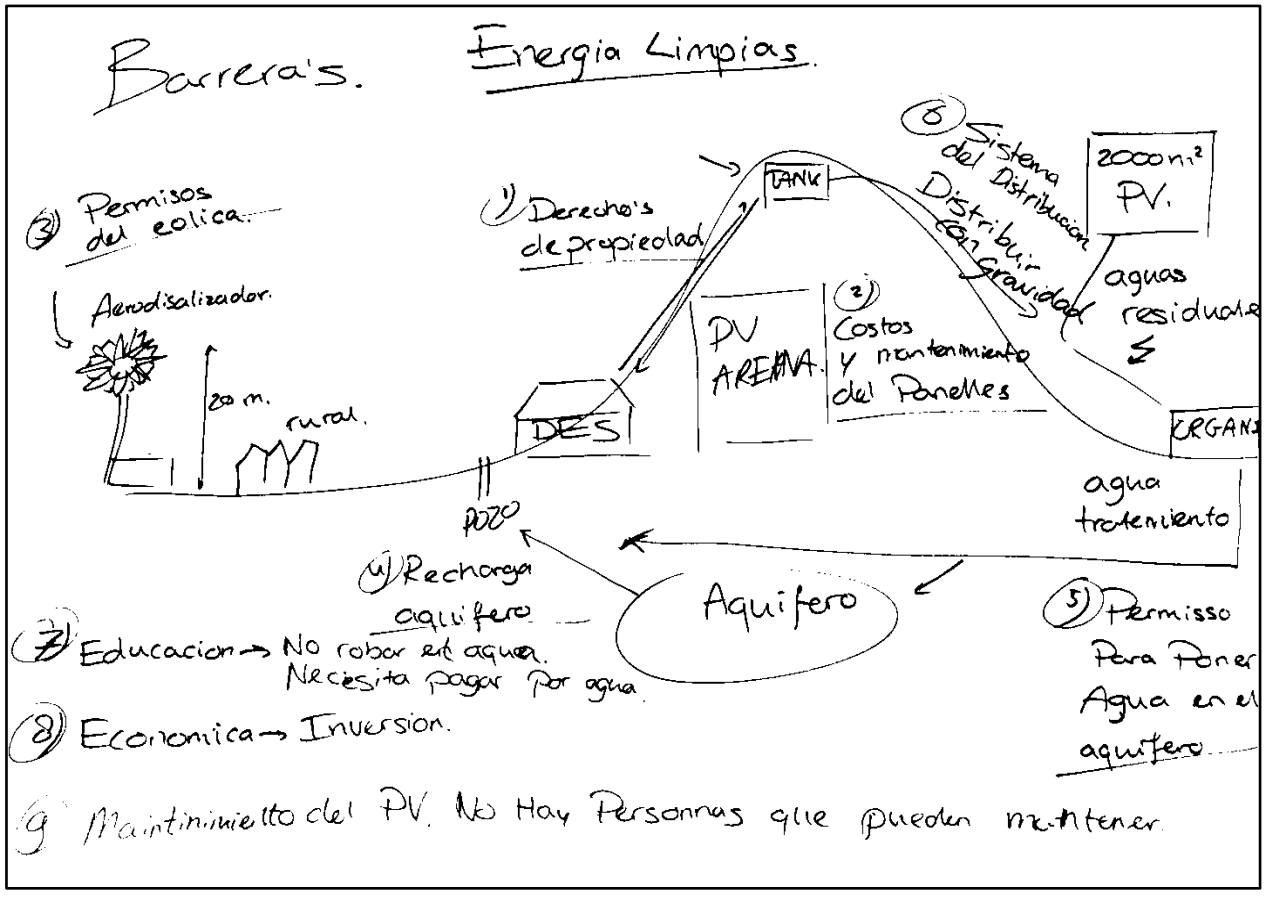
The model is clearly inspired by the brainstorm model, because it uses rainwater harvesting and aerodizililiadors for water production. The water harvested by rooftops in the urban zone is transported via solar driven installations towards the great tank on the hill. Distribution from this great tank towards households is facilitated by gravity. The solar panels are installed in rooftops. The sewage system puts the waste water into the sea and the empowering of the pumps is fully solar driven. Before the disposal into sea the water is treated and contamination removed by a treatment system. For the months without rain the desalination plant functions on a mix of solar and wind power. The rural zone is then supplied by electric big scale water trucks. The urban zone is still supplied from the big tank. The desalinated water is pumped into the tank.

The barriers for this design are clearly structured into technological, social and institutional areas



and in 9 ballpoints

1. Property rights on the hill can block the building of the tank and the needed infrastructure
2. The investment costs and space required to facilitate the solar panels are huge. Property rights and corruption can block this investment and the required space
3. The permitting process to build wind mills to facilitate potable water for the rural area in dry periods is not clear.
4. The artificial recharge of the aquifer with rainwater has big unclarities and questions from environmental perspective
5. The distribution system needs to be revised and installed
6. The consumers need to be educated in continuous water supply and its effects on the utility bill
7. Currently, no educated professionals are available on the island to maintain solar panels. Professionals from Bogota need to be flew in to repair them.



The RES group developed a clear plan to tackle the various barriers on the way towards a fully renewables energy driven water distribution model. The language of the timeline is a combination of Spanish and English and therefore easy to translate. The raw drawings are processed into a clear table form to secure the information. (See table 8).

TABLE 8 BACKCASTING OUTCOMES RENEWABLES ENERGY SYSTEMS

2015	2020	2025	2030
Start process with land with property owners to search for solutions	Start buying space to install solar panel installations and tank and infrastructure	Finalize the process of buying land for interventions	Minimize problems due to property rights
Start with the participation of big investors to finance plan	1st invest round. Companies San Andres, IADB, other investors	2nd investment round	Maximize external investment in water system
Start process with CORALINA in order to permit aerodesalinizadors	Finish study and start pilot with aerodesalinizadors	Evaluate pilot and scale up production water trough wind	Full use of possibilities aerodesalinizadors
Start process with CORALINA in order to permit and research artificial recharge aquifer	Finish study and start pilot with artificial recharge aquifer.	Evaluate pilot and scale up production artificial recharge	Full use of possibilities artificial recharge
Start plan for restructure water distribution system, enable change of institutions , start building small scale pilot project	Start building pilot project water infrastructure, reform Pro Activa towards new distribution	Scale up pilot project, towards 50 % of total water distribution	Create robust distribution system
Start study towards a smart water user of continuous water supply	Install 3 pilots of educating users in continuous water supply	Evaluate pilots and start with best one. Scale up.	Create a smart user of continuous water supply
Create education for 5 persons towards installing and maintenance of renewable energy systems.	Finalize education and evaluate market	Create an education system that fulfils market demand towards educated personnel for Caribbean area.	Realize well equipped and educated persons to install and maintain Renewables energy systems
Install pilot Elemental water makers towards desalination in dry months	Evaluate pilot and research possibilities of scale up or decentralized production	Finalize process with Colombian government to change subsidies for electricity	Maximize renewables energy installed in desalination process.

3.3.2 Backcasting "Rainwater harvesting"

The system identifies 2 areas in san Andres and starts with the explorative forecast that rain will cover 8 months of water demand, but that a back-up system provides water the 4 residuary months. During the rainy season in San Andres the rain is exhaustive and the participants asked the question: It is energy demanding to desalinate the sea water; is it possible to store the exhaustive rain in the rain season in the aquifer, to later on harvest that same water and desalinate it in the dry season? The question to that answer was formulated by a participant who drew the superficial recharge of aquifers in the paper. The rainwater is in the rain season harvested and through solar and wind energy transported towards the great tank on top of the hill. The water is the n distributed through gravity towards the houses. The urban zone uses desalination processes in the dry season to fulfil the water demand. In the rural zone the process is decentralized and a number of aerodizilinador's function in the dry season to empower the water demand. The system provides continuous water supply for all inhabitants and therefore the users need to be educated in the use and effects of the utility. The big tank that is deployed on the top of the hill requires space and the houses that are built in this section are to be removed. The water utility company Pro Activa is the owner of the system and demands a fair price for m3 water.

The rainwater harvesting group came up with the following barriers:

1. The environmental agency Coralina does not have any standards for the installation of windmills. Previous projects were stopped, because the permit to install windmills was not given. The lack of clear standards and the permitting trajectory are a barrier
2. The artificial recharge of the aquifer influences the natural aquifer. This natural resource has to be treated very carefully to safeguard it for further generations. Studies and pilots have to clear the effects of artificial storage of water. External knowledge has to be invited towards the island to provide an objective study towards the feasibility on a technological and economical scale.
3. In order to install the tank on the hill sufficient free space is required. To create this room for the tanks houses need to be expropriated and property rights redesigned, this process can be time consuming and result in public opposition.
4. The newly build water infrastructure that collects rainwater at the houses and transport it to the big tank and transport it back to the customer can be complex and expensive due to island economy and corruption.
5. To install the tank and the required infrastructure various property rights has to change. This process can be time consuming and public opposition can emerge.
6. Inhabitants in San Andres are not use to continuous water supply. Instalment leads to overuse, spilling and huge utility bills for the inhabitants
7. The big hotel chains on the island produce their own water, because Pro Activa cannot guarantee the continuous water supply. The hotels have a great distrust in the ability of Pro Activa to provide and maintain this continuous supply.

The reasoning of this group was to set thresholds from a governmental perspective and encourage market parties with bonuses to realize these thresholds. The following table is set up to clearly present these thresholds (see table 9). Five different outcomes are translated into an 80 % threshold in 2025 and a 50 % in 2020. To develop these thresholds, pilots are launched in 2015

TABLE 9 RAINWATER HARVESTING

2015	2020	2025	2030
Start pilots to install the network of rain water distribution	Up scaling of pilots towards 3 months of rainwater harvesting	8 months 80 % dependent on rainwater harvesting	8 months 100 % dependent on rainwater harvesting
Pilots to install RES in the water pumping activity	50 % dependent on RES to provide energy for pumping activity	80 % dependent on RES to provide energy for pumping activity	100 % dependent on RES to provide energy for pumping activity
Study towards which RES is applicable to provide energy for desalination in dry period	50 % of energy required for desalination process is RES driven produced	80 % of energy required for desalination process is RES driven produced	100 % RES installed to power desalination process in dry period
Demand for change in putting energy into the grid	50 % of the renewables energy during wet months is put into the grid.	80 % of the renewables energy during wet months is put into the grid	100 % possible to put the RES energy the other 8 months into the RET
Pilots with hotels and rainwater harvesting.	50 % of the hotels Is connected to the water system	80 % of the hotels Is connected to the water system	All the hotels have a connection towards the water service

3.3.3 Backcasting "Recycling"

The participants of the vision focused on recycling developed the following design, by keeping in mind that nothing is recycled nowadays in San Andres.

The high level design shows a closed loop system, where the natural eco system is used to lower the energy costs of cleaning of water. The water is taken out from the aquifer and pumped via renewables energy systems to the consumers. The houses of the consumers are connected with a disposal system that collects the wastewater and put it into a high tech cleaning facility that environmentally friendly treats the water and puts the water via a revolutionary system back into the aquifer. All the energy used is provided by the gasification of biogas and the rest is powered by solar panels or wind energy. The demand that the design and barriers was explicitly structured into technological, economical and institutional bullet points was not followed by this group. Instead of this requirement the group selected the recycling circle for the drawing and forgot about the 3 subjects that should have been designed.

In order to reach this design the participants were asked to draw up barriers that could be in the line in reaching the foreseen design that was visualized in the design assignment

The identified barriers are divided into the same drawing structure as the design. There are five barriers identified:

1. Artificial recharge of aquifer. There is no knowledge on the island to create this process.
2. Extraction and use of biogas to produce energy on the island
3. Construction of the sewage system
4. Construction of the net zero energy treatment installation. In Colombia such a thing does not exist
5. Regulation of the 5000 domestic wells in order to be able to control the level of the aquifer

The proposed timeline to tackle these barriers is shown in table 10.

TABLE 10 BACKCASTING RECYCLING

2015	2020	2025	2030
Study towards artificial recharge aquifer	Institutions ready for implementing artificial recharge of aquifer	50 % of waste water putted into the aquifer.	100 % recharge of the aquifer with treated waste water
Search the laws that prohibit artificial recharge of aquifer	Eliminate laws that prohibit recharge of aquifer, be institutionally ready	50 % of waste water putted into the aquifer.	100 % recharge of the aquifer with treated waste water
Start studies and experiment with pilots towards feasibility biogas exploitation	Finalize institutional framework and have 10 % of the biogas turned into energy	50 % of the biogas turned into energy	Exploit all the biogas and turn into energy for the treatment process.
Start construction sewage system	40 % of households connected to the system	Finalize sewage construction	Maximize connections towards sewage system.
Study towards the possibilities of treatment systems	Implement 3 pilots of treatment system and choose the best one	Install best system	Power 100 % the treatment system with biogas + solar/wind power

3.3.4 Backcasting "Smart use®"

The smart use(r) design focusses therefore to use water in a smart and efficient way. Therefore, the focus of this vision is on influencing behaviour. The design is split into two sub designs. The first subpart stresses the knowledge of the environmental agency and water harvesting companies of the aquifer. The group stated that "as long as we do not know how the aquifer works and react, we do not know how much water we can extract on a sustainable way". Therefore a study was already recommended in the design to intellectually gain more knowledge on the way the ecosystem of the aquifer works. Furthermore, the knowledge gained is shared with the whole population of San Andres to create a shared understanding that leads to a shared responsibility. This system should be easily accessible from mobile devices such as iPhones and android phones. This is designed to cope with the disability to regulate the 5000 domestic wells that were dug in the Island of San Andres. The other part of the design stresses the recalibration of the use of water by tourist and inhabitants. Inhabitants use 115 litre water per day and tourist use the amount of 293 litres water per day. To minimize the water usage the people needs to be educated in the use of utilities in an island environment. The design opposes a study towards the way to maximize the effect of regulation and measures to minimize water use.

Changing behaviour- and in particular motivating more "sustainable" behaviour- is far from straightforward. When performing such a research it is imperative to take on a multidisciplinary approach that is required. The group was explicitly demanded to take the following line of reasoning with regard to (1) Technological, (2) Social and institutional barriers.

1. The behavioural change in water usage can be problematic. It is settled deep into the cultural habits of the inhabitants to use the water.

2. Tourists pay a lot for the stay in San Andres. The majority of the hotels in San Andres is set up as all inclusive resort, so the tourists demand a full service. Questions like, why should I save water can be expected from the tourists.
3. The 5000 domestic wells cannot be regulated from a Coralina perspective. Due to poverty the social control is limited. The poor neighbourhoods are socially isolated and neighbours cover each other if authorities come in to check or regulate.
4. The money to study the situation of the aquifer has to be drawn from Bogota. This is time consuming process and full of corruption barriers. The aquifer is a complex system and uncertainty will withhold.
5. The software tool that has to be developed to share the information under the inhabitants needs to be accepted by them. Not all inhabitants have the access to computers.
6. The property rights in the hill block the metering of the San Andres aquifer.
7. All knowledge have to be flew in. no professionals are present on the island that can study the aquifer.

To emerge solutions for the identified barriers, the participants created the following drawing that back casts from the desired situation in 2030 (see table 11).

TABLE 11 BACKCASTING SMART USE (R)

2015	2020	2025	2030
Search for partners to study behaviour aquifer and set up project plan	Finalize study part 1 towards aquifer	Finalize study part 2 towards aquifer	Complete transparent behaviour of aquifer
Start plan about user requirements for desired system	Implement 1st results study behaviour aquifer	Implement results of 2nd part study aquifer	IoS and Android possible to check status aquifer
Start 3 pilots for intelligent use of aquifer based on other countries experiences	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart use of aquifer
Pilots with 3 selected programmes based on experiences of other island nations	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart user of water by inhabitants
Start 3 different pilots with tourist groups to use water efficient	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart use of water by tourists

3.4 Elaboration and choice of objectives

The backcasting workshop developed four different visions that each has their focus. The providence foundation and the San Andres government demanded a pathway that is supported by the local stakeholders. Therefore, the shared value list serves as criterion to decide which of the alternatives harvested in the workshop receives a place in the supported framework towards a supported sustainable water management for San Andres in 2030 (See figure 40).

To make the outcomes comparable towards each other, the outcomes of the backcasting methodology are translated into clear objectives. These are processed as described in paragraph 2.6.4

Firstly, the objectives are grouped into domain to identify possible doubles (see figure 39). The double objective “Maximize renewables driven desalination in dry period “is part and the same as “Maximize renewables installed in desalination process” and therefore removed

Second, the objectives are scored on the added value towards the shared value list. The Likert score is multiplied with the normative score of the shared value. Hereby an added value score of the strategic objective towards the fundamental objective (goal research) emerges (see figure 40).

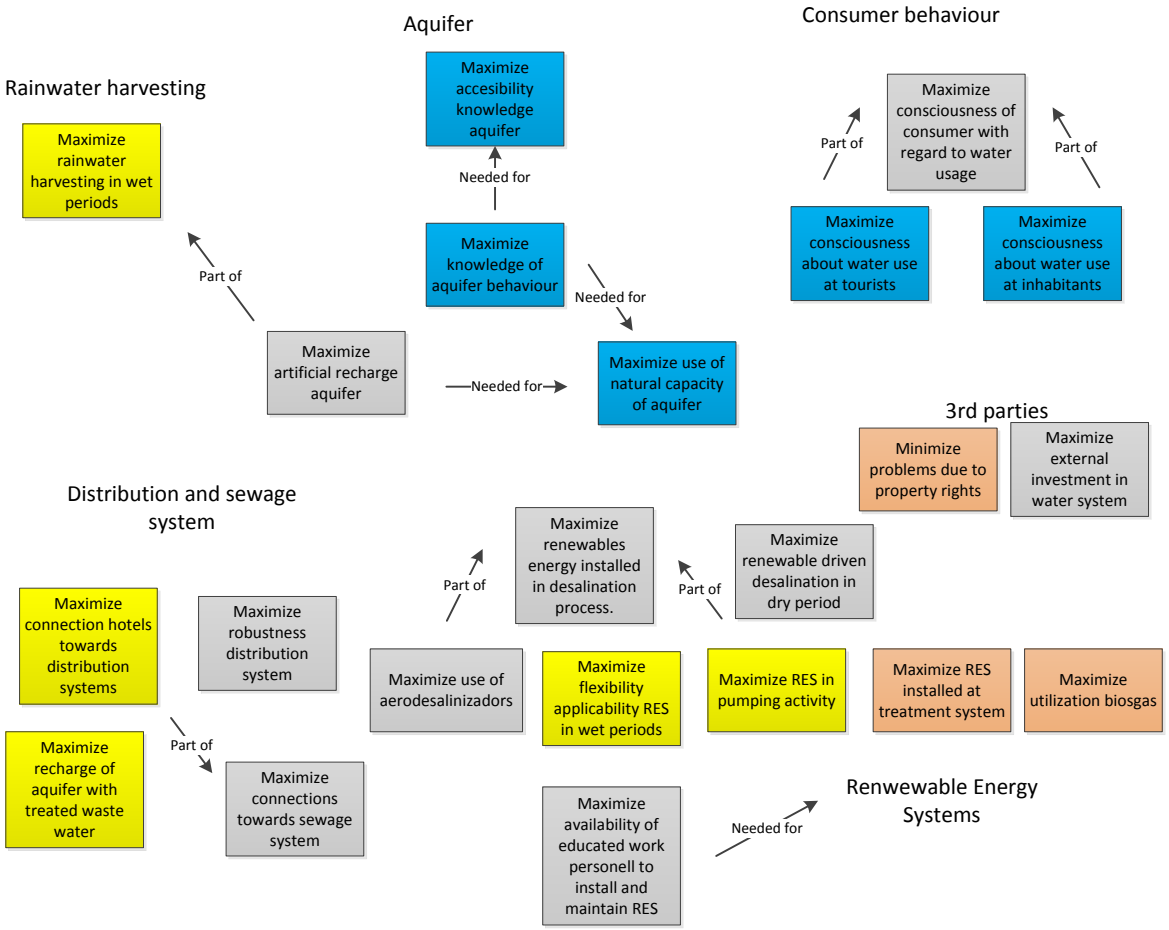


FIGURE 39 SCORES OF STRATEGIC OBJECTIVES FROM BACKCASTING WORKSHOP TOWARDS VALUES PARTICIPANTS

Figure 40 score of strategic objectives towards end objective assessed by values participant

None of the strategic objectives scores higher than 3 and reaches the high score on the values of the participants towards the end objective. This is easily explained by the difference in the values of the participants.

The goal of the research is to realize a supported policy methodology towards a sustainable water system for san Andres in 2030. The 21 strategic objectives are rated by crossing social support and added value towards the fundamental objective. The objectives awarded low added value towards the fundamental objective (score <1) are assessed as not applicable towards the fundamental objective and therefore removed. The removed objectives may be found in the elaboration of other strategic objectives, but are not solely back casted as individual strategic objective.

- Minimize problems due to property rights (0,55)
- Maximize connections towards sewage system (0,39)
- Maximize recharge of aquifer with treated waste water (0,14)
- Maximize connections hotels towards distribution systems (0,71)

The elimination of the alternatives that scored below one emerged 16 strategic objectives that share broad support under the stakeholders. The support is based upon shared valuation of participants. The backcasting workshop results are used to describe pathways towards the alternatives (see figure 41).

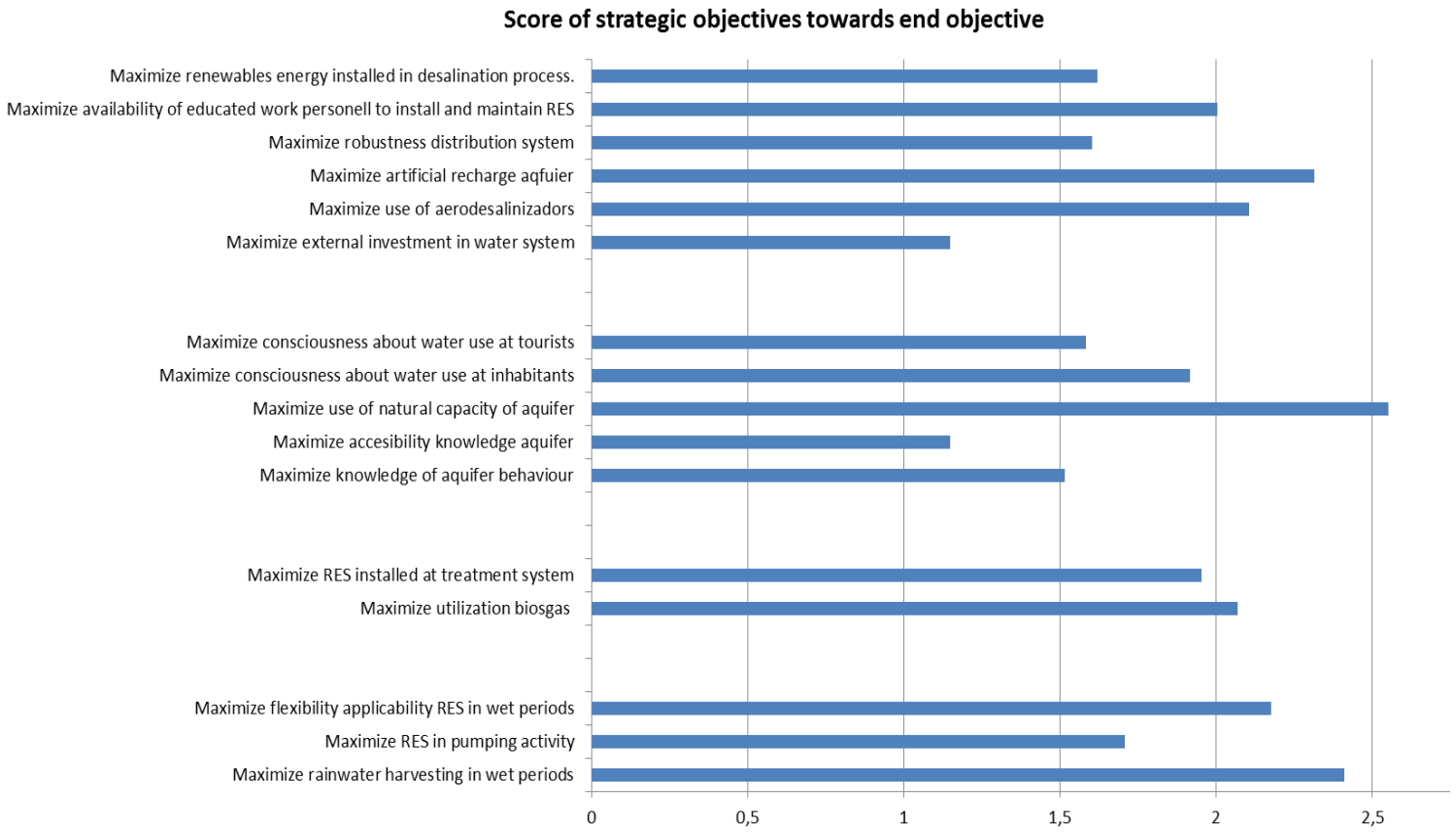


FIGURE 41 SELECTED STRATEGIC OBJECTIVES

3.4.1 Elaboration strategic objectives

The 16 strategic objectives are elaborated upon per category to create a plan towards a supported sustainable water system for San Andres in 2030. The elaboration starts with the most supported and important strategic objectives and end with the least supported and important objective. Future interventions or policy adaptions by the government or environmental organization can be pillared and given precedence according to this list. The categories are interdependent on each other and therefore interface management between the categories is important. When interdependencies occur, the strategic objectives are written down together and an interface management proposal. For every strategic objective an implementation plan is written down, which includes a stakeholder engagement proposal. This proposal derives possible coalitions and opponents for the required transition, derived from the value elicitation in the interviews. The scores on the strategic objectives are processed in a social support matrix, which enables the stakeholders to quick scan the possible partners and opponents for water management decisions. The top three of the list is elaborated upon below and the full list is shown in appendix VII.

Maximize use of natural capacity aquifer (2.6)

The most valued and important value of the participants is to maximize the use of the natural capacity of the aquifer. The natural filter is the most efficient as storage capacity for rainwater harvesting and the most efficient desalination filter. The backcasting session provided the following means towards the strategic objective (table 12).

TABLE 12 MAXIMIZE USE OF NATURAL CAPACITY AQUIFER

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Smart use of aquifer	Strategic objective	Maximize the use of the natural capacity of the aquifer
Trajectory backcasting	Evaluate and implement results of evaluation	Means objectives	--
	Start 3 pilots for intelligent use of aquifer based on other countries experiences		Maximize information and knowledge on aquifer behaviour
	Select best programme en start implementing results study		Maximize chance on success by selecting best programme.

Maximize Rainwater harvesting in wet periods (2.3)

The historical way of harvesting water is deeply bedded into the habits and culture of the Islanders and therefore awarded the second place in important value towards a sustainable water management for San Andres. The support to maximize rainwater harvesting in dry periods is high through all the involved stakeholders. Therefore, the possibilities to maximize this sustainable resource are elaborated upon through presenting the means objectives. The means objectives are derived from the backcasting workshop as shown in paragraph 3.3.

TABLE 13 MEANS OBJECTIVES RAINWATER HARVESTING

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Widespread adoption of rainwater harvesting	strategic objective	Maximize rainwater harvesting
Trajectory backcasting	Create artificial recharge aquifer	Means objectives	Maximize artificial recharge aquifer
	Scale up rainwater harvesting at households		Maximize storage capacity households
	Money incentives to store rainwater in communities		Maximize fiscal incentives for community storage

The identified means objective "maximize artificial recharge aquifer" is also a strategic objective on its own. This objective is therefore elaborated upon in table 13.

Maximize artificial recharge aquifer (2.2)

The means objective of "scale up artificial recharge" was awarded the 3rd highest score in the supported importance table. The backcasting of this variable is not detailed (see table 14). The thesis stresses the development of the framework and therefore the analyst does not intervene in this situation. The findings will be taken into account in the discussion in chapter 4). Clear goal of the participants is that the knowledge of artificial recharge needs to be explored.

TABLE 14 MAXIMIZE ARTIFICIAL RECHARGE

Backcasting	Example	Value Focused Thinking	Example
Component of future vision	Create artificial recharge aquifer	strategic objective	Maximize artificial recharge
Trajectory backcasting	Create knowledge about the process of artificial recharge	Means objectives	Maximize knowledge artificial recharge aquifer
	Scale up artificial recharge		Maximize artificial recharge (in cubic meter) aquifer

3.5 Embedding of research and stimulating follow up

3.5.1 Coalition and opponent matrix

Coalitions and possible opponents of different strategic objectives can be identified by crossing the valuation of stakeholders towards the strategic objectives. This matrix enables the quick scan for coalition partners, development of solutions for identified barriers and possible contingency plans to be activated. The different strategic objectives can be detailed towards coalitions that share the strategic objectives and this group should be facilitated in getting together and develop plans that realize the milestones.

The total 16 strategic objectives were shared with the participants and through feedback the following matrix is created (see table 15)[2]:

Pro strategic objective (actively willing to participate in coalition to enable the objective)

Neutral to strategic objective (pro/con versus strategic objective but no participation) ***Blanco***

Negative to strategic objective (Actively willing to block this objective)

Stakeholders	elemental water	Aqua works	sweet water	aguas de san	future consumer	Ministry o	Native consumer	Decameror	Pro Activa	Coralina	Providence	IADB	Nacional Unive
Strategic objective													
Maximize rainwater harvesting in wet periods					✓		✓			✓	✓		✓
Maximize RES in pumping activity				✓		✓			✓	✓	✓		✓
Maximize flexibility applicability RES in wet periods						✓							
Maximize utilization biosgas													
Maximize RES installed at treatment system	✓				✓		✓						✓
Maximize knowledge of aquifer behaviour		✓	✓	✓		✓			✓	✓	✓		✓
Maximize accesibility knowledge aquifer		✓			✓	✓	✓			✓	✓		
Maximize use of natural capacity of aquifer		✓	✓					✓	✓				
Maximize consciousness about water use at inhabitants					✓		✓			✓	✓	✓	✓
Maximize consciousness about water use at tourists							✓	✓	✓	✓	✓	✓	✓
Maximize external investment in water system	✓			✓		✓			✓			✓	
Maximize use of aerodesalinizadors							✓		✗				
Maximize artificial recharge aqfuier		✓	✓		✗		✗			✗	✗		✓
Maximize robustness distribution system		✗	✗	✓	✓	✓		✓	✓			✓	✓
Maximize availability of educated work personell to install and maintain RES								✓		✓	✓		
Maximize renewables energy installed in desalination process.	✓	✓	✓	✓	✓				✓				

TABLE 15 PROPONENTS AND OPPONENTS OF STRATEGIC OBJECTIVES

[2] 13/15 parties responded on the survey. The "Gobierno servicios publicos" (Department utilities San Andres Government) and the "Gobierno qualidad del agua" (Department water quality San Andres Government) failed to respond on the survey.

First thing that strikes is the amount of pro strategic thoughts around the participants. The diagram is filled with green checkmarks and this means that a lot strategic objectives share wide support under the participants. The only red area is found around the artificial recharge of the aquifer and the robustness of the distribution system. Also the objective “Maximize use of aerodizilinador” is given a negative checkmark by the environmental organization Coralina, which uses a negative alignment for every project with wind turbines on the island. The negative checkmarks on “Maximize artificial recharge of aquifer” are found with the consumers and environmental organizations. These parties share a concern regarding the negative externalities that might occur during the process. This concern is mostly ignorance driven and can be taken away by emerging an open process around artificial recharge. The objective “maximize robustness distribution system” is feared by the commercial water producers. Bottled water in the actual form is superfluous if all households get a connection compared to the Dutch water system. These parties need to reconsider their business model if the system works perfect, but given the actual situation the transition could easily take up to 20-30 years.

3.5.2 Construct follow up workshop

The framework demands the identification of possibilities for further workshops or actions that need to be executed to safeguard follow up. The workshops are not scheduled from the start of the research to safeguard the evolutionary principle of the research. The core challenge is to keep the connection between the participants and show them that the plans that emerged are taken into account and graded upon potential towards their values. The combination of strategic objectives with their backcasted trajectories and the coalition matrix are unstructured information. The following paragraph realizes a structured proposal to emerge and pillar an implementation workshop. This workshop can facilitate agenda building, networking and structuring of coalitions. Furthermore, coalition building and possible opponent’s mitigation through bargaining can occur. This workshop is moderated by the focal owner of this project “The providence foundation” that was engaged and informed about the process and willing to cooperate and take the step to this workshop.

3.5.3 Construction of detailed plan by analyst

The participants developed a draft of strategic objectives, the actor support per objective and the possible coalitions that can be realized in order to develop that objective. Next to that, the analyst disposes great insight in the system and possible opportunities to develop the system towards the desired state. Together with the desire of the focal owner to focus on implementation this results in the development of a critical path towards a sustainable system. This critical path displays the most supported and key strategic objectives given the analyst knowledge about the system. This plan is putted into the discussion in the implementation workshop.

Elaboration of all the thoughts of the analyst would result in to much text. To safeguard the distinctness and clarity 5 bullet points of action with possible coalitions are mentioned. This 5 target points are equally important.

1. Develop and share detailed knowledge about aquifer.

The use of the natural capacity of the aquifer demands perfect information about the natural behaviour and capacity of this resource. The basis for this information is available within CORALINA, but exact modelling and precise forecasts lack. Different studies in different rounds need to be extracted in order to enable this information stream. Firstly, CORALINA searches a capable team or organisation that creates a dynamic model of the aquifer and is able to perform forecasts up to a reasonable failure error. The search for state of the art technology or modelling skills all around the world and tender is executed by the environmental agency that tenders the package

towards the most applicable partner. CORALINA and the commercial water entities are considered frontrunners and have to take the lead in financing the research. The financial contribution that the private water companies provide is paid back in detailed information about the aquifer. The continuity of the water bottling companies is therefore secured.

2. Maximize domestic and aquifer rainwater harvesting

Almost 95 % of the houses have storage capacity through a cistern. These small scale storages are not sufficient to cope with the longer dry periods and the capacity needs to be extended. This objective can be coupled towards the storage of water in communities. Large scale water storage enables cost efficient building of structures, but emerges regulation on the other hand. Native consumers with help from the local government could apply for Inter-American Development Bank (IADB) resources to evolve plans and community storage and decentralized distribution. Possible opponent is Pro Activa that values a large distribution network and this system would undermine their business model. An option to deal with this possible opponent is to engage Pro Activa in the business model through tariff structures and other regulations around community storage and supply.

The largest storage tank possible is the aquifer. Artificial aquifer recharge has proved to work in other areas of the world. The search for the best method is executed by mapping existing projects in the world and selecting the most promising design. This design needs to be evaluated towards applicability in close cooperation with the research group that created a dynamic model of the aquifer in San Andres. If the artificial recharge is applicable, pilot projects could be executed and after evaluation scaled up towards maximum amounts given certain restraints adapted from the modeller. The organisations that highly value this objective are the market parties that bottle water and the commercial consumers. Possible opponents can be found in CORALINA, native consumers and government as the procedure can destroy or change the natural biosphere of the island. Therefore, commercial parties need to team up and create a lobby to convince the possible opponents. Finally, commercial parties need to harvest scientific information regarding artificial recharge and convince opponents of the possibilities and need of artificial recharge.

3. Erect a water committee in Coralina that safeguards the process towards a sustainable water system

The essence of water is one of the basic needs for life. The water system in San Andres is rapidly developing into a dangerous status. The government recognizes the need for change, but the political situation withholds developments towards a better system. To safeguard the transition towards a sustainable water system a committee that includes an even mix of consumers, commercial parties and non-commercial entities needs to be established. This committee has a meeting every two months and develops the water system towards a sustainable water system.

4. Install renewable driven desalination devices

The see is an abundant resource of water and this water is drinkable after desalination process. Nowadays, the systems are in the development phase and expensive. The island could create a space where pilots of various renewables driven desalination installations could be installed and tested. Therefore, subsidies should be installed and regulations need to de adapted towards the needs of the systems. Here through San Andres can become a test center for desalination systems that also showcases other positive externalities such as, knowledge build up, attraction of educated persons and economic stimulant.

5. Emerge law for decentralized water production.

San Andres utility planning is caught in Colombian law. Colombian law is very hard to change. Adaptions in this law should be made to make decentralized water production possible. Renewables energy systems are highly suitable to deploy at the remote locations of the island. Nowadays, decentralized water production is illegal. This can be changed by maintaining an active lobby towards decentralized production.

3.5.4 Review process

To review the whole process the survey was sent out (Appendix VI), where the participants could provide feedback about the whole process. This survey provides valuable information to improve the framework after the first implementation from the participant perspective. The combination of the participant perspective and analyst perspective safeguards a balanced improvement of the framework. This part is elaborated upon in section 4.2

4. DISCUSSION

The results and conclusions of the case study are sent for consent to all the participants to deliver a check for the interpretation of the interviews and the workshop results. The conclusions of the research and pathways have been discussed with various senior positions in San Andres and the Ministry of Environment, Housing and Territorial Development of Colombia. Furthermore, much of the information found in the problem orientation was checked by the response in interviews and the feedback during the workshop. Despite all information checks there are shortcomings in this study. First off all the use of theory is discussed. Second, the framework is discussed on the implementation. The conclusions from an analyst and user perspective emerge a refined framework. Finally, a quality discussion of the framework provides answers on the credibility, transferability, dependability and conformability of the research.

4.1 Reflection on theory use

The research started with the construction of the methodological framework that combined two methodologies that hypothetically would be able to provide an answer on the main research question. The choice of these methodologies is based upon the theoretical relevance with the research question and the aptitude to provide a scientific contribution towards the discussion of participatory sustainable policy making. The suitability and reflection of the construction of the framework is discussed in this paragraph.

The research embraces backcasting as a starting point and searched for a methodology that supplemented the identified loose end of some of the backcasting methodologies. The research towards this complementary methodology is inherently incomplete. Value focused thinking was selected on its ability to identify supported pathways towards future sustainable system and other positive elements that come with the methodology. The backcasting methodologies were derived into building blocks, which were selected on applicability and feasibility towards the main goal of supported sustainable policy building. The combination of these building blocks with the selected blocks of the Value focused thinking methodology emerged a framework that confirmed the theoretical relevance of the theory for several reasons.

The theoretical coupling emerges an opportunity to disconnect participants from business as usual and get them into the next paradigm. Secondly, the framework enabled the comparison and structuring of the outcomes of the backcasting session. Furthermore, the multidisciplinary nature of the problem is echoed by the theory because the social, technological and institutional mechanisms are addressed.

Next, the framework acknowledges the effects of lock-in and path dependency leading to rigidity of the policy advice. This drawback is partly countered by the integration of new products and start-ups by the design of the island in 2030, but the lock in effect of policy making is inherently connected to back casting.

Finally, the attention and dependence on actors and their activities in shaping the policy; the framework is vulnerable to imperfect information, bounded reality and strategic behaviour of its participants. In order to commiserate mentioned problems, the shaped framework identifies the different perspectives, interest and values of the participants. However, some difficulties with the newly build framework came across during the case study, which come to light using the framework are discussed in paragraph 4.2

4.2 Evaluation framework from analyst perspective

This part of the discussion entails the discussion of findings, which can be added to strengthen the methodological framework. The framework is analysed regarding the 5 steps that were explored in the process. The paragraph elaborates on possible changes that improve the framework (see table 3).

The orientation starts with 3 proven methodologies and continues with the definition of a sustainable system definition. This definition and gap analysis enables the visualization of the problems of the current system in comparison to a total sustainable system towards the analyst and stakeholders. The possible improvement on this stage is to clearly define the level of aggregation of the analysis. The research is executed at a high level for a 20-50 years backcasting analysis and therefore the aggregation level of the sustainability analysis is executed at the same level. The definition of renewables potentials is a tricky part where the analyst plays a huge role. The possible innovations are showcased upfront to the analysis and a level of objectiveness should be trusted to the analyst in order to safeguard the objectiveness and impartiality of the process. In order to improve this section the participants could be asked to present innovations in a shared environment to secure and emerge an

open process, where innovations are equally showcased to the participants. To safeguard the participation and completeness of this analysis, an open procedure is proposed and integrated in the final framework.

The interviews function as a control mechanism over the first four steps of the framework and are extremely important. The participants get involved and curious about the problems and possible solutions. Further research can use, evaluate and improve the questions into a solid base of standard questions to make the interview more efficient. The shared value map is extremely useful, because the participants get an insight about the key values and needs of other participants.

The following step (see table 3) entails the future development stage, where the definition of normative requirements caused some problems. The research demanded senior positioned participants, which likely possessed an academic grade. Small organizations in San Andres do not possess this kind of personnel. To secure the development of supported pathways and entirety of stakeholders in the research, also less senior participants needed to be accepted.

This core problem of backcasting in remote areas is difficult to solve. However, the early participation of authorities of the country (central government) could engage more senior positions on the island. The problem that some selected organizations do not possess any senior positions with an academic grade could be solved by educating these persons beforehand in strategic thinking and the possibilities that backcasting has to offer.

Based on literature review, the disconnection of participants from business as usual seemed the most difficult step in island conditions. Therefore, the diversion of participant's thoughts from business as usual towards a sustainable water system in 2030 was enhanced by integrating the value driven design. The feel free to join session was visited by 5 key players in the water system, which led towards a great design. Actually, this moment is a great thermometer for stakeholder engagement. A possibility is that the session is visited by none of the participants. If no participants show up, the analyst has an opportunity to restart the process and rethink the relevance and subject of the research. If all participants appear the level of engagement is great, but organization is difficult. To structure this part an invitation towards key stakeholders might be better, ensuring all possible visions are present.

The backcasting analysis (see table 3) was introduced with 2 presentations that elaborated upon the problems that are faced in the future; the shared values of the participants and the process that is followed (see Appendix V&VI). Data availability is critical for the erection of these presentations. The main problems during the backcasting sessions were the following:

- Participants were pulled away by Business as usual
- Participants did not have great creativity in selecting long term solutions for mentioned barriers
- Islanders are not driven to think strategically, the day to day mentality on the island is explicitly present.

The first and last problems are difficult to deal in short notice of a backcasting project. The second problem can be managed by reserving time for an open discussion about the problem and keeping the discussion off certain points by a fantastic moderator. The third and fourth problem can be forestalled by selecting more scientifically educated strategic thinkers, but these are not abundant in small islands.

The proven workshop format was not very clear towards the participants; all groups needed guidance in the structure of this complete new format of thinking. The availability of one moderator per 4 groups was not enough. Groups with little backcasting experience need a more structured experience in a backcasting session.

The first presentation elaborated about the actual situation and extrapolated the findings into 2030. The participants were shocked by the

decline of ground water and possible problems that could appear in the future. The extrapolation of data was an average of 5 different independent research organizations and thus reasonably trustworthy.

Participants asked questions about how this trend extrapolation fits into the normative nature of the research. The trend extrapolation was however necessary to show the urgency of the problem towards the stakeholders. The second presentation elaborated upon the possibilities to bridge the future gap. The presentation of these future systems is sensitive towards certain stakeholders and in larger research sensitive for political and financial influences on the moderator. Next to this sensibility, the quality of the information is extremely important. The moderator needs to know state of the art technology and start ups in order to mitigate some of the rigidity of the backcasting study. An option to deal with this problem is found in describing scenarios and uncertainties towards the participants about future developments.

Furthermore, the design of the desired system was executed in a clear way. The barriers written down were clear but the solution to cope or tackle these barriers was not very thorough and creative. This was partly due to the time span and the sequel of the lost attention and concentration of the participants. The whole workshop in one session of strategic thinking could be too much for Island culture of working. The workshop can better be divided in 2 parts with more reflection on every stage (design-barriers- solutions). This would emerge more focus on the solution and generate the possibility to educate the participants in the possible general solutions for various kinds of barriers to encourage creativity. This would require an extra day, which is more time demanding towards the participants. The decision in the trade-off between a one day exhaustive workshop and a two day schedule can be made by the analyst during the interviews with the participants.

The elaboration and choice of alternatives demanded the following process. First of all, the posters that had been erected by the groups during the backcasting session needed to be translated from Spanish towards English to emerge a monolingual report. Various language mistakes or interpretability failures can emerge by translating the posters. Translation was now executed by the moderator that was knowledgeable of the content of the posters and the goal of certain groups. Language mistakes can occur, but the overall quality of the translation was then secured. The ideal situation is to get a group together that speaks the same language as the report requires to eliminate language barriers.

Secondly, the reformulation of the various strategic goals into clear strategic objectives was executed. The process generates clearness about the direction and the content of the objectives. However, some information losses occur in the translation from the strategic back casted goals into the format of the objectives. The strategic objective “100 % possible to put the RES energy the other 8 months into the RET” was translated into “Maximize adaptability of Renewables Energy Systems towards the RET” (see table 16).

Thirdly, the framework demanded the selection of the best strategic objectives based on the shared values of the participants. Therefore, the analyst scored the strategic objective on a Likert

TABLE 16 EXAMPLE OF STRATEGIC GOAL TOWARDS STRATEGIC OBJECTIVE

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	100 % possible to put the RES energy the other 8 months into the RET	strategic objective	Maximize adaptability of Renewables energy systems towards the RET

scale from 0 (no added value) to 4 (high added value)(see table 4) on each of the values of the shared value list. This score is multiplied with the valuation of the participants of the strategic objective. The Likert scale enabled sensitive utility scores that are handed out by the analyst, which makes the process extremely subjective. An open group process is unfeasible, because the stakeholders have other opinions on valuations. This weakly objective spot in the research is best to comply with by selecting an objective researcher, who is financially independent of the stakeholders and does not have any personal gain in the realization of certain projects.

The final part of the elaboration and choice of objectives enhances the construction of the plan to reach the strategic objectives. This process is executed in the backcasting session, where the participants construct a pathway to cope with the identified barriers. The identification and the construction of the pathway are dependent on the creativity and experience of the participants. The framework depends thereby heavy on the participants and there solutions for certain barriers. The case in San Andres showed that some groups were experienced in generating designs and barriers on the economical, technological and institutional areas. The actual backcasting from 2030 till 2010 showed little creativity and clear options. The solution for this core problem is found in the more thorough selection of participants, which can be executed by already testing the applicant experience in strategic thinking in the interview. Next, the analyst can provide an overall pathway, by selecting the best scoring alternatives.

The final part of the framework (Embedding of research and stimulating follow up, see table 3) is generated to structure the actual coalitions and support the various stakeholders with tools to emerge support and communication between stakeholders. The framework included the construction of responsibilities and a dependency matrix that eventually emerged into a coalition and opponent matrix, where participants can identify possible coalitions and opponents. Due to time restriction emails were sent to the participants to identify the participants that were: Pro strategic objective, neutral to strategic objective or negative to strategic objective. All parties responded in a time frame of 2 weeks and therefore this was a success.

The combination of strategic objectives with back casted trajectories and the coalition matrix are well structured information to emerge an implementation workshop. This workshop can facilitate agenda building, networking and structuring of coalitions. Furthermore, coalition building and possible opponent's mitigation through bargaining can occur. The opportunity to emerge a workshop is proposed towards the Providence Foundation, who was very enthusiastic about the idea. Recommendation for future application of the framework incorporates this workshop from the start to safeguard follow up with the participants.

The final part of the process entails the feedback of the participants on the survey. An internet tool was shaped, were the participants were asked the questions that were directly coupled towards the goals of the research. 11/15 stakeholders responded on the survey, were the participants responded the following questions. The questions were posed in open questions and in multiple choice questions on a Likert scale to harvest full and sensitive information about the process. The first two open questions are elaborated upon in text and the rest presented in a table. The full report of the interview can be found in appendix IX. The combinations of the statements of this paragraph together with the results of the survey develop the framework towards a tool to develop supported pathways.

The opinions about the workshop varied from participant to participant, but the majority recognized the need of early stakeholder involvement, through participation. Some remarks were made about the value elicitation and the difficulty of that process and a double value in the list. This problem was recognized by the analyst and from the third interview solved. Next, the overall added value of the whole process was questioned. 11/15 participants reacted very positively about the whole process. The only remark was made about the length of the workshop session, which is already discussed above. The third question: "What was the added value of the workshop day?" was answered by selecting high or excellent by 90 % of the stakeholders. The rest of the questions are directly derived from the goals of the research and therefore discussed in the conclusion.

4.3 Discussion process results

The framework is as rich as the participant's creativity, ability for strategic thinking and ideas. In order to facilitate and accelerate these human characteristics, the framework needs to develop a high usability and efficiency towards the participants. Therefore, the methodological framework will be evaluated on the following criteria as set by Quist (2007). The input for the answers is provided by a combination of answers from the participants in the survey and findings of the analyst.

Goal 1: Generation of normative options for the future and analyse these briefly on their environmental improvement, creativity and feasibility.

The four visions share a core of ideas that emerged during the value driven brainstorm session. Three out of four designs incorporate a buffer on the hill to mitigate the intermittent nature of rainfall and renewable energy systems. Next, the designs focus on other subjects and generate great normative designs, in which a high level in creativity in the designs and barriers are displayed. Senior positions in San Andres are highly aware of state of the art models about sustainable models and successful implemented systems on other islands in the world. Due to a lack of experience, time restriction and loss of concentration the backcasting on the timeline from 2030 towards 2012 resulted in low quality outcomes. The participants responded in the same line en awarded their normative options with an average score of 4 (high) on the likert scale of 1-5.

Goal 2: Putting attractive future visions or normative scenarios on the agenda of relevant societal and political arenas

The researcher left the island after the workshop session and is therefore dependent on participants to evaluate this criterion. The participants represented 75 % of the important people in the water business and society in San Andres and therefore can be concluded that agenda setting of this group is definitely a success. From an analyst perspective, the political agenda setting is somehow more difficult. The local government was represented with 3 key figures in the water sector. Unfortunately, the vice-minister for Water and Sanitation and Departmental delegated a local responsible entity towards the workshop, because large decision making happens in Bogota. The survey shows us that the some of the participants scored this criterion little (15%) and that 85% of the participants rewarded the goal with an excellent result (see figure 42)

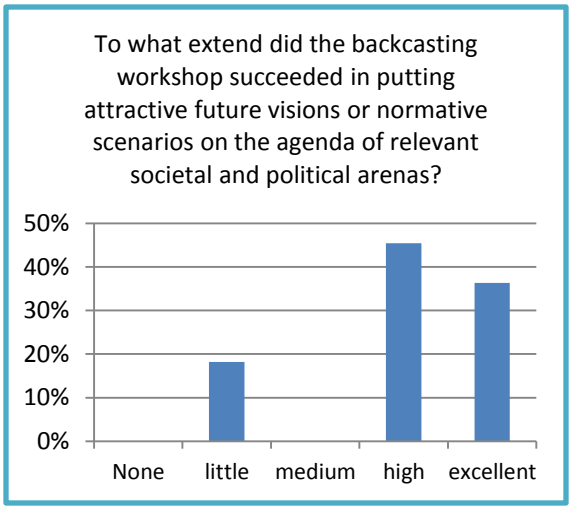


FIGURE 42 ATTRACTIVE VISIONS ON AGENDA

Goal 3: A follow-up agenda containing activities for different groups of stakeholders contributing to bringing about the desirable future

Two coalitions were installed in the actual workshop. Firstly, the company that facilitated the analyst (EEDAS) searched for a social responsible investment in order to increase the social company credibility. Through contact with the researcher and attendance in the workshop the aerodizilinador was selected as an opportunity to install and the contracts were assembled to create this possible business deal (see appendix IX). Nowadays, EEDAS is searching for the best spot to install the aerodizilinador.

During the workshop groups were assembled following the key values of stakeholders, which allows for congenial groups that work together instead of having arguments. Coralina employees were teamed up with commercial water producing companies about the smart use(r) design and the group figured out that the commercial water companies heavily relied on the aquifer for their profit and continuity, without having any accurate information about this precious resource. Therefore, the stakeholders decided to team up and create a workgroup that enables the transparency of the aquifer towards the users. Unfortunate, no written proof of this agreement can be shown. The survey showed that the participants were also less satisfied with this result of the process. (See figure 43)

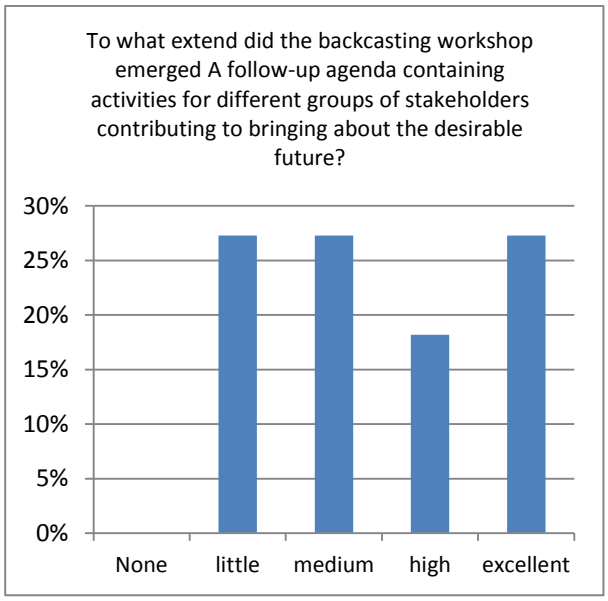


FIGURE 43 "EMERGED FOLLOW UP"

Goal 4: Stakeholder awareness and learning with respect to the options, the consequences, and the opinions of other stakeholders

The first part of the workshop entailed a game followed by two presentations by the moderator. Various questions were asked by the participants and learning occurred from understanding the situation towards learning about future developments that could solve the problem. The workshop entailed 3 stages of writing and presenting. The participants valued this goal as displayed in figure 44. Hereby the research can state that the learning and awareness among stakeholders was experienced as considerably high among the participants.

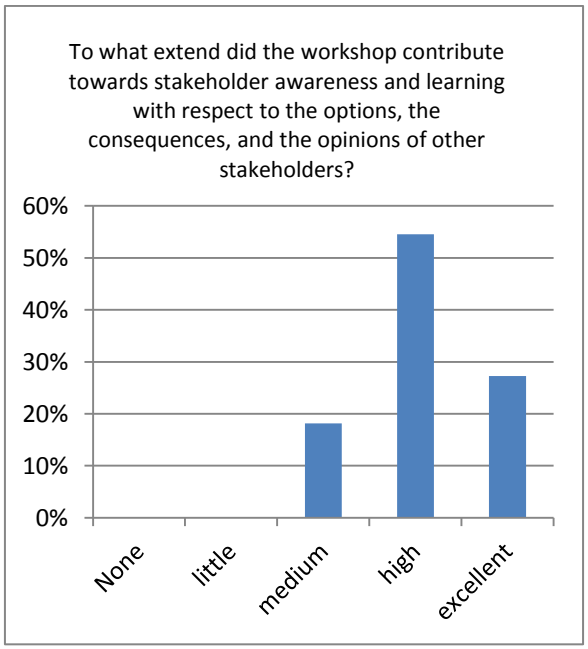


FIGURE 44 "AWARENESS AND LEARNING STAKEHOLDERS

Goal 5: Stakeholder support and commitment with respect to vision, designs, analysis, and commitment to the follow-up agenda

The commitment to the follow up agenda is the lowest of all the questioned goals. The survey displays that more than 35 % voted little commitment to the follow up. Due to the departure of the analyst and the minimal clout of the providence foundation, the heartbeat of the research diminished. However, 35 % of the participants voted a high extend towards the follow up and results can be expected from this group (see figure 45). The discussion elaborated upon this lack of follow up and the following paragraph presents the solution for the gap.

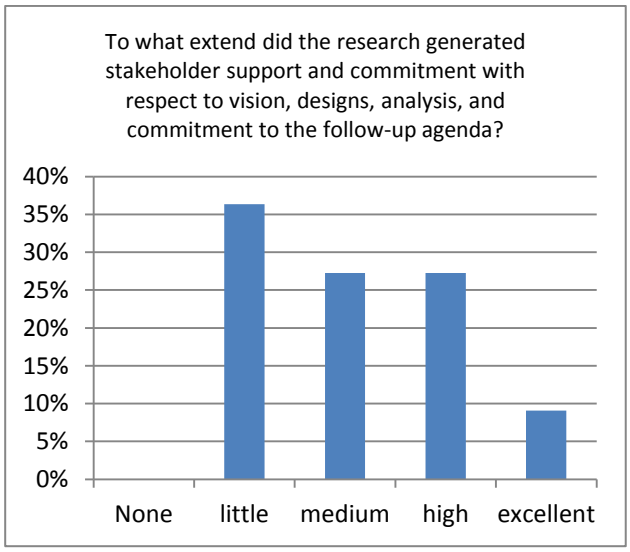


FIGURE 45 STAKEHOLDER SUPPORT AND COMMITMENT

Paragraph 4.3 concludes with the refined framework and displays key suggestions to use the tool towards sustainable planning (see table 17. This framework is slightly different then the framework presented in table 3.

In part 1 of the framework the participants are able to provide input for the identification of renewables potentials. Next, in step 4 of the framework the analyst provides input for the construction of the pathway towards the fundamental objective.

Finally, to construct a follow up agenda, a second workshop is included in the framework. In this workshop the pathways are discussed and coalitions built that develop the pathway towards the strategic objective.

TABLE 17 REFINED FRAMEWORK

1. Strategic problem orientation	Method
Define demarcation and level analysis, set goals	Analyses : System analysis following: (Enserink et al., 2010)
Analyze institutional situation	Analyses: Four layer model (Williamson, 1998)
Identify stakeholders	Stakeholder analysis. Mapping with focal owner project Following (Bryson, 2004
Define sustainability values	Analyses: Desk survey Following the Natural step method (Holmberg (1998)
Identify renewable potentials	Analyses: Desk survey (analyst) and input participants.
Elicit Values	Interview all stakeholders.
Create (un)shared values map	Mapping and creating value tree
2. Develop future visions	
Definition normative requirements	Definition of trends, definition requirements of future visions and preconditions
(Brainstorm) alternatives from values and develop value based future vision	Workshop format with "feel free to join invitation" , desk work
3. Backcasting workshop	
Disconnect stakeholders from business as usual	Present analyses of current situation and present value based future vision
What ?Define social, institutional and economical milestones	Backcasting workshop format following sustainable technology development (STD) format. Distinction is made between (1) technological, social and institutional milestones
How? Overall strategy choice	
4. Elaborate future alternative and define follow up agenda	
Formulating specific interventions (strategic - fundamental)	Build a schematic version of visions.
Select the strategic objectives	Select the optimal building blocks of different visions based on values stakeholders
Develop plan to reach objectives	Construct plan towards reaching the objectives in 2030
5. Embed results and agenda & stimulate follow up.	
Implement stakeholder dependancy matrix	Construction of stakeholder responsibilites and dependancy matrix.
Construct follow up agenda	Organize a second implementation workshop, where the outocmes of the process are discussed and actual coalitions are made.
review process	Survey after workshop about follow up agenda with testing of goals study
Participatory block	Non participatory block

4.4 Quality of the framework

The research is centralized in two terms: Small Island development and the framework towards supported sustainable planning. While driven by the existing theories in the early phases of the research, the proposed framework is applied to one case for the island of San Andres. One of the key questions is the applicability and the quality of use of the framework towards other islands and especially the islands included in the SIV group. According to Guba and Lincoln (1985) the research has to discuss the credibility, transferability, dependability and confirm ability in order to provide a sound answer to that question. These terms are explained and discussed in the paragraph to provide a sound answer on the generalization opportunity question.

4.4.1 Credibility

Credibility is the qualitative variant of internal validity and is a property of a study, which reflects the extent to which a causal conclusion based on a study is free of systematic errors(Guba and Lincoln, 1985). This reflects the extent of the actors that support the outcomes of the process. The credibility is in the research partly safeguarded by the iteration of different parts. To start, conclusions of the interview are showcased before the workshop to run a check on the interpretation of the results, which are shared among the participants to reflect and discuss them. The credibility of the interview is hereby safeguarded. First, the subparts are discussed on credibility; where after general findings about the use of the framework are exposed. The first four elements (see table 3) in the framework are discussed where after some general findings pass the review.

The second item of the process entails the value driven brainstorm design, which is based upon the shared values identified through the interviewees. The “feel free to join” session emerges creative behaviour and enthusiasm under the participants, but on the other hand evokes the possibility that the “silent actors” do not have any input on this design. This is empathised by designing from shared values, but the brainstorm also demands creativity from participants. This creativity contains subjectivity on key values of the present participants and is biased. Therefore, the value driven design is only used to encourage creativity, inspire participants towards future designs and is not included as an alternative in the total equation.

The third item contains the workshop, were the attendance was satisfying; thirteen out of fifteen organizations participated in the workshop towards a supported sustainable policy making for San Andres. The workshop started with the human knot game, which engaged and awoke the participants in solving multi-actor problem situations. Next, 2 presentations took care of setting the sense of urgency and provide the participants with tools to react, where after the designs, barriers and solutions are drawn. The process erected 12 drawings with variable quality and creativity, which is likely caused by the variety in stakeholders in each group. The selection process requires participants that are accustomed with strategic thinking. The case in san Andres showed that the island culture includes a day to day mentality and only senior positioned people able to think over such a time span. This was acknowledged in prerequisites of the selection of participants to work with the framework. For example, the unavailability of senior positions with a university grade in San Andres, demanded employees from organizations without these requirements to participate. If this requirement is maintained, some important organizations could not participate. The trade-off between losing support for future policy versus quality of the future policy is best made by the analyst in close cooperation with the focal owner of the research.

The fourth item entails the elaboration and choice of alternatives, in which the analyst structures and grades the back casting outcomes in a model. This section of the methodology is transparent to all participants, but the analyst has a great influence in determining the score of various alternatives

towards the values of the participants. The strategic objectives are scored by the analyst on a Likert scale from 0 (no added value) to 4 (high added value) (see table 4) is multiplied with the valuation of the participants of the strategic objective. The Likert scale enabled sensitive utility scores that are handed out by the analyst, but still makes the process sensible to subjectivity. This process could be opened towards participants in an online tool, but is time consuming and better executed by a person that oversees the process. The results are open for review and open for discussion at the implementation workshop.

Furthermore, the score of the analyst is multiplied with the value score of the participants. This score is partly determined by the association of an outcome towards the values of the participants. Hereby inequalities emerge for example: Objectives like (Maximize use of natural capacity aquifer) score higher than sub objectives needed to realize the objective (E.g. minimize problems due to property rights). To summarize, long term goals are valued lower and less attractive towards stakeholders then short term goals, but the short term needs the long term to function. This possibly emerges an unfeasible planning situation. This can be repaired in the last section, where the analyst provides his version of the pathway, but will always be a subject of discussion.

The five subparts of the framework are discussed, where after some remarks about the credibility of the general framework are stated. First of all, the case studies are broadly defined; leading to a general image of the problems and therefore the in depth details of the policy advice are limited. Next, a risk arises that the result of the backcasting studies is inclined by “group think”, because a large part of the design, barriers and solutions has come to light in a session with groups of four people. People operating in a same group often incline to state general thoughts in the environment. Hereby “silent” actors are easily drowned and certain information established by other actors’ results from “group think” rather than the same idea devising from various people.

Secondly, the analyst obtains a high degree of freedom in the framework, which enables creativity and pivoting during the process. This safeguards the evolutionary principle of policy building during the sessions, but also provides a high degree of latitude and thus influence towards the analyst. Especially, the selection of innovations and start ups that are showcased towards the participants is sensitive for external influences. This freedom provides creativity and possible pivoting during the process, but makes the process sensitive for external influences that jeopardize the independence of the research and the analyst. Therefore, the choice of an independent analyst is critical to safeguard a clean and good process towards an honest policy building area.

Third, the focal owner of the study is extremely important for the research, because the normative demands for the study are set with this actor. Next, the focal owner is important in facilitating the contact with the stakeholders, the workshop and implementation workshop. Therefore, the entity should be committed towards the goal of the research. Furthermore, the whole model towards sustainable planning functions when the focal owner of the research is an independent organization, which obtains a high level goal that, matches the high level goal of the other participants. In the case of San Andres the providence foundation has a high level goal of sustainability and the other parties also have a great need for sustainability. If the focal owner pursues other values and goals then participants, the value harvesting of the participants requires more time and effort. Next, the analyst will have more difficulty in formulating the shared goal of the backcasting session, which results in a challenging start of the process for all stakeholders. If no common ground is found in the values of the participants, the normative demands setting for the process are vague and the process will be of low efficiency in emerging a follow up.

Fourth, the translation of the Spanish / Spanish-English drawings of the designs, barriers and solutions is made by the moderator. Translation and communication can evoke interpretation issues and therefore the moderator translated the drawings. The moderator knows the general intend of the various groups, which secures the overall translation.

Furthermore, the analyst needs time to emerge the visions and pathways in transparent and clear pathways and grade them regarding the values of the participants. Next, the intensity of the framework builds up towards the backcasting session, where after the participants in San Andres felt an empty end.

Final remark on the backcasting session made by participants was that their concentration level dropped in the long time span of strategic thinking. A break was included after 3 hours, but the concentration of the participants dropped while constructing the time path towards the strategic goals. As said in paragraph 3.7 the analyst has to make the trade-off between a one day packed schedule or a two day schedule, with more reflection on every stage (design- barriers-solutions). This would emerge more focus on the solution and generate the possibility to educate the participants in the general solutions for various kinds of barriers to encourage creativity. Therefore, the level of credibility of the last stage of the workshop; the back casted designs are therefore to doubt. In retrospect, the research can state that the credibility of the workshop is high, 70 % of the participants awarded the overall added value of the research high to excellent (see appendix IX).

4.4.2 Transferability

The level of transferability refers to the degree to which the results of qualitative research can be generalized or transferred to other contexts or settings(Guba and Lincoln, 1985). One of the key points in designing the framework was the goal of a high grade of applicability towards sustainable planning on other islands. The researcher can enhance transferability by showcasing a thorough description of the content and the assumptions that were central to the research. The entity that transfers the framework towards another environment is then responsible about how sensible the framework is. Therefore, this paragraph discusses chronologically the assumptions and possible barriers towards a transfer to another environment.

The strategic problem orientation showcases a high grade of transferability, which is caused by the search nature of the part. Proven methodologies enable the analyst to scope and define the problem, where after the scoped area is researched on possibilities to change the actual situations and provide the participants with tools for change. The framework does not prescribe the selection of participants out of a pool of stakeholders and is therefore not (yet) transferrable towards large problems with over 50 stakeholders. Furthermore, the framework incorporates the thoughts and values of the selected stakeholders through interviews, which are presented in a shared value map. In retrospect, the strategic problem orientation is fully transferrable to other sustainable planning situations.

The future developments phase entails the “setting of normative demands”, which are free to define by the analyst in combination with the participants. For example, the goal in San Andres was to develop supported pathways towards a sustainable water management in 2030. This lined up with the goal of the focal owner and was therefore usable for the process. The question if the framework will work if the focal owner has different thought than the rest of the participants is answered with a yes, but participation will take a downfall. Furthermore, the process is more chaotic and the results difficult to evaluate and grade. In retrospect, the process might work, but state of the art moderation skills are required to get a union and a supported result. The item “brainstorm value driven design” will have the same difficulties if the participants do not share any common ground or values. Taken all together, the future development part is transferrable. However, if participants get into arguments about key values

of the normative definition the process might be less efficient in producing follow up.

The backcasting workshop day emerges creativity and learning about other stakeholders perspectives. The format of designing a future goal and working towards that goal can be implemented in every policy making process. This format is fully transferrable and the only boundaries are found in the amount of stakeholders that participate. Thins number has to be manageable for de moderator(s). The elaboration, choice of alternatives and constructing follow up depends largely on the results of the backcasting session. The level of transferability is therefore high.

4.4.3 Dependability

The traditional definition of reliability in quantitative research is repeatability, concerned with whether the research would obtain the same results if we could observe the same thing twice. In qualitative research and especially in building frameworks repeatability is always difficult, because different situations occur. According to Guba and Lincoln (1985) the concept of dependability is the qualitative variant for repeatability. Dependability emphasizes the change in different environments where the research is executed and the expected change in results that the research produces.

Paragraph 4.4.2 showcased that the framework is well transferrable towards other situations, provided that the participants do not exceed fifty stakeholders and have a high level shared understanding about a sustainable future. Both of these problems are resolvable, but the framework does not provide the tools or management manual. Furthermore, the framework is built to guide sustainability changes, but can also easily be transformed to guide economical or urban planning processes.

Every environment contains different stakeholders and therefore will results in different results and discussions. Therefore the dependability is assessed as low.

4.4.4 Confirm ability

Qualitative research inclines to accept that the researcher carries an exclusive standpoint to the study. “Confirm ability refers to the degree to which the results could be confirmed or corroborated by others”(Guba and Lincoln, 1985). Various pathways can be followed to enhance confirm ability. This paragraph takes “the devil’s advocate “role that examines the data collection, procedures and makes judgements about the potential for bias or distortion.

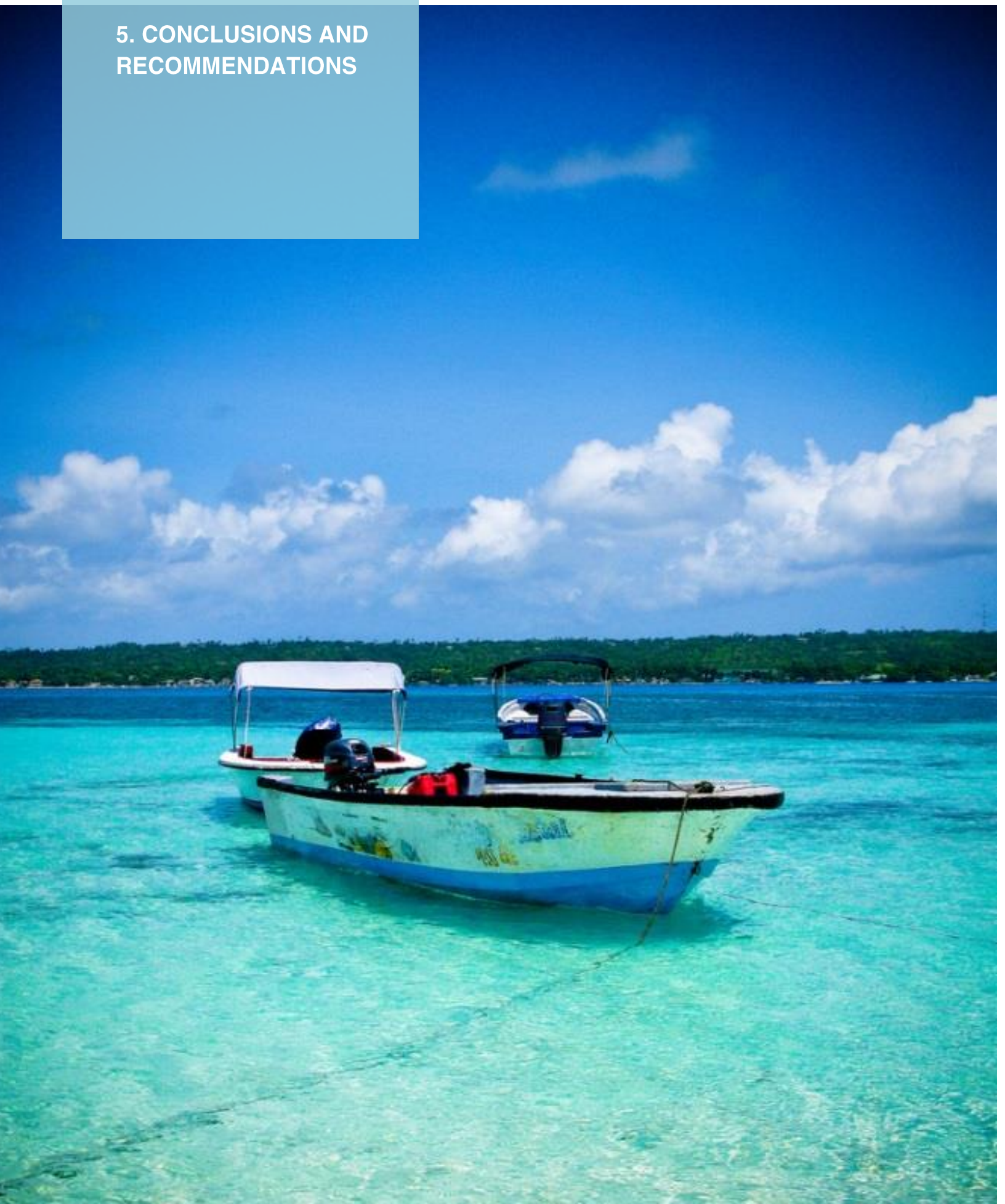
Firstly, the data collection starts with the generation of the presupposed values that lead to sustainability. This set of 10 values can be completed with values of the participant, but almost all participants agree with this predetermined set of values. The process demands value elicitation of 100 points over the total set of values and uses this valuation to later grade the various strategic objectives that are the result of the backcasting process, which makes the value elicitation an important issue. The ground pillar of the values of the participants is determined by the analyst and sensitive for the thoughts and influence of the analyst. The future visioning process fully depends on the inputs of the participants. However, the analyst could push some participants more towards the value driven brainstorm than others.

Second, the workshop session is sensible to input of the analyst through preparation of the presentations and moderation during the workshop. This secures an evolutionary process and the possibility to pivot during the process, but makes it also sensible to subjectivity of the analyst, which needs to be convincing towards the stakeholders, because they make the designs. In retrospect, the workshop seems a sensible process for influences of the analyst, but social control of all the stakeholders emerges validated results.

Third, the elaboration and choice of the alternatives happens through desk work of the analyst. The process commences with the reformulation of the backcasting outcomes

towards value focused thinking objectives. There are no standards for this process and this is sensitive for minor translation mistakes and communication errors. A spread sheet arises where the analyst provides the outcomes a score on a likert scale towards the values of the participants. This score is multiplied with the normative score of the value, which emerges an overall score of the strategic objectives. Hereby the largest pitfall in confirm ability of the whole process is identified. The analyst is able to determine the score on the values, which emerges a huge influence on the outcomes of the process. Therefore, the next analyst can value other variables higher or lower on the Likert scale and this directly changes the outcome of the process. Also the formulation of the final pathway by the combination of the analyst's insights and the results of the backcasting session are of low conformability. In retrospect the conformability of the research is very low, due to the large influence of human behaviour and variance in the values of stakeholders that exist.

5. CONCLUSIONS AND RECOMMENDATIONS



5.1 Conclusion

This chapter concludes the research by presenting the key findings. With the main objective: *Construct a supported pathway towards a sustainable water system for the island of San Andres in 2030*, a preliminary framework was proposed in section 2.6. Throughout chapters 3-4 this framework was executed, appropriately refined and thoroughly discussed on the use of theory and quality of the framework. This chapter firstly answers the research questions and the main research question, where after the scientific contribution is presented. Finally, recommendations and suggestions for further research are given.

The search that leads towards the answer on the main research question: *What is the optimal way to emerge a supported policy towards a sustainable water system for San Andres in 2030?* Was found by the analyst by answering the following sub questions:

1. ***How can back casting and value focused thinking actor analysis be integrated into one methodological framework?***

Backcasting methodology originated in the 1970s in energy studies and evolved into a methodological framework for system innovations towards sustainability by means of normative and desirable futures. Value focused thinking (VFT) is a fellow of the family of decision analytic processes. " Value-focused thinking advocates thinking about values first and then evaluating the alternatives present that achieve those values" (Keeney, 1992). The combination of these methods leads to a research methodology, which provides tools and methods that could take into account technological, economic, cultural, institutional, organizational and spatial aspects.

Over the last 30 years backcasting has emerged 4 general backcasting methodologies that are derived in building blocks and combined with VFT approach into a new framework. The proposed framework applies a tried-and-tested decision analytic method to help face back casting outcomes towards real interventions for the application of desirable futures. The framework is executed and refined during the study and the final framework is shown in paragraph 3.8 accompanied with a manual to use the framework, enabling further use of the framework.

2. ***What is the current situation regarding the water system in San Andres?***

First of all, the current water use is depleting the natural resources on San Andres. 75 % of the total water demand is extracted from groundwater and this causes a high pressure on the aquifers level and quality. The demand and thus the pressure on the aquifer is rising by a combination of population exponential growing range of tourists visiting the island. In 2020 the total water use of the island rises towards more than18000 m3/day, which creates a pressure on the aquifer of more than 13500 m3/ day. The aquifer is charged with 11200 m3/ day, so the daily loss is in 2020 already 2300 m3/day. The losses towards 2030 are even higher due to a higher demand and this difference keeps rising. The future mismatch between limited supply and growing demand is however not the only problem in the water system.

Second, to produce and distribute the total water demand the system uses more than 1.2 million litre diesel, which emits 7.3 million kg CO2 per year into the atmosphere. The old trucks that distribute the water towards rural areas on the island add another 60.000 kg CO2 and more than 5000 kg NOx.

Third, conditions that systematically undermine people's capacity to meet their basic human needs exist in the payment of the inhabitants towards the water company Pro Activa. The Raizales does not have the money to pay for the water service. If the valves of the system are opened, the population fills up their cisterns and is not able to pay for the service provided. When

the government installed the water service system the users were not given a proper education about water costs and water use. This result in large accumulated bills for the water service (4 times the monthly income is not exceptional) and resulted in expropriate of houses and land by credit managing companies. In retrospect, the whole water system in San Andres is a mess and problems are about to get worse due to climate change and rising energy prices. Overall can be stated; structural change needs to happen in order to avoid larger problems to originate.

3. What are desirable visions for achieving a sustainable water system on San Andres in 2030?

The local stakeholders erected four different focus visions towards a sustainable future in San Andres. The visions were derived from the value driven design that was made in the value driven brainstorm session and are presented below:

Rainwater harvesting: Till 1980 there was no desalination plant on the island and the inhabitants harvested rain water for drinking and sanitary purposes. This deep nested culture of rainwater harvesting explains that almost 95 % of the households in San Andres propriets a cistern of more than 3m3. The design is formulated by a participant who drew the superficial recharge of aquifers in the paper. The rainwater is in the rain season harvested and through solar and wind energy transported towards the great tank on top of the hill. The water is the n distributed through gravity towards the houses. The urban zone uses desalination processes in the dry season to fulfil the water demand. In the rural zone the process is decentralized and a number of aerodizilinador function in the dry season to empower the water demand. The water utility company Pro Activa is the owner of the system and demands a fair price for m3 water.

Recycling: The high level design shows a closed loop system, where the natural eco system is used to lower the energy costs of cleaning of water. The water is taken out from the aquifer and pumped via renewables energy systems to the consumers. The houses of the consumers are connected with a disposal system that collects the wastewater and put it into a high tech cleaning facility that environmentally friendly treats the water and puts the water via a revolutionary system back into the aquifer. All the energy used is provided by the gasification of biogas and the rest is powered by solar panels or wind energy.

Smart user: smart use(r) design focusses therefore to use water in a smart and efficient way. Therefore, the focus of this vision is on influencing behaviour. The design is split into two sub designs. The first subpart stresses the knowledge of the environmental agency and water harvesting companies of the aquifer. The design state; as long as we do not know how the aquifer works and react, we do not know how much water we can extract on a sustainable way. Therefore a study is recommended in the design to intellectually gain more knowledge on the way the ecosystem of the aquifer works. Furthermore, the knowledge gained is shared with the whole population of San Andres to create a shared understanding that leads to a shared responsibility. This system should be easily accessible from mobile devices such as iPhones and android phones. This is designed to cope with the disability to regulate the 5000 domestic wells that were dug in the Island of San Andres. The other part of the design stresses the recalibration of the use of water by tourist and inhabitants. Inhabitants use 115 litre water per day and tourist use the amount of 293 litres water per day.

Renewables energy systems: The design starts with a clear drawing of San Andres and the energy necessities of the different water production and distribution systems. The total energy needed for the whole system is 7 million kWh in 2013. The model is clearly inspired by the brainstorm model, because it uses rainwater harvesting and aerodizilinadors for water production. The water harvested by rooftops in the urban zone is transported via solar driven

installations towards the great tank on the hill. Distribution from this great tank towards households is facilitated by gravity. The solar panels are installed in rooftops. The sewage system puts the waste water into the sea and the empowering of the pumps is fully solar driven. Before the disposal into sea the water is treated and contamination removed by a treatment system. For the months without rain the desalination plant functions on a mix of solar and wind power. The rural zone is then supplied by electric big scale water trucks. The urban zone is still supplied from the big tank.

4. Which interventions and actions can be identified to develop a supported policy towards a sustainable water system for San Andres in 2030?

The backcasting process erected a set of outcomes that were translated into clear decision objectives. This translation emerges the possibility to score the objectives on the values of the participants. The result of this process is a value driven assessment on the various strategic objectives.

The process results in a score of the added value of the strategic objectives towards the values of the participants. Strategic objectives with a score lower then (low added value) are removed, because no social or stakeholder support exist in realizing that objective. The list of supported objectives is shown in appendix IX" full plan for San Andres'. This list of back casted trajectories can serve as pillar to define future policies. This list is then used by the analyst to develop a new plan that also includes his/her insights. This resulted in a 5 critical path plan:

1. Develop and share detailed knowledge about aquifer.

The use of the natural capacity of the aquifer demands perfect information about the natural behaviour and capacity of this resource. The basis for this information is available within CORALINA, but exact modelling and precise forecasts lack. Different studies in different rounds need to be extracted in order to enable this information stream. Firstly, CORALINA searches a capable team or organisation that creates a dynamic model of the aquifer and is able to perform forecasts up to a reasonable failure error. The search for state of the art technology or modelling skills all around the world and tender is executed by the environmental agency that tenders the package towards the most applicable partner. CORALINA and the commercial water entities are considered frontrunners and have to take the lead in financing the research. The financial contribution that the private water companies provide is paid back in detailed information about the aquifer. The continuity of the water bottling companies is therefore secured.

2. Maximize domestic and aquifer rainwater harvesting

Almost 95 % of the houses have storage capacity through a cistern. These small scale storages are not sufficient to cope with the longer dry periods and the capacity needs to be extended. This objective can be coupled towards the storage of water in communities. Large scale water storage enables cost efficient building of structures, but emerges regulation on the other hand. Native consumers with help from the local government could apply for Inter-American Development Bank (IADB) resources to evolve plans and community storage and decentralized distribution. Possible opponent is Pro Activa that values a large distribution network and this system would undermine their business model. An option to deal with this possible opponent is to engage Pro Activa in the business model through tariff structures and other regulations around community storage and supply.

The largest storage tank possible is the aquifer. Artificial aquifer recharge has proved to work in other areas of the world. The search for the best method is executed by mapping existing projects in the world and selecting the most promising design. This design needs to be evaluated towards applicability in close cooperation with

the research group that created a dynamic model of the aquifer in San Andres. If the artificial recharge is applicable, pilot projects could be executed and after evaluation scaled up towards maximum amounts given certain restraints adapted from the modeller. The organisations that highly value this objective are the market parties that bottle water and the commercial consumers. Possible opponents can be found in CORALINA, native consumers and government as the procedure can destroy or change the natural biosphere of the island. Therefore, commercial parties need to team up and create a lobby to convince the possible opponents. Finally, commercial parties need to harvest scientific information regarding artificial recharge and convince opponents of the possibilities and need of artificial recharge.

3. Erect a water committee in Coralina that safeguards the process towards a sustainable water system

The essence of water is one of the basic needs for life. The water system in San Andres is rapidly developing into a dangerous status. The government recognizes the need for change, but the political situation withholds developments towards a better system. To safeguard the transition towards a sustainable water system a committee that includes an even mix of consumers, commercial parties and non-commercial entities needs to be established. This committee has a meeting every two months and develops the water system towards a sustainable water system.

4. Install renewable driven desalination devices

The see is an abundant resource of water and this water is drinkable after desalination process. Nowadays, the systems are in the development phase and expensive. The island could create a space where pilots of various renewables driven desalination installations could be installed and tested. Therefore, subsidies should be installed and regulations need to de adapted towards the needs of the systems. Here through San Andres can become a test centre for desalination systems that also showcases other positive externalities such as, knowledge build up, attraction of educated persons and economic stimulant.

5. Emerge law for decentralized water production.

San Andres utility planning is caught in Colombian law. Colombian law is very hard to change. Adaptions in this law should be made to make decentralized water production possible. Renewables energy systems are highly suitable to deploy at the remote locations of the island. Nowadays, decentralized water production is illegal. This can be changed by maintaining an active lobby towards decentralized production.

5. To what extent is the framework of back casting and value focused thinking applicable to grade and develop pathways towards supported sustainable systems?

Chapter 4 elaborates in detail about the applicability of the framework towards the main research question. Hereby a summary of the findings is presented. To answer this question the methodological framework is evaluated on the following criteria as set by (Turner D, 2010). The framework is tested on the ability to provide added value towards the questions. The input for the answers is provided by a combination of answers from the participants in the survey and findings of the analyst.

The credibility of the framework is high in the strategic problem formulation, the development of future visions and the backcasting session. Failures of internal validity are taken away by the iteration of results towards the participants. The outcomes of the session are reformulated in strategic objectives and scored on the shared value list of the participants by the analyst. The credibility of this process depends on the impartiality of the analyst. In retrospect, the analyst is responsible for the credibility of the outcomes of the framework towards the

participants that are the only ones that can legitimately judge the credibility of the results.

The transferability of the frameworks is assessed as high. The framework is generally applicable towards utility planning problems. Problems in effectively forming supported pathways can arise when the normative demands of the framework and the core value of the focal owner of the research is contrary towards other stakeholders.

The concept of dependability is the qualitative variant for reliability. Dependability emphasizes the change in different environments where the research is executed and the expected change in results that the research produces. Every environment contains different stakeholders and therefore will results in different results and discussions. Therefore the dependability is assessed as high.

The confirm ability of the research start very high. The strategic problem formulation displays a high level of confirm ability. After this part the level of confirm ability drops. The development of future visions and the backcasting session are human driven interactions that lead to results. The level of conformability rises with the elaboration and choice of alternatives, which can be confirmed and reconstructed in order to assess the results.

In retrospect, the framework is applicable to develop supported pathways for sustainable systems. However, it largely depends on the creativity of the participants, the quality of the participants and the impartiality of the analyst. If these parameters are set on a high level and managed well, the framework is able to provide high quality supported pathways towards sustainable systems.

5.2 Recommendations for San Andres and future research

The recommendation chapter is divided into two parts; firstly, the report discusses the recommended follow up in san Andres, where after the general recommendations are provided for future users of the framework.

5.2.1 Recommendations for San Andres

The execution of the framework in San Andres emerged fertile ground for policy making and coalition building towards a sustainable water system for San Andres in 2030. The question that is answered in this paragraph is: How can the providence foundation emerge further follow up in order to get to the desired situation? Chapter 4 already discusses the need of a second workshop, where the participants are guided through the process of translation of the outcomes into decision objectives, followed by the value score on every strategic objective. Next, this input together with the coalition/opposition matrix can enable an implementation workshop. This workshop format is to be theoretically and empirically explored by the Providence foundation. Another possibility is to invite the analyst from the first part to also execute the implementation workshop. During the workshop coalitions are formed and more detailed plans of certain stakeholders can be presented, what will enhance follow up and implementation of objectives.

The drawback of the island culture remains the more centralized power and strong bonds between certain entities, which enhances the deeply vested corruption. Due to this corruption, the thrust in politicians managing the island is low. Furthermore, decision making happens in Bogota, which generates untailored and unfeasible solutions towards island problems. Taken all of these arguments together, local stakeholders have to form a pact and include themselves in decision making processes.

The advice towards the stakeholders is cooperating with authorities and emerge a “water

foundation", where local stakeholders meet every two months and discuss the situation regarding water management and aquifer behaviour. In retrospect, this foundation can channel all needs and create a strong stakeholder towards planning at the central government.

5.2.2 Recommendations for future use framework

The generalizability of the research is stated in paragraph 4.2 as transferability. This paragraph focusses on the recommendations for future users of the framework.

First off all, the framework is guidance towards certain planning activities that only activate participants desires and needs for a future system. In retrospect, the framework is as rich as the participant's creativity and thoughts. Therefore the framework is largely dependent on the selection of the participants and this should be executed by the analyst with great devotion and thoroughness.

Next, the framework is inherently connected with a lock in effect and rigidity of the policy advice. To counter these properties, the researcher needs freedom in the framework to include start-ups, promising technologies and future stakeholders into the process. Furthermore a yearly meeting with all stakeholders to discuss new solutions could be integrated.

5.2.3 Future research

The application of the framework is narrow and geographically defined. However, the fact that this research has an exploratory nature emerges many topics for further research to provide better understanding of the problems in cooperative long term sustainability planning. The combination of VFT methodology and backcasting into one framework has shown both its theoretical relevance and its practical usability to guide long term sustainability planning on San Andres. However, the research encounters some difficulties of the framework

First of all, the translations of backcasting outcomes into clear decision objectives emerged loss of information. This structural guidance of formulation of objectives provides a possibility to compare and weigh objectives, but on the other hand enhances information loss. This translation could be studied more elaborately.

Second, the framework is putted into practice for the first time in San Andres. The researcher had minor experience in executing sustainable planning workshops and therefore, further use of the framework will further refine the methodology. To be able to emerge more specific policy advice and follow up, the methodology need to mature through applications in various fields through researchers with different backgrounds.

Third, the dependence of the framework towards the impartiality of the researcher is large. This makes the framework vulnerable to corruption and influences from third parties. Possible solution could be the involvement of a third party that controls the impartiality of the moderator and process.

Fourth, the criteria to grade and validate the actual follow up or success for a session need to develop. Thresholds for cooperative planning processes need to emerge in order to provide feedback on the methodology.

Finally, the transmission system operator (TSO) in San Andres asked for the execution of the framework on the electricity system of San Andres. The opportunity is already there, sent an email if you are interested and willing to develop this island towards a more sustainable way.

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Appendix I "Interview questions"

Stakeholder analysis

7. What is the organizations definition of sustainability regarding the water system in San Andres? (interests)
8. What are major issues in the water system in San Andres in the last decade? (gap)
9. What is the interest of your organization regarding sustainability regarding the water system and how does your organization act to safeguard these interests? (strategy)

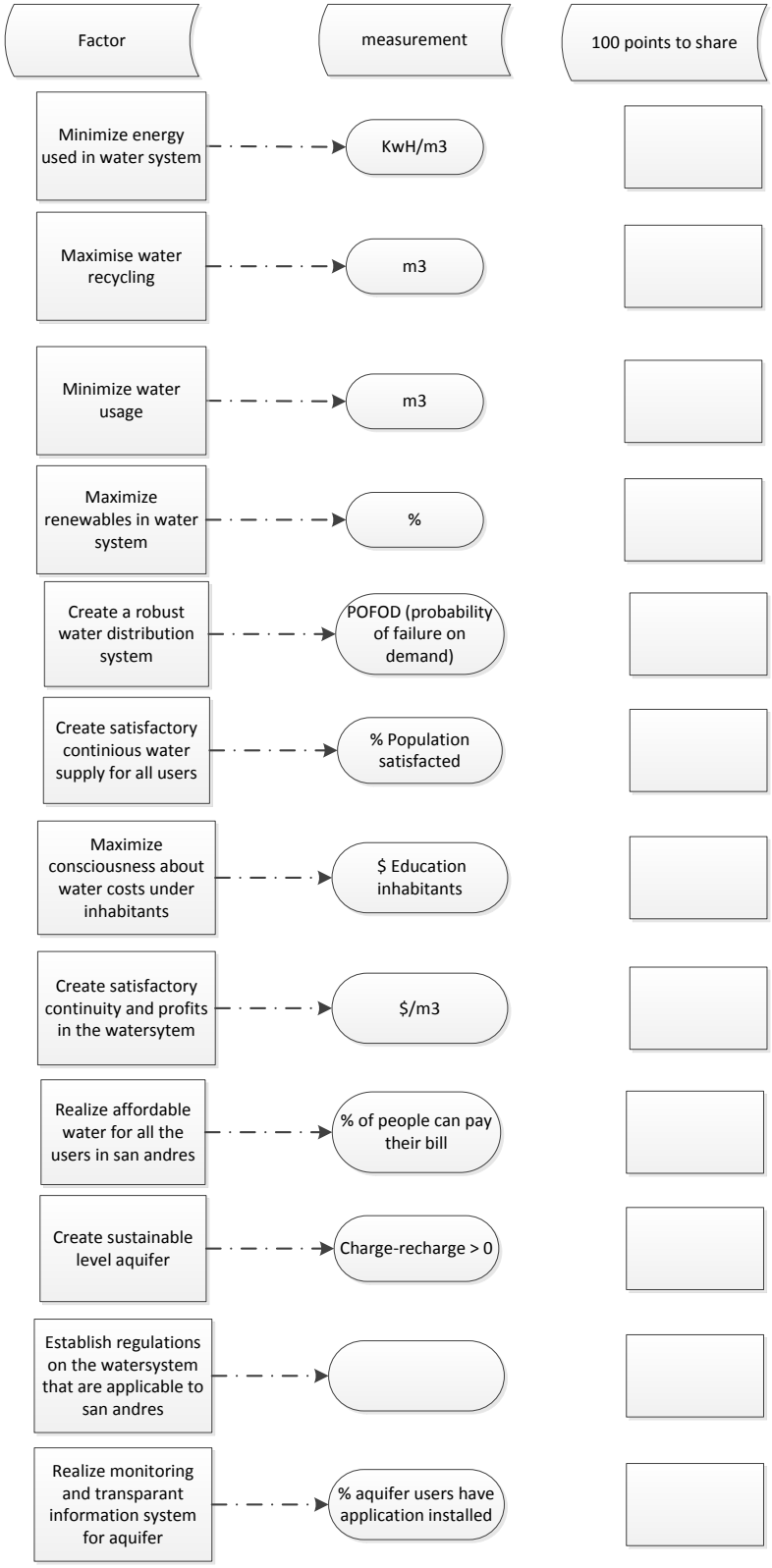
Value elicitation process

10. What do you want? What do you value regarding the water system for San Andres?
11. *Consequences.* What has occurred that was good or bad? What might occur that you care about?
12. Different perspectives. What would your competitor or your constituency be concerned about? At some time in the future, what would concern you?
13. *Strategic objectives*. What are your ultimate objectives? What are your values that are absolutely fundamental?
14. *Generic objectives*. What objectives do you have for your customers, your employees, your shareholders, yourself?
15. What environmental, social, economic, or health and safety objectives are important?
16. Quantifying objectives. What is the organizations value listing according to the following diagram? The organization can divide 100 points over the 10 values. If a value does not exist there are other spaces to fill them in. (value elicitation and creativity generation for development future vision, values come from system analysis, but stakeholders can put in values as well.)
17. Which trends should be taken into account creating a sustainable water system for the island of San Andres? (1) Growth of population, (2) economic growth, (3) climate change, (4) depletion of aquifer, (5) Increasing energy prices (6) Salinization of the aquifer, and (7)…….?

Future vision process

18. What is your dream for the water system in San Andres?
19. What would your company's role be in this dream?
20. What do you see as the community's major strengths and assets?
21. What is your vision towards a sustainable water system for San Andres on a technological perspective?
22. What is your vision towards a sustainable water system for the island of San Andres in 2030 on a social perspective?
23. What is your vision towards a sustainable water system for San Andres on an institutional perspective (law and moral changes)?
24. Who are playing a crucial role in the transition?
25. Who is going to develop this future vision?

Appendix II “list of values”



Appendix III "Stakeholder analysis, Problems, Objectives and strategy"

Stakeholder	Problem	Objectives	Strategy
1. Ministry of utilities (National Government) represented by the regional ministry of utilities (Government of San Andres).	There is not 100 % water coverage for all inhabitants of san Andres	100 % coverage at minimal costs for nature, people.	(1)Install RES systems that ensure the sustainable duration of the aquifer till 2100 (2)Install rainwater harvesting systems that enable rainwater harvesting in big scale
2. Coralina	The level and the aquifer is diminishing through over exploitation caused by overpopulation	Keep and maintain the same level in quality and level of the aquifer, through monitoring the system and service the clients of the water system with transparent data	Manage through monitoring and regulation the level of the aquifer. Especially find a solution for the 5000 wells on the island that are not regulated. Realize other sources of water for the inhabitants of san Andres through rainwater harvesting or sea water desalination, with low negative environmental effects.
3. Vice-Ministry for Water and Sanitation and Departmental Plans (provision of water)	70 % of the inhabitants of San Andres lacks water supply	Consolidating structural reforms in the drinking water and basic sanitation sector, to achieve a positive impact on the reduction of poverty through actual coverage of water, sewerage, and sanitation services.	Apply within possibilities policies towards the small island conditions of water supply. Create a tailor made solution that is supported through the stakeholders on the island to create water for all at good conditions.
4. Potable Water and Basic Sanitation Regulatory	Quality of water in San Andres was dramatic in 2010. Nowadays the quality in the public water system is better, but a lot of poor people lack the ability to pay for the system.	to create and preserve the necessary conditions to provide sanitary services by regulating the organizations and agencies that provide this services, may them be public or private; its duties include establishing criteria for quality towards the users and implementing subsidies to low income users	Evolutionary start with a process of developing different zones on the island. Develop a plan to serve water to rural areas on the island on behalf of a social cost benefit analyses. Analyse per area the choice of rainwater harvesting process versus connection to the grid and develop plans for subsidies and finance plans to develop low cost quality solutions for all areas in San Andres.

5. Aguas de San Andres	No continuous water supply for all inhabitants of San Andres	Realize efficient water distribution system at low cost with low losses of water	Decentralize production and invest heavily in the water distribution system of San Andres.
6. Pro Activa(Production)	High energy costs at production potable water (30 % costs is energy)	Realize 100 % RES in water production and produce potable water at low costs	Realize decentralized production with more alternative energy resources that diminish energy costs
7.Sweet water(Production)	(1)High energy costs at production potable water (30 % costs is energy). (2) Contamination in source aquifer	(1)Efficient water production (2)Controlled exploitation of the aquifer	Install Renewables energy systems in water treatment , enlarge the share of rainwater harvesting
8.Aqua Works(Production)	Depletion of the level of the aquifer, contamination of the aquifer and the rising costs of energy for desalination process	Sustainable level of aquifer till 2100, maintain quality aquifer, install renewables in production process to reduce energy bill.	Cooperate with Pro Activa and Coralina to maintain level of aquifer and build a second location to lower distribution contamination and costs.
Pro Activa(distribution)	Huge losses in distribution system causes high losses in company, Resistance of users to connect to the public water system ,Risk of non-entry to wells	Realize efficient water distribution system.	Urban area: Invest in water distribution system. Rural area; invest in renewables energy driven decentralized water production
8.Conty water	Overexploitation of aquifer by competitors	Realize harmonious way of extracting from nature	Follow rules from Coralina
Aqua works, sweet water (distribution)	Distribution of water creates high costs and contamination to the environment	Realize decentralized plants to minimize distance between consumer and company.	Start with electric vehicles distribution. Decentralize production capacity
9.Future consumer	Lack of long term planning and goals and the lack of a policy that regulates sustainable water production and development	A closed loop system of internal utilities system working in a sustainable way around the biosphere reserve	Assist in developing an integral cycle of all the utilities around the biosphere reserve with a strong technical pulse
10.Royal Decameron	Utilities bill is to high (15 %) compared to other hotels (8 %)	Educate tourists ans inhabitants in water usage	Develop education programs for tourist to live in a biosphere reserve

11.Providence foundation	There is not a continuous clean water supply for the community. There are neighbourhoods with once in a month aqueduct water supply. The expansion of the aqueduct net has been focused mainly in urban areas of the island. There is no a clear water supply solution for the isolated communities of the island.	Sustainability regarding the water system in San Andres Island from our point of view involves an integrated water management system taking into account the socioeconomics aspects of the island inhabitants, the special characteristics as an isolated system and the technical approach	The establishment of an integrated water management system effective and efficient; the harvesting and storage of rain water should be considered in the local public policies within the water management subject for households
12.Elemental water makers	No commercial scale development of innovation	Introduce energy efficient and cost effective renewable driven desalination systems to provide freshwater while using only the power of the sea, sun, earth & wind.	Develop commercial units from small scale till bigger ones.
13.Inter-American development bank	70 % of people in San Andres lack the availability of continuous clean water supply	Develop long term investment plan that is supported by the stakeholders in order to create a robust finance structure for fruitful investments	Search for a good structured investment plan that is better supported and thought through than the investment of the government into the public water service system
14.Nacional University de Colombia	(1)Population does not have any access to water. Only the rich people have good access. (2)Difficult to construct a public water system in the corrupt conditions in san Andres. Also the geological situation plays a role in this	Create affordable water for the whole population of San Andres, with conditions that are the same to the conditions of sustainability of the Biosphere reserve.	Search for the most low cost supply of water services for the population of San Andres. The university identified rainwater harvesting as lowest cost option and is looking for projects to share knowledge and help the poorest people of San Andres to organize rainwater harvesting.

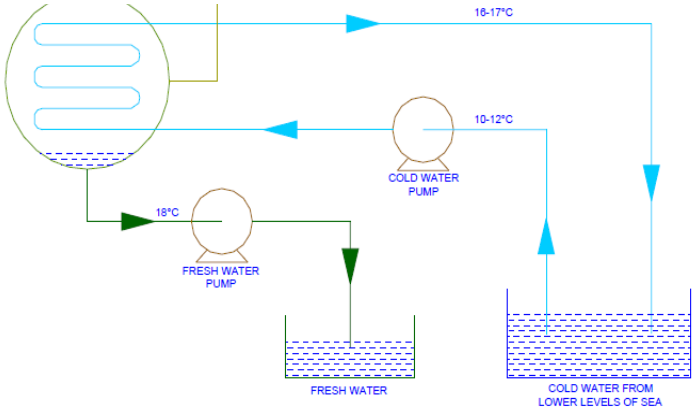
Appendix IV “Showcase of innovations”

Solar driven desalination

Elemental Water Makers provides renewable driven desalination systems for decentralized drinking water production. With rising energy prices, increasing population, rising living standards, climate change and increasing water stress, there is a growing need for renewable driven desalination. Elemental Water Makers has developed an innovative desalination system that only uses solar and/or wind energy in an efficient and costs effective way to create drinking water from seawater or brackish groundwater (see figure 36). This makes the solution very suitable for remote areas in water scarce regions with limited access to an electricity grid. A pilot plant was installed in 2012 in Indonesia and produced 2,5 m3/ day at a cost of 3 euro (7.500 COP)/m3.

SOLAR DRIVEN DESALINATION SYSTEM

The Low Temperature Thermal Desalination (LTTD) method requires the evaporation of water taken from the sea by ocean thermal energy conversion (OTEC) which makes the process eco-friendly and uses renewable source of energy. LTTD uses the temperature difference which exists between the surface layer water (28°-30°C) & deep sea layer water (7°-10°C) existing in an ocean to produce potable water(see figure 36).



LOW TEMPERATEURE DESALINIATION SYSTEM

Membrane Distillations units for remote areas are another option of solar driven desalination. Two different system designs (Compact System and Two-Loop System) are available. Nine compact systems for fresh water capacities up to 150 l/day and 2 two-loop systems (1x 1000 and 1x 1600 l/day) with an integrated heat storage system for a 24h-operation have been installed at different test sites. The first system was installed in Gran Canaria, Spain in 2004 and is still in daily operation. In 2010 it is foreseen to install a 100% solar driven system, and also a hybrid system (solar and waste heat) with a capacity of 5 m^3/day.

MEMBRANE DISTILLATION SYSTEM

The Aerodesalizador offers a solution to the problem of drinking water for human consumption in isolated and complex conditions, where there are no conventional supply networks. The system is designed to make the driving energy generated by wind, making mechanical energy needed to develop the treatment process, purification and / or purification of salt or brackish water through filters and reverse osmosis membranes, obtaining water potable fit for human consumption at very reasonable costs. The system is able to provide an average of 2.2 cubic meters of water, with a daily average of 6 m/s wind speed. The production of the water is dependent on the wind available and has a variation per day as wind is an intermittent energy resource.

According to Papatrou (2010) the lowest cost renewables energy desalination method is promised to be off grid wind powered solutions, which can approach 1 €/m2 in large scale plants. If we look at the diagram the brackish water Solar Panel Reverse osmosis is the lowest energy costs per m3 potable water produced. Examples of large off grid wind powered systems can be found in Gran Canaria and Greece, but the costs per m3 potable water produced are estimated at 6-8 euro per m3 potable water. Furthermore, the numbers display a cost of almost 12 euro per m3 water produced in seawater photovoltaic reverse osmosis (seawater PV-RO). According to company presentations of elemental water makers and Trunz (see figure 41) the price of renewable energy driven seawater PV-RO can drop to 3-5 euro/m3 water, largely due to a price drop in photovoltaic panels.

AERODESALIZADOR

TRUNZ SOLAR DRIVEN WATER REVERSE OSMOSIS SYSTEM WITH BACK UP BATTERIES INSTALLED IN CHILE

Rainwater harvesting is a traditional system used by the Native islanders, whereas the immigrated Colombians do not use the rainwater for their fresh water supply. Less than 40 % of the roofs is prepared for rainwater harvesting (Quist et al., 2002). In the following text the newest systems are showcased

RAINCAUSER

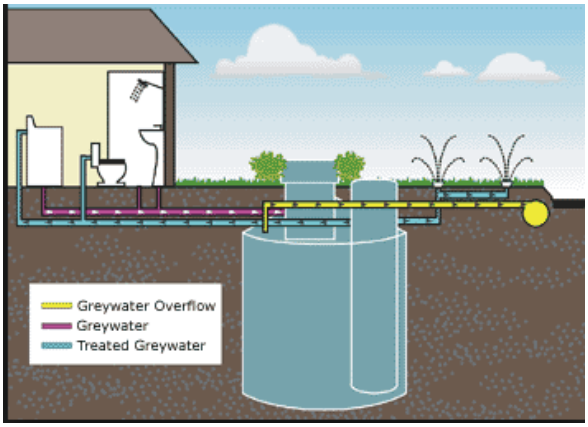
Instead of using the roof for catchment, the RainSaucer, which looks like an upside down umbrella, collects rain straight from the sky. This decreases the potential for contamination and makes potable water for developing countries a potential application. Other applications of this free standing rainwater collection approach are sustainable gardening and small plot farming. The Raincauser costs around 70 US dollars. The majority of the houses in San Andres feature a cistern so the investment for the system is low.

RIVER FROM THE SKY

River from Sky is a domestic rainwater harvesting system. It channels rooftop rainwater from every house in a community, through gutters and pipes, to a network of multi-tier underground reservoirs as shown below. The strategy is to form public-private-community partnership or social enterprise to provide drinking water to the people. It rents roofs from home owners or acquires rights to harvest their rooftop rainwater. The local government leases, at no cost, about 10,000 M2 land next to the shared community reservoir. A social takes care of the post-implementation upkeep and holistic sustainability — social, cultural, economic, institutional, political, operational, and ecological. One half of the harvested rooftop rainwater is stored in the reservoir attached to the house for the exclusive use of the home owner. The other half flows to the shared community reservoir. People who live under thatched roofs or who cannot afford to have their own reservoirs take water from the shared reservoir.

Water recycling

In San Andres the recycling process does not exist. All the water that is used flows directly into the sea via the submarine diffusor. The waste water is often contaminated and flows into the UNESCO Biosphere reserve, while the water could be used to recharge the aquifer. Therefore, it needs to be treated before in a way that is harmonious with the sustainability principles. Organica waste water presented a greenhouse system where bacteria are used to clean the waste water without the presence of a large smelling facility on the island



GREY WATER CIRCUIT

Next to the large scale facilities inhabitants could also do a great job in recycling at decentralized scale. Water used in toilets and shower counts for 75 % of the water bill. Almost every household in San Andres has a cistern (see figure 46). If the water from the washing machine and the shower are treated and reused for flushing the toilets, this would decrease the residential water usage with 35 %.

ORGANICA GREENHOUSE WASTEWATER TREATMENT SYSTEM

Appendix V "Presentation Gap"

Bienvenidos al taller

El camino hacia un sistema de agua sostenible para la isla de San Andrés en el 2030

elemental water makers

eit Knowledge & Innovation Community Climate-KIC

TU Delft Delft University of Technology

FUNDACIÓN PROVIDENCE

Agenda

1430 – 1500 bienvenida

1500 - 1530 juego para romper el hiel0 + situación actual

1530 - 1550 proceso +visión futuro + posibilidades futuras

1550-1650 primero asignación (diseño y barreras)

1650-1710 pausa

1720-1820 Presentación + 2nd asignación “construir el camino + Presentación

1815-1845 redes y bebidas despedidas

Juego para romper el hielo

Que aprendemos?

Que es un sistema sostenible?

En una sociedad sostenible, la naturaleza no está sujeta a aumentar sistemáticamente

las concentraciones de las sustancias extraídas de la corteza terrestre

Las concentraciones de las sustancias producidas por la sociedad

degradación de los medios físicos

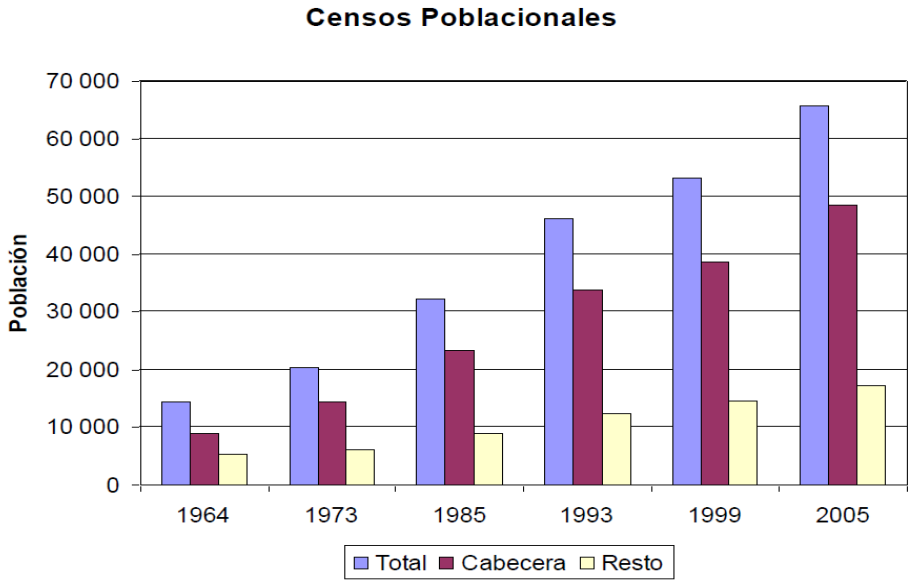
Y, tambien

No se debe desarollar un sistema que limite o afecte la capacided de las personas para satisfacer sus necesidades basicas

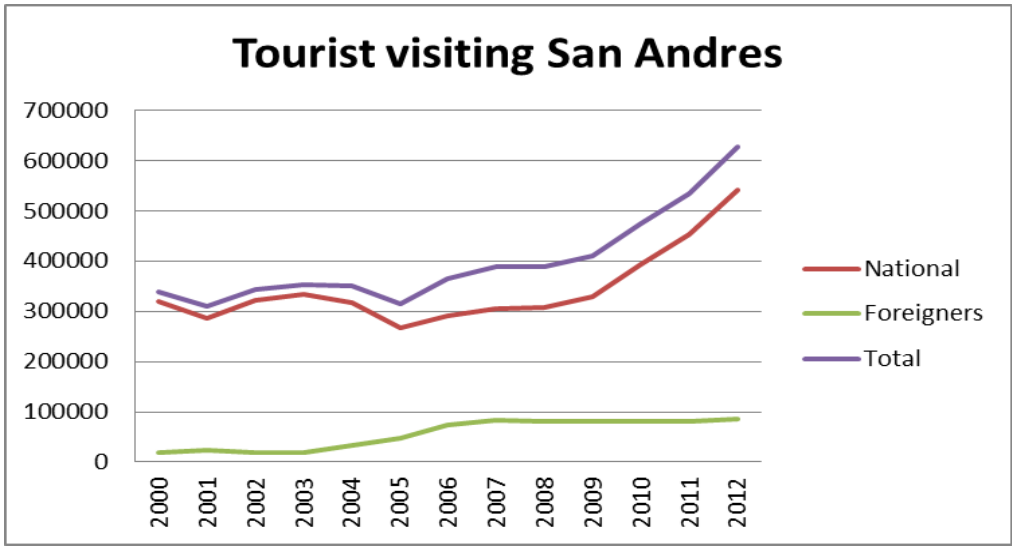
Situación actual

Demanda población (habitantes + turistas)

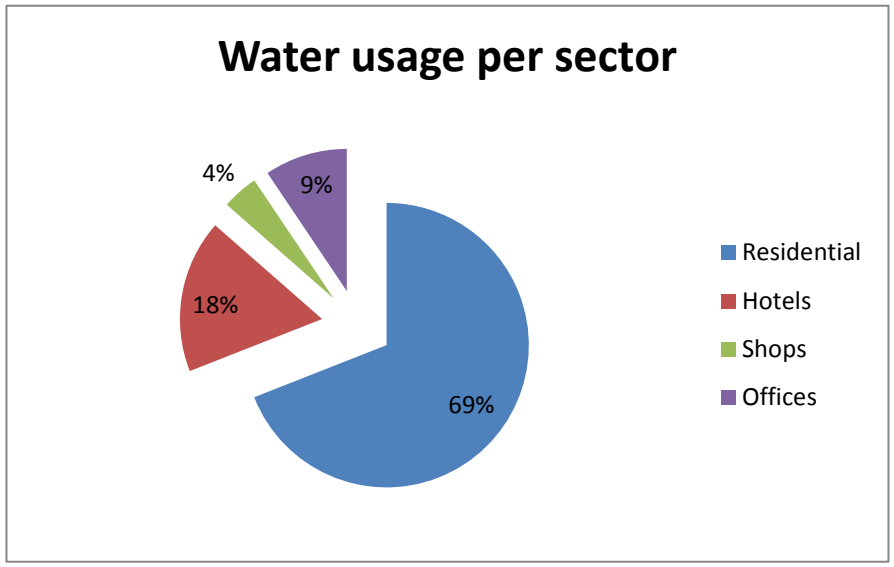
Customer	Shops	Offices	Tourists	Residents
Water use m3	0,23	3,9	0,293	0,115



POPULATION ON SAN ANDRES (1964-2005)(GUERRERO, 2010, QUIST AND VERGRAGT, 2006)



TOURIST VISTING SAN ANDRES 2000-2012 (OFFICINA DU TOURISMO, 2013)



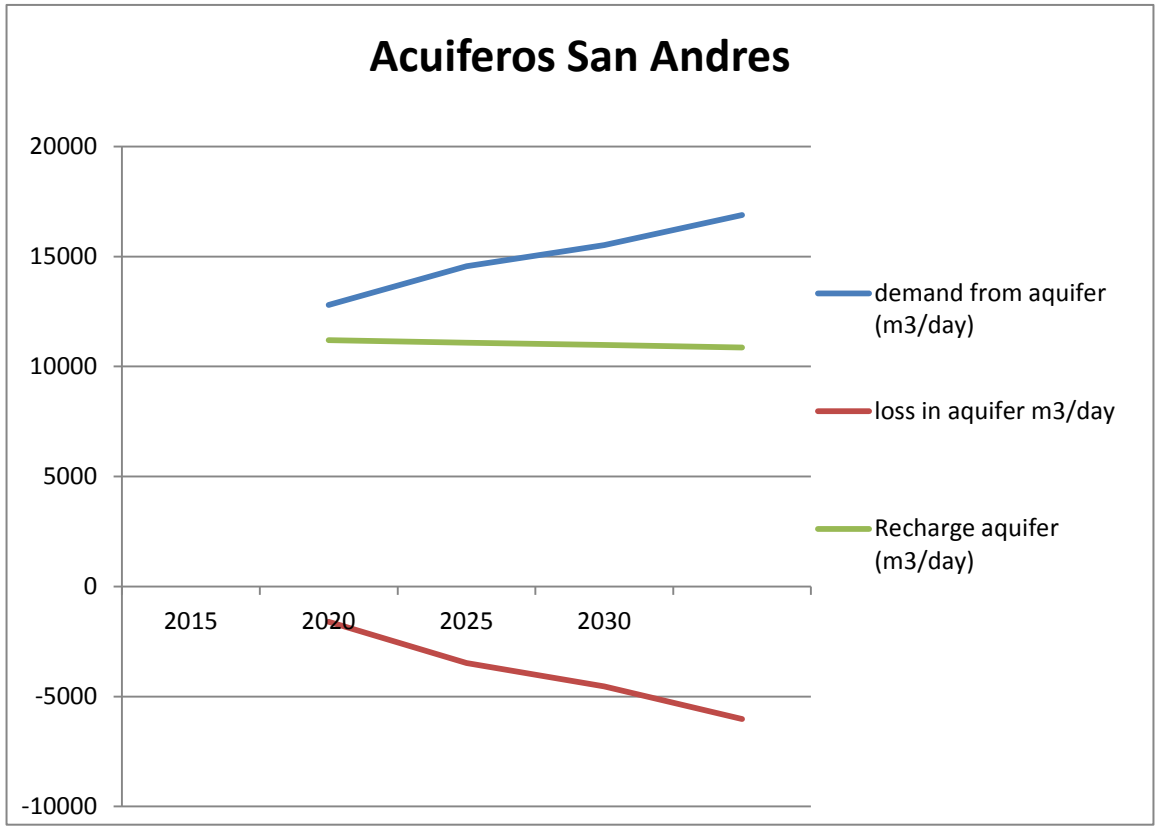
Water usage m3/day					
year	Residential	Hotels	Shops	Offices	total m3/day
2013	10005	2525	598	1365	14493
2015	10580	3291	621	1482	15974
2020	12075	4014	644	1560	18293
2025	13225	4014	644	1560	19443
2030	14950	4014	644	1560	21168

EXPECTED WATER USE TILL 2030

Per year	Electricity (kWh)	Diesel (liters)	Emitted Co2 (kg)
Production and sewage	5.659.200	1.061.100	4.600.000,00
Distribution		547.500	2737200
Total		1.608.600	7.337.200

Concentración de SUSTANCIAS PRODUCIDAS por la sociedad

DEGRADACIÓN POR MEDIOS FISICOS



BASED ON IPCC INDEX CARIBE (2007)

Situación agravada del fenómeno del niño /la niña

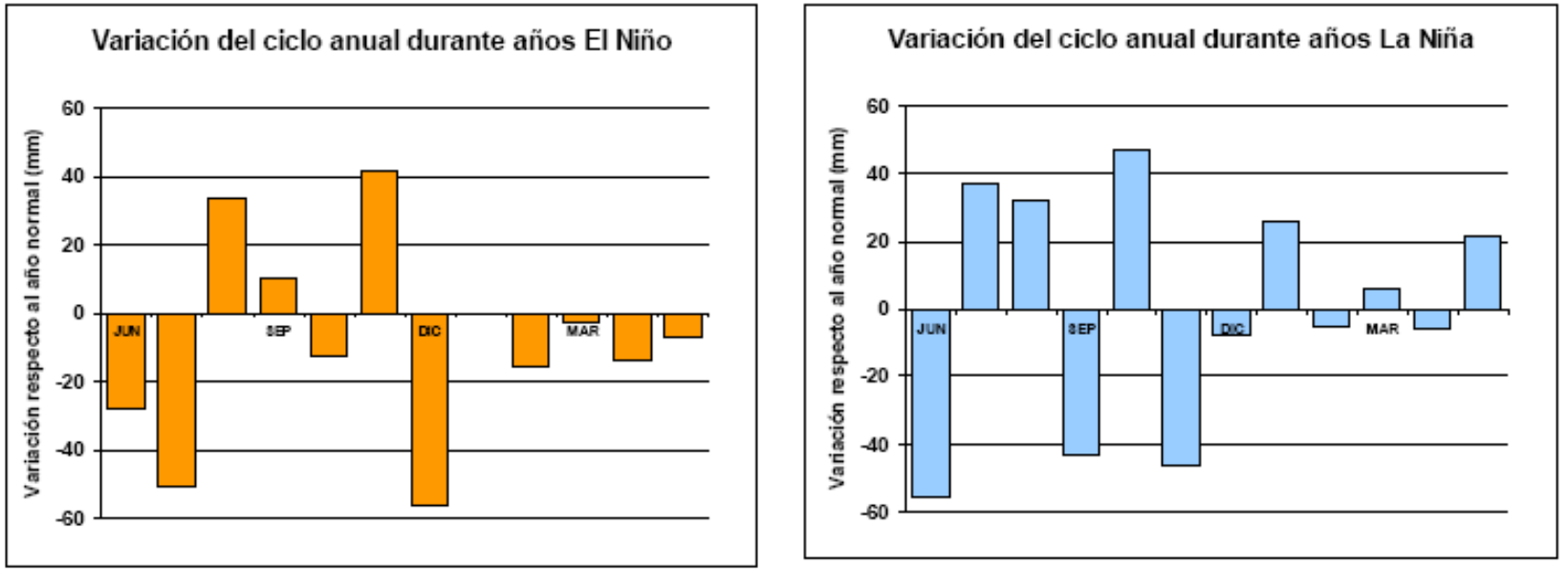
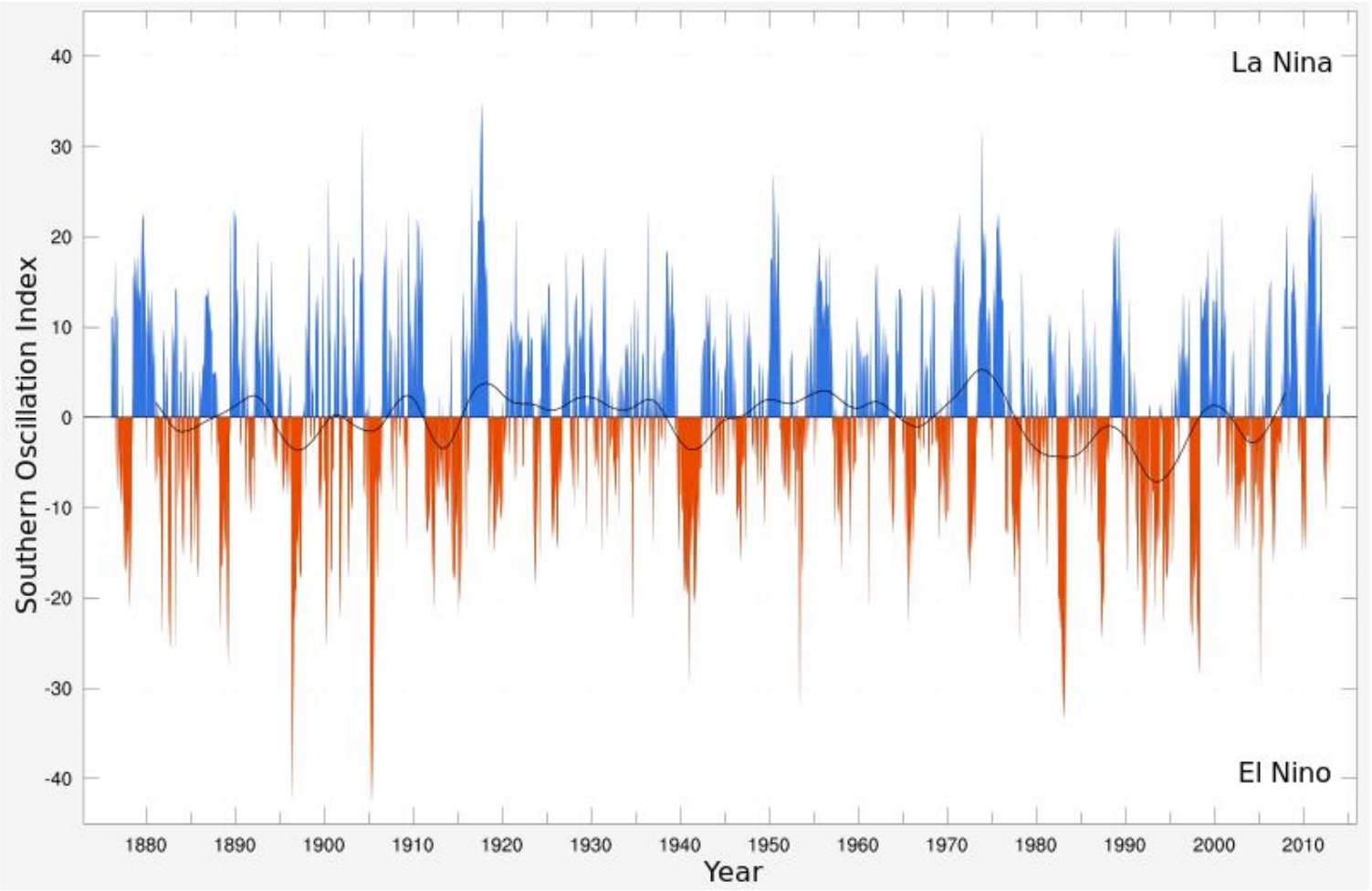


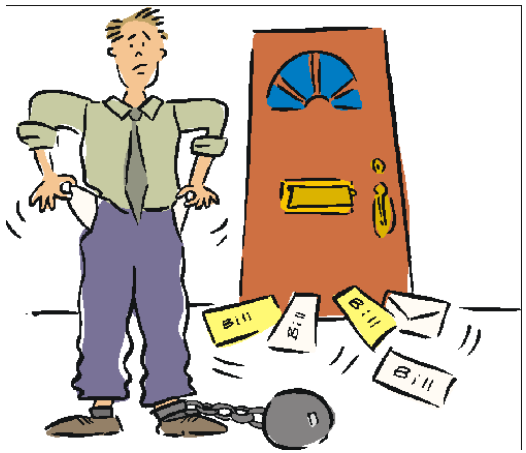
Figura 3.6. Ciclo anual promedio de las anomalías de las lluvias en los años de ocurrencia del El Niño (izquierda), y La Niña (derecha).

Tiempos el Niña/ del Niño



1. **no se debe desarrollar un sistema que limite o afecte la capacidad de las personas para satisfacer sus necesidades basicas**

- **70 % DE LA POBLACIÓN NO TIENE acceso al agua potable PARA USO DE SANEAMIENTO**
- **los habitantes no fueron educados EN EL USO DE CONTINUAR EL ABASTECIMIENTO DE AGUA**
- **los habitantes no pueden pagar la cuenta del agua de proactiva**



3 PROBLEMAS: cambio de clima, acuífero y humano

1. **“video change mr president”**

Conclusiones?

2. **situación acuífero**

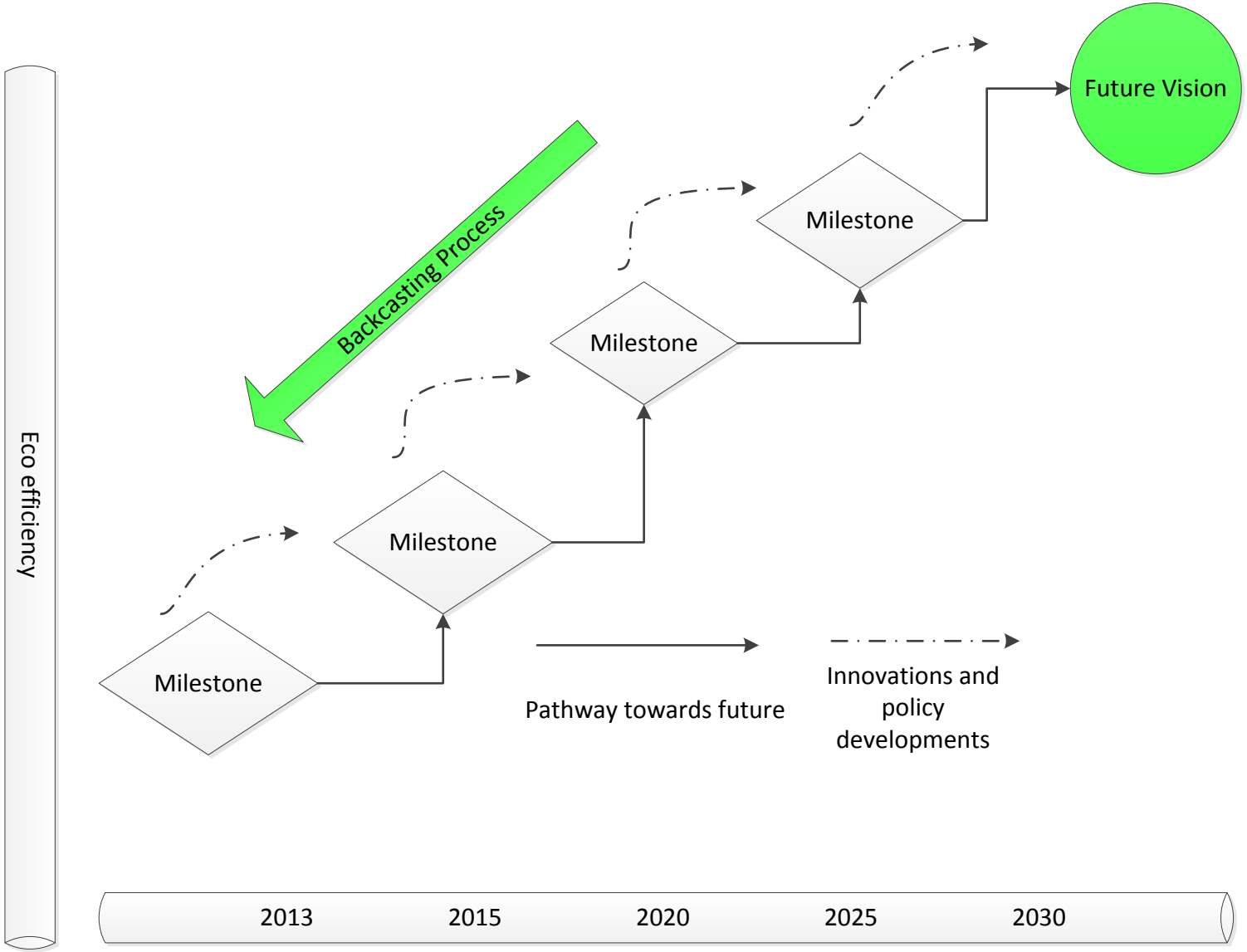
Conclusiones?

3. **situación humana**

Conclusions’?

Appendix VI 2nd presentation workshop "Visions till 2030"

Presentación del proceso ingeniería inversa



Objetivos del proceso

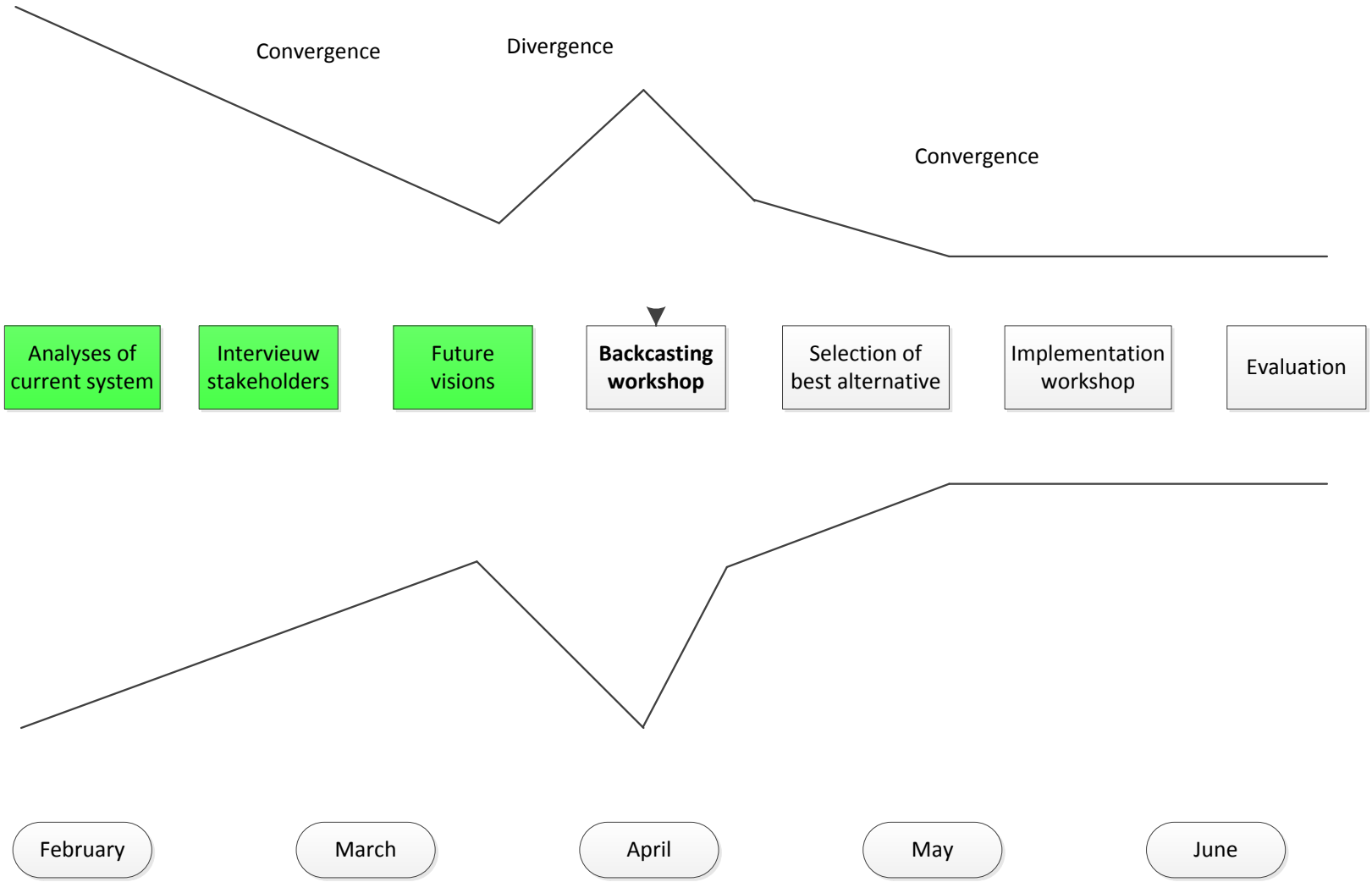
1. Incluir visiones atractivas del futuro en los programas sociales y políticos del gobierno

2. Realizar un programa de seguimiento que contenga actividades para los diferentes grupos de actores que contribuyen al logro de un futuro deseable

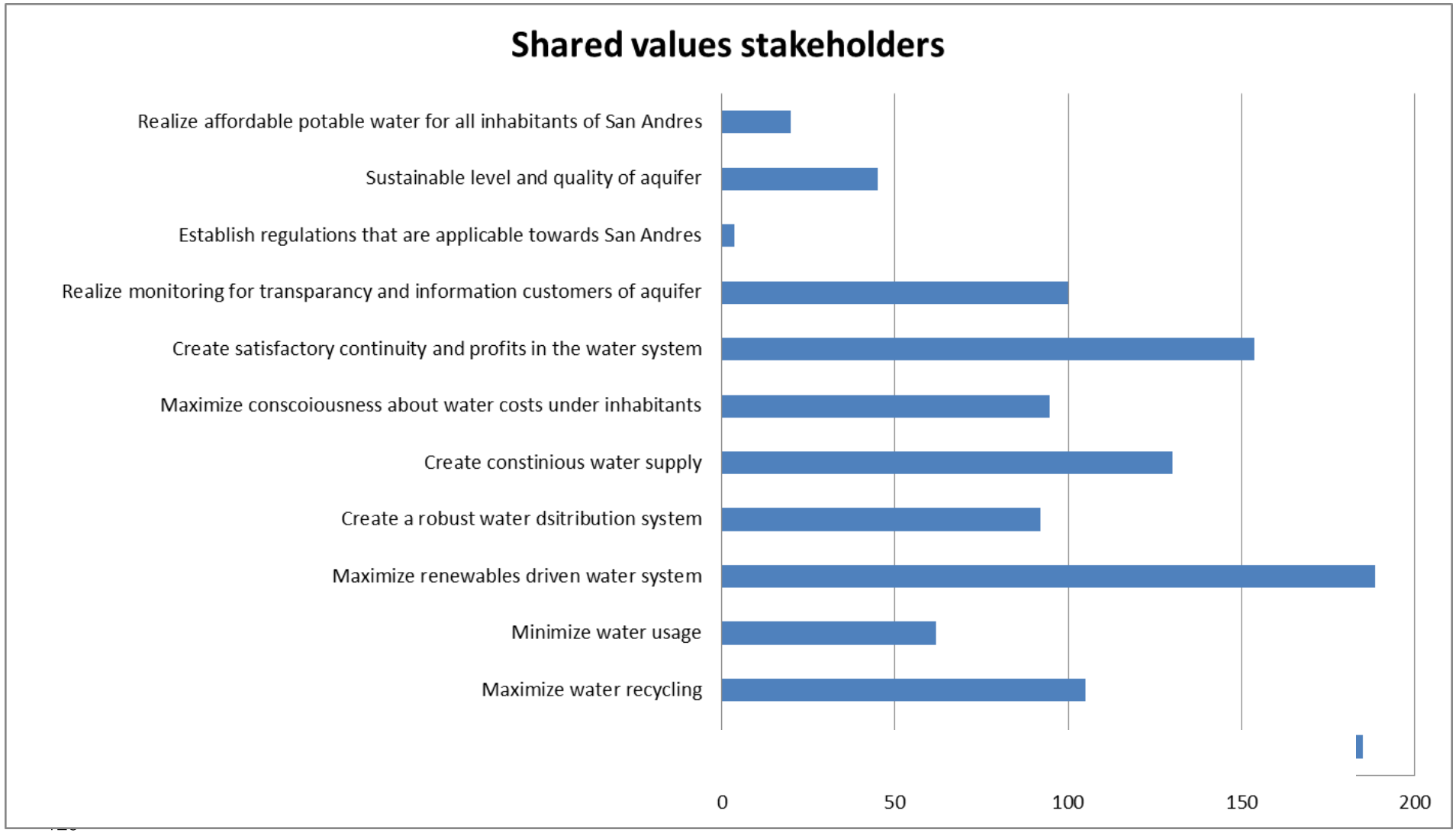
3. Concientizar a los actores con respecto a las opciones, las consecuencias y las opiniones de otros grupos de interesados

4. Apoyar a los actores con respecto a la visión, diseños, análisis y compromiso del programa de seguimiento

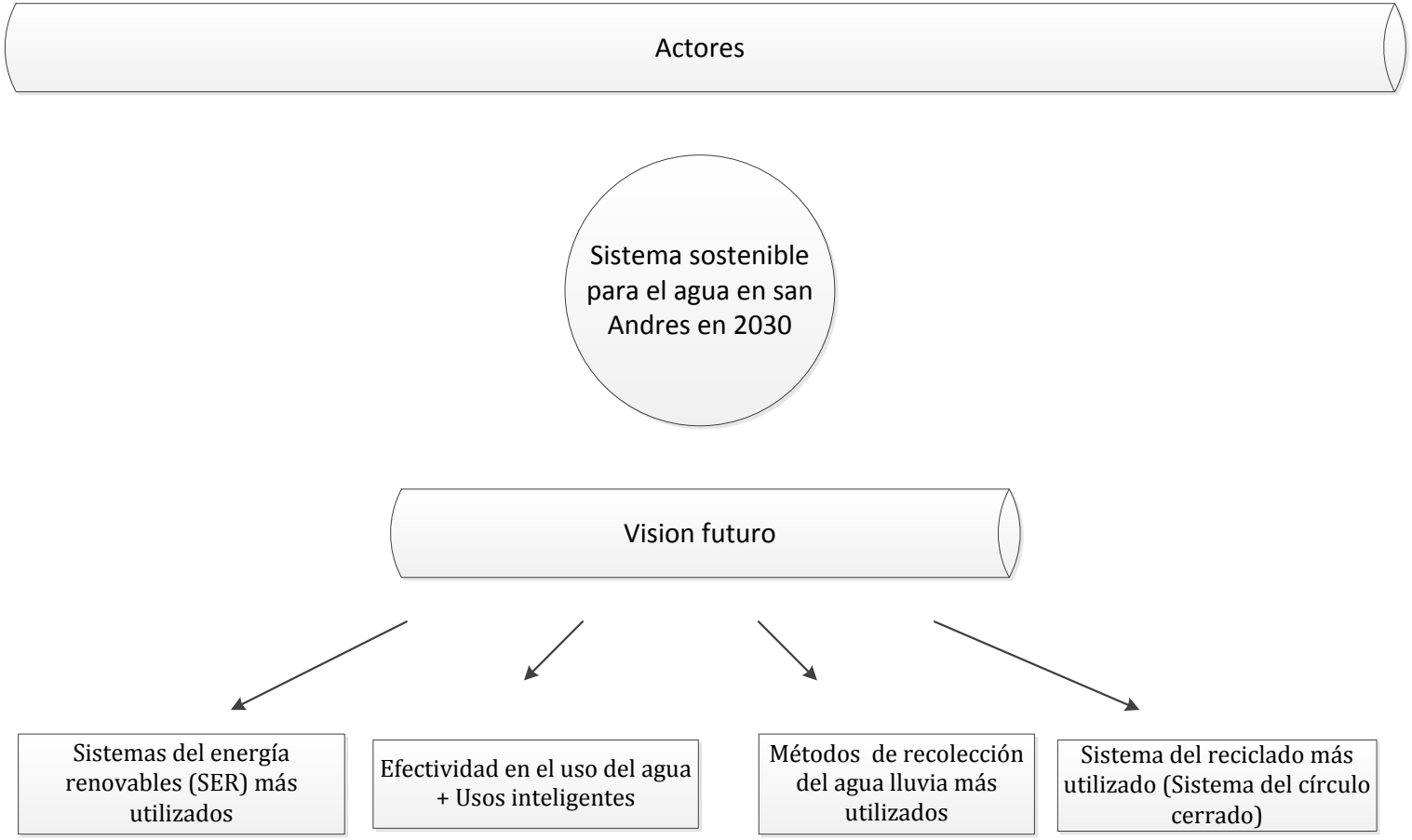
Línea del tiempo del proceso ingeniería inversa



Valores compartidos

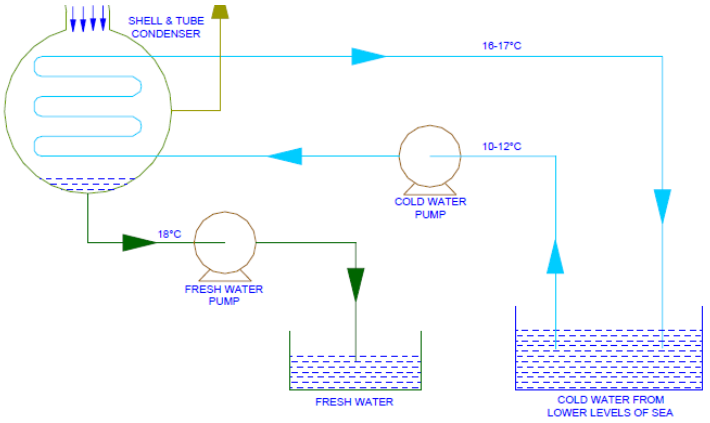


Visión futuro de los actores



Sistemas del energías renovables (SER) más utilizados

ORYX MEBRANE DISTALLATION UNIT



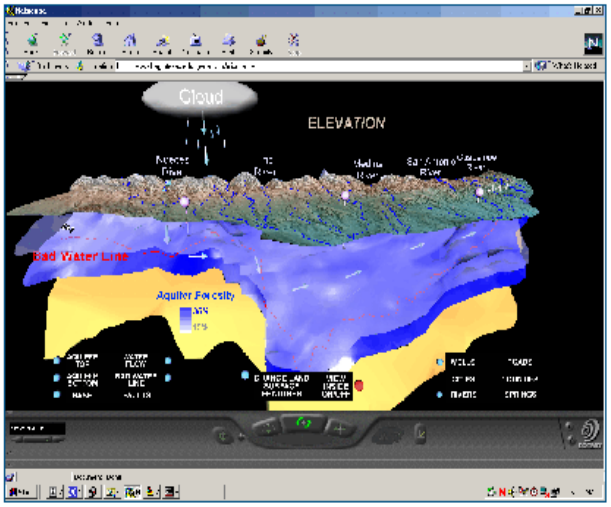
LOW TEMPERATURE THERMAL DESALINATION (LTTD)

AERODESALIZADOR

CANARY ISLAND DESALINATION SYSTEM

Efectividad en el uso del agua + Usos inteligentes

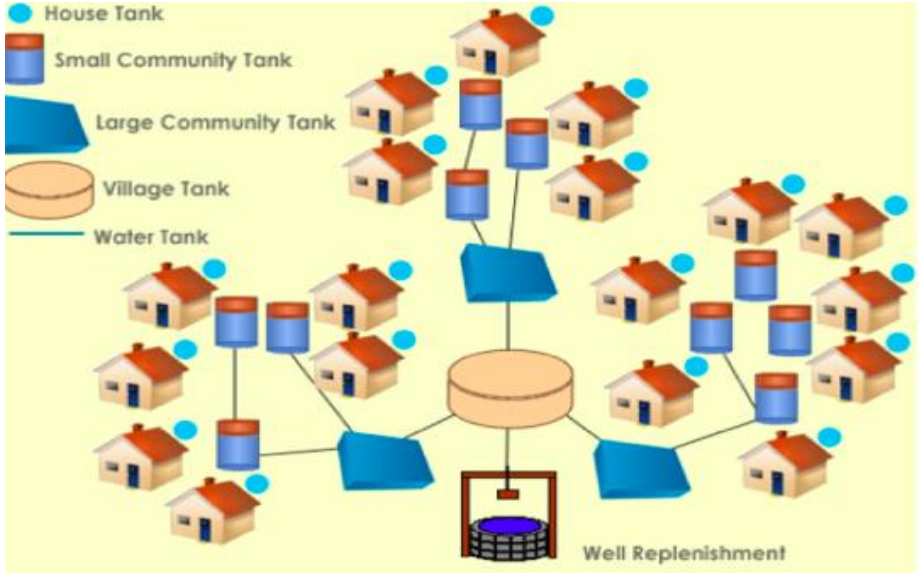
SMART USER OF WATER



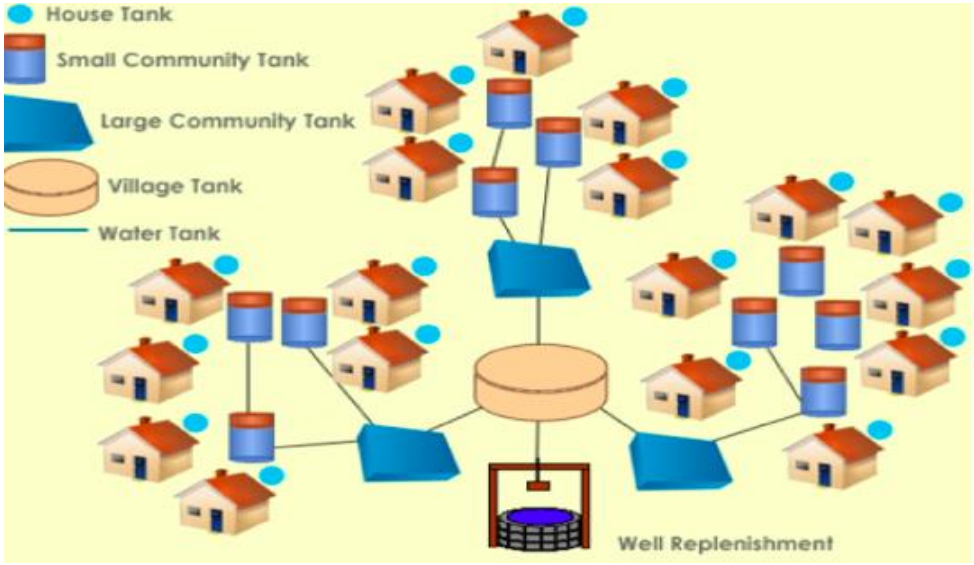
METERING AQUIFER

ENERGY EFFICINCY CAMPAIGN

Métodos de recolección del agua lluvia más utilizados

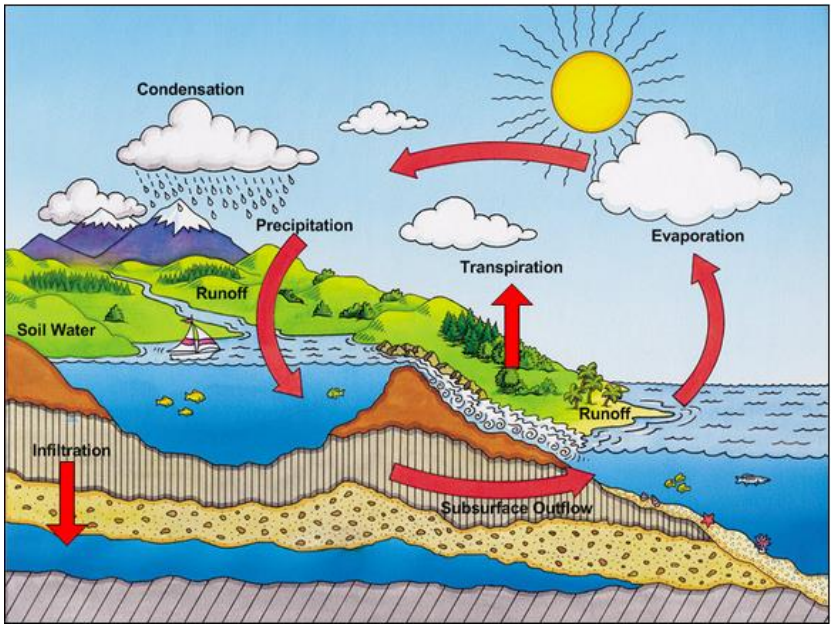


RAINCAUSER

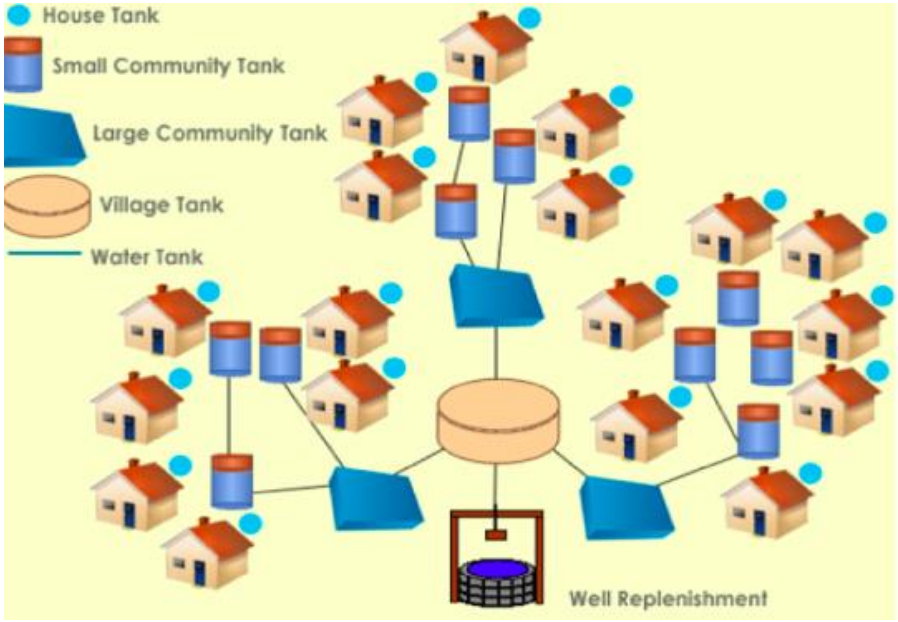


RIVER FROM THE SKY

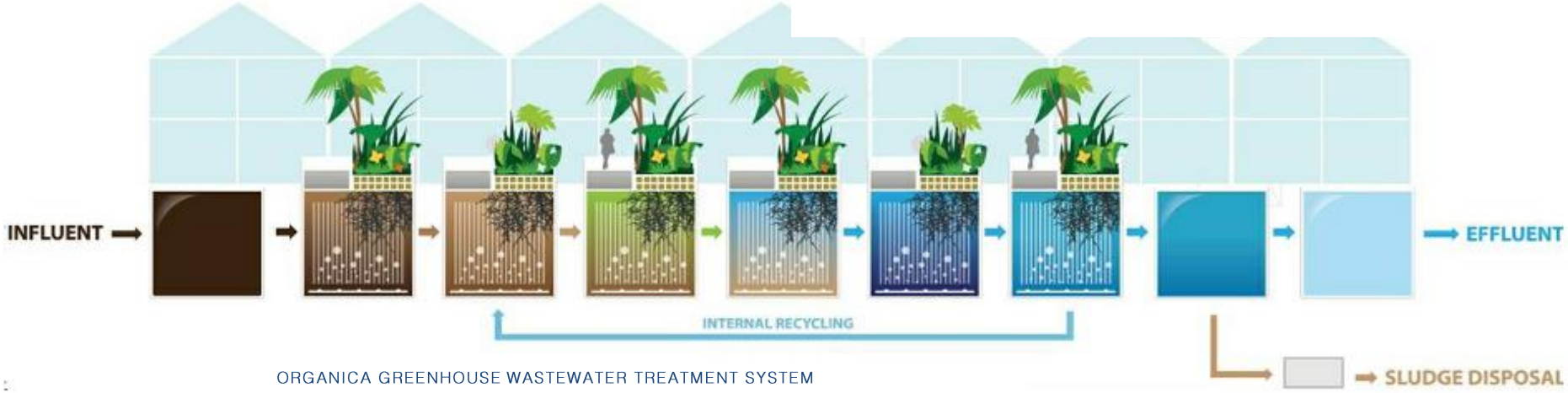
Sistema de reciclado más utilizado (Sistema del círculo cerrado)



CLOSED LOOP SYSTEM



GREY WATER CIRCUIT



ORGANICA GREENHOUSE WASTEWATER TREATMENT SYSTEM

Grupos

Sistemas del energías renovables (SER) más utilizados	**Efectividad en el uso del agua + Usos inteligentes**	**Métodos de recolección del agua lluvia más utilizados**	**Sistema del reciclado más utilizado (Sistema del círculo cerrado)**
Edward Jay (Future Consumer)	Juan Vasquez (sweet water)	Francisko Avella (Nacional University)	Nubia Rojas (Aqua works)
Elizabeth Young (Pro Activa)	Tomas Guerrero (Coralina)	William Bent (Conty water)	Wilson Arroyo (NIEL)
Ronald Pájaro (Servicios Publicos Gobierno)	Jose Fuentes (Decameron)	Alejandro Castilla (SALUD)	Leidis Barrios Ortega (Aguas de san andres)

1 Actividad “Diseño” (papel 1)

1. Tecnológico

Ejemplo: ¿Cuántos metros cuadrados se necesita de captación de aguas pluviales para cubrir toda la demanda en San Andrés? ¿Cómo se desarrollará la tecnología de captación de agua de lluvia?

2. Social

Ejemplo: ¿La recolección de aguas pluviales está al alcance de todos los habitantes de San Andrés? ¿Qué procesos de la comunidad tenemos que educar / desarrollar?

3. Institucional

Ejemplo: ¿Qué leyes y costumbres culturales necesitamos para crear un sistema de recolección de aguas pluviales viable para San Andrés?

2 Actividad “Barreras” (Papel 2)

1. **Barreras** Supongamos que la opción X se ha implementado en el año 2030, que obstáculos se han generado?
    a. Tecnológica
    b. Social
    c. Institucional

2. **Reto principal** (Cuál es el problema principal en la implementación?)

3. **Solución** (solucionar el mayor problema) ¿Qué, Cómo, Quién?

4. **Break**

5. **Presentación de grupos del diseño y barreras**

2da Actividad “Construir el camino” (papel 3)

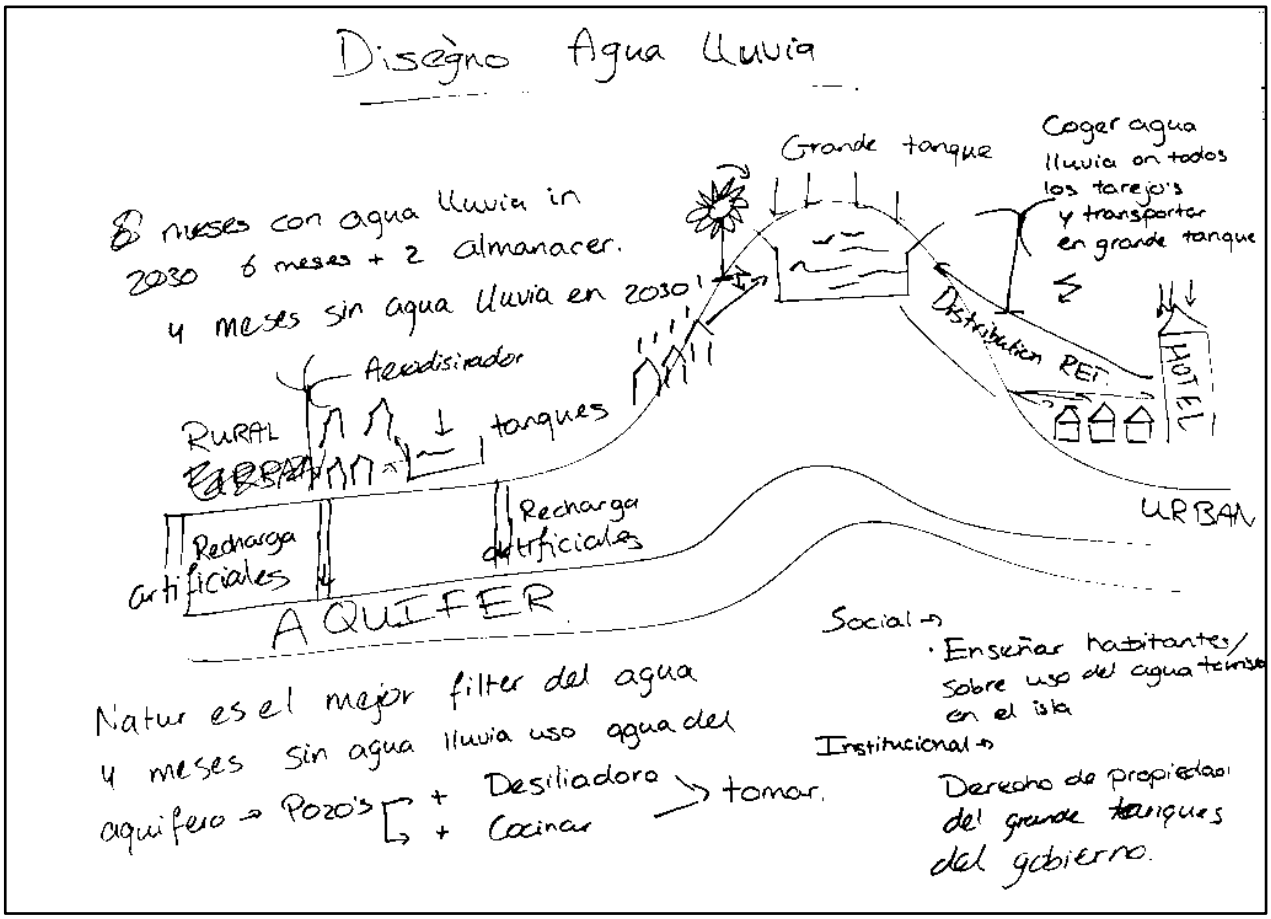
1. Los participantes deberán trazan la trayectoria de aplicación en una línea del tiempo, colocando las principales intervenciones relacionadas con las barreras en el tiempo.
    - 2015
    - 2020
    - 2025
    - 2030
2. Hitos tecnológicos, sociales e institucionales
3. Quién se opondría a este desarrollo?
4. Construir matriz de actores para la realización
5. **Presentación del grupos**
6. **Ronda para poner puntos cuando tú quieres participar en desarrollo del objetivo. 3 possibilidades para participar.**

Appendix VII Results Backcasting session

Rainwater harvesting"

The participants of the rainwater harvesting group came up with the following design depicted below.

The rainwater harvesting design focusses on the original form of water supply of the Island of San Andres. Till 1980 there was no desalination plant on the island and the inhabitants harvested rain water for drinking and sanitary purposes. This deep nested culture of rainwater harvesting explains that almost 95 % of the households in San Andres propriets a cistern of more than 3m3. The historic culture was the starting point of this design, which has to be adapted to the changing rain periods caused by Climate change and the El Nino phenomenon. The system identifies 2 areas in san Andres and starts with the explorative forecast that rain will cover 8 months of water demand, but that a back-up system provides water the 4 residuary months. During the rainy season in San Andres the rain is exhaustive and the participants asked the question: It is energy demanding to desalinate the sea water; Is it possible to store the exhaustive rain in the rain season in the aquifer, to later on harvest that same water and desalinate it in the dry season? The question to that answer was formulated by a participant who drew the superficial recharge of aquifers in the paper. The rainwater is in the rain season harvested and through solar and wind energy transported towards the great tank on top of the hill. The water is the n distributed through gravity towards the houses. The urban zone uses desalination processes in the dry season to fulfil the water demand. In the rural zone the process is decentralized and a number of aerodizilinador's function in the dry season to empower the water demand. The system provides continuous water supply for all inhabitants and therefore the users need to be educated in the use and effects of the utility. The big tank that is deployed on the top of the hill requires space and the houses that are built in this section are to be removed. The water utility company Pro Activa is the owner of the system

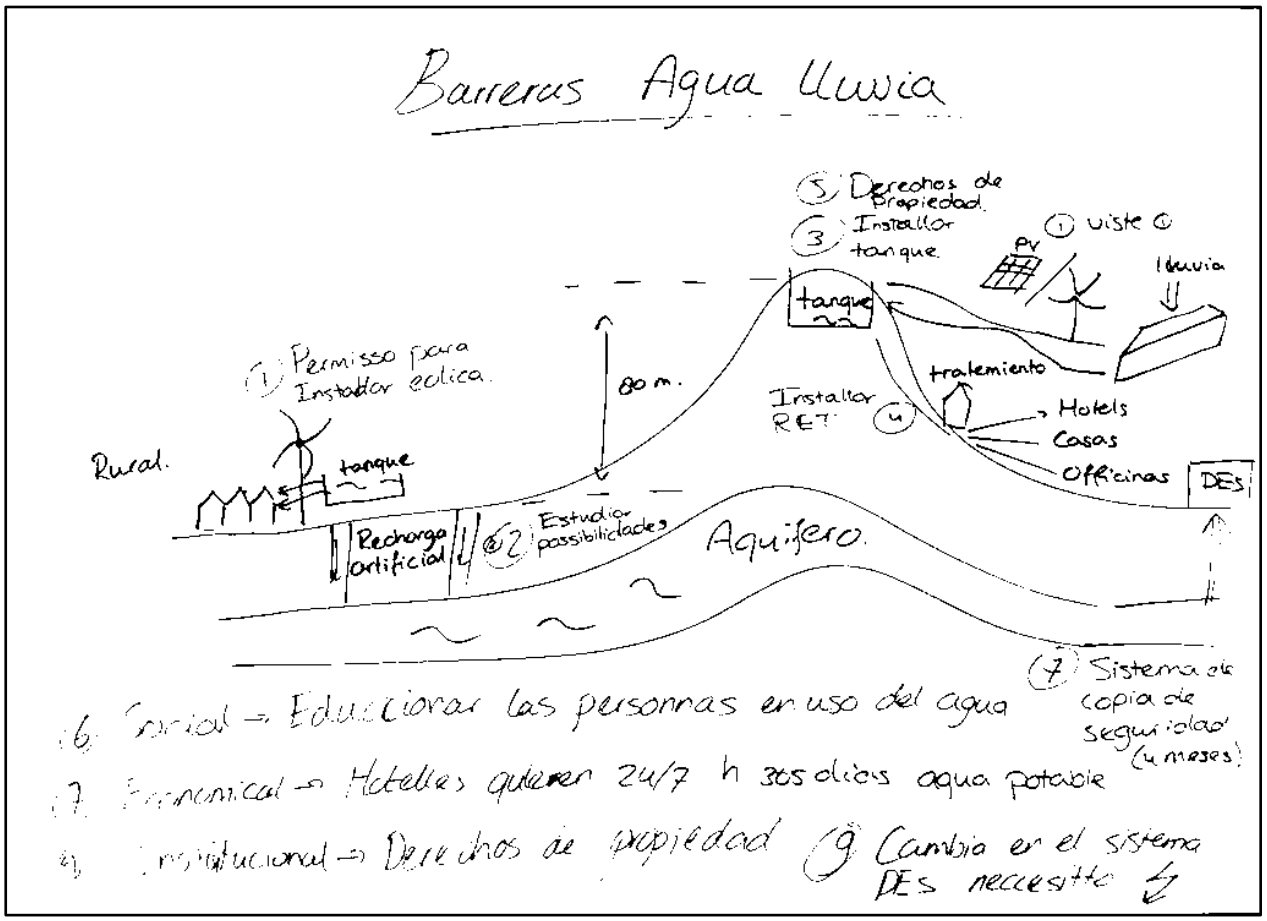


and demands a fair price for m3 water.

Secondly, the participants were asked to assess the desired situations in 2030 on possible barriers. The participants were asked to do so in a visual setting and created the following figure below.

The moderator demanded that the structure technological, economical and institutional was kept in place to organize the drawings. The rainwater harvesting group came up with the following barriers:

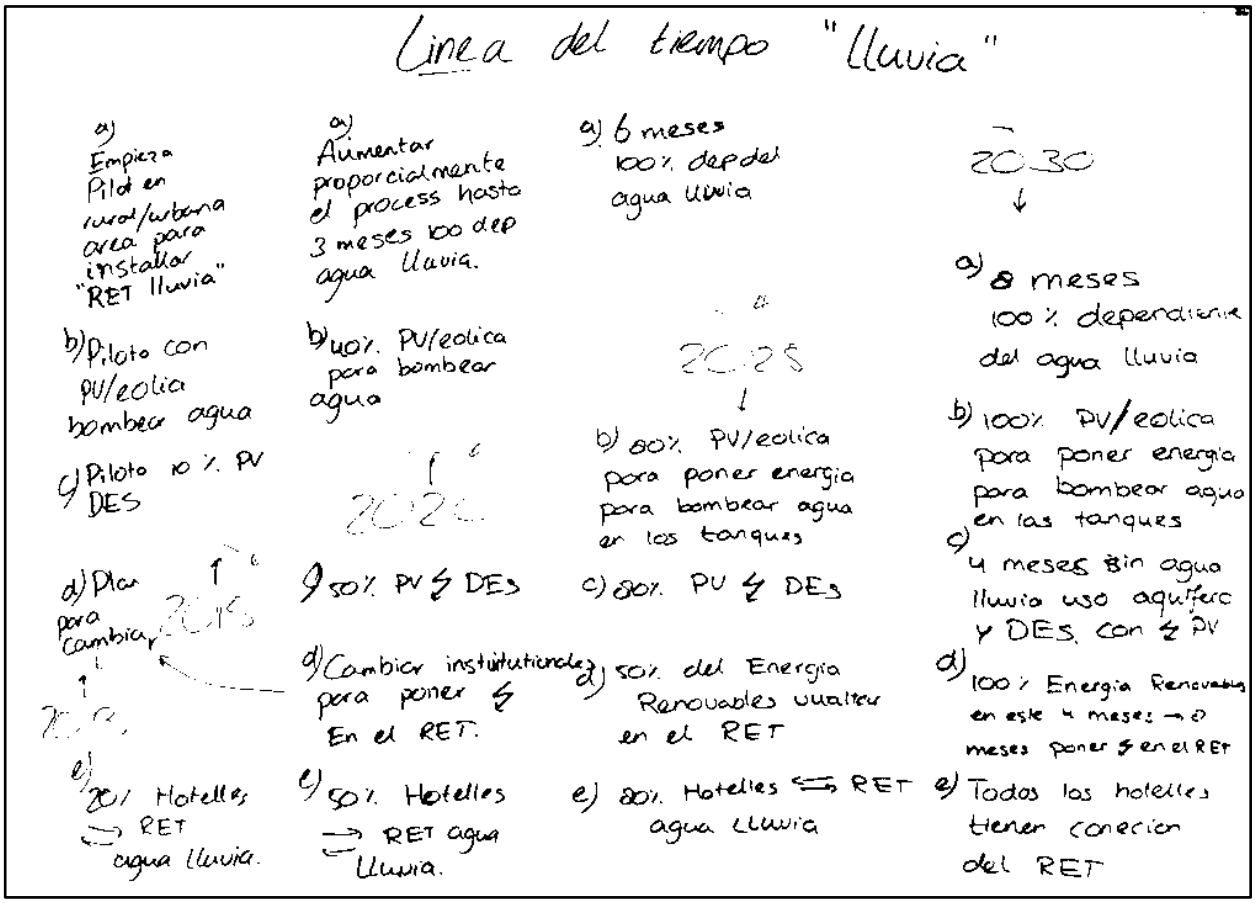
8. The environmental agency Coralina does not have any standards for the installation of windmills. Previous projects were stopped, because the permit to install windmills was not given. The lack of clear standards and the permitting trajectory are a barrier
9. The artificial recharge of the aquifer influences the natural aquifer. This natural resource has to be treated very carefully to safeguard it for further generations. Studies and pilots have to clear the effects of artificial storage of water. External knowledge has to be invited towards the island to provide an objective study towards the feasibility on a technological and economical scale.
10. In order to install the tank on the hill sufficient free space is required. To create this room for the tanks houses need to be expropriated and property rights redesigned, this process can be time consuming and result in public opposition.
11. The newly build water infrastructure that collects rainwater at the houses and transport it to the big tank and transport it back to the customer can be complex and expensive due to island economy and corruption.
12. To install the tank and the required infrastructure various property rights has



to change. This process can be time consuming and public opposition can emerge.

13. Inhabitants in San Andres are not use to continuous water supply. Instalment leads to overuse, spilling and huge utility bills for the inhabitants
14. The big hotel chains on the island produce their own water, because Pro Activa cannot guarantee the continuous water supply. The hotels have a great distrust in the ability of Pro Activa to provide and maintain this continuous supply.
15. Property right (is double) See barrier 2.

The actual backcasting process takes place in the 3rd step. Participants are asked to vision the desired state of the system in 2030 and reason backwards. Through this process the different barriers are placed into time perspective and tackled with a tailor made solution. The participants visualized the process till 2030 for the rainwater harvesting system as following: The reasoning of this group was to set thresholds from a governmental perspective and encourage market parties with bonuses to realize these thresholds. The following table is set up to clearly present these thresholds.



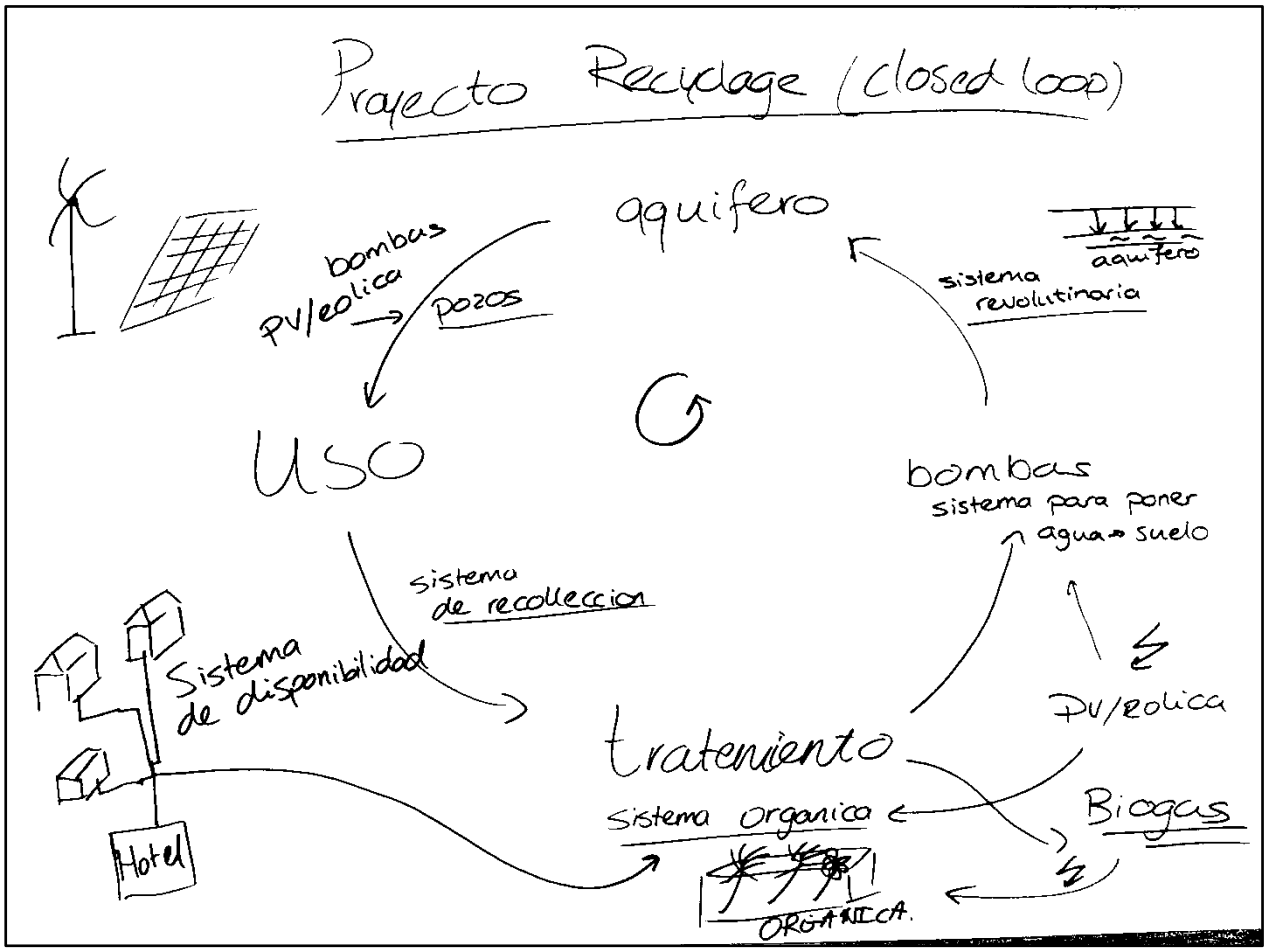
2015	2020	2025	2030
Start pilots to install the network of rain water distribution	Up scaling of pilots towards 3 months of rainwater harvesting	8 months 80 % dependent on rainwater harvesting	8 months 100 % dependent on rainwater harvesting
Pilots to install RES in the water pumping activity	50 % dependent on RES to provide energy for pumping activity	80 % dependent on RES to provide energy for pumping activity	100 % dependent on RES to provide energy for pumping activity
Study towards which RES is applicable to provide energy for desalination in dry period	50 % of energy required for desalination process is RES driven produced	80 % of energy required for desalination process is RES driven produced	100 % RES installed to power desalination process in dry period
Demand for change in putting energy into the grid	50 % of the renewables energy during wet months is put into the grid.	80 % of the renewables energy during wet months is put into the grid	100 % possible to put the RES energy the other 8 months into the RET
Pilots with hotels and rainwater harvesting.	50 % of the hotels Is connected to the water system	80 % of the hotels Is connected to the water system	All the hotels have a connection towards the water service

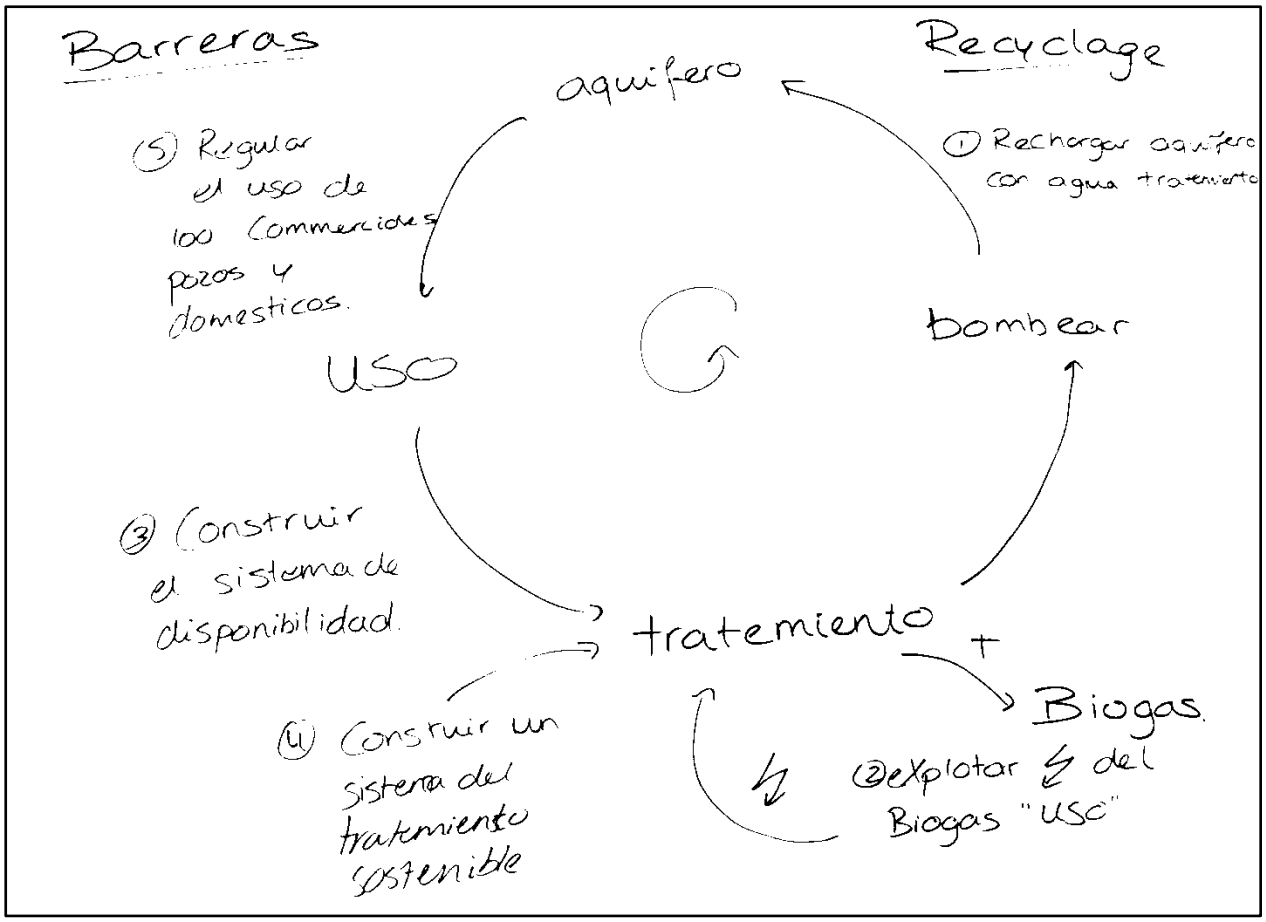
Recycling

The participants of the vision focused on recycling developed the following design, by keeping in mind that nothing is recycled nowadays in San Andres.

The high level design shows a closed loop system, where the natural eco system is used to lower the energy costs of cleaning of water. The water is taken out from the aquifer and pumped via renewables energy systems to the consumers. The houses of the consumers are connected with a disposal system that collects the wastewater and put it into a high tech cleaning facility that environmentally friendly treats the water and puts the water via a revolutionary system back into the aquifer. All the energy used is provided by the gasification of biogas and the rest is powered by solar panels or wind energy. The demand that the design and barriers was explicitly structured into technological, economical and institutional bullet points was not followed by this group. Instead of this requirement the group selected the recycling circle for the drawing and forgot about the 3 subjects that should have been designed.

In order to reach this design the participants were asked to draw up barriers that could be in the line in reaching the foreseen design that was visualized in the design assignment:





The identified barriers are divided into the same drawing structure as the design. There are five barriers identified:

6. Artificial recharge of aquifer. There is no knowledge on the island to create this process.
7. Extraction and use of biogas to produce energy on the island
8. Construction of the sewage system
9. Construction of the net zero energy treatment installation. In Colombia such a thing does not exist
10. Regulation of the 5000 domestic wells in order to be able to control the level of the aquifer

The proposed timeline to tackle these barriers is shown in the next picture.

The picture shows the backcasting strategy of the group in 5 demanded steps. To translate and schematize the variables the process is shown in table 11.

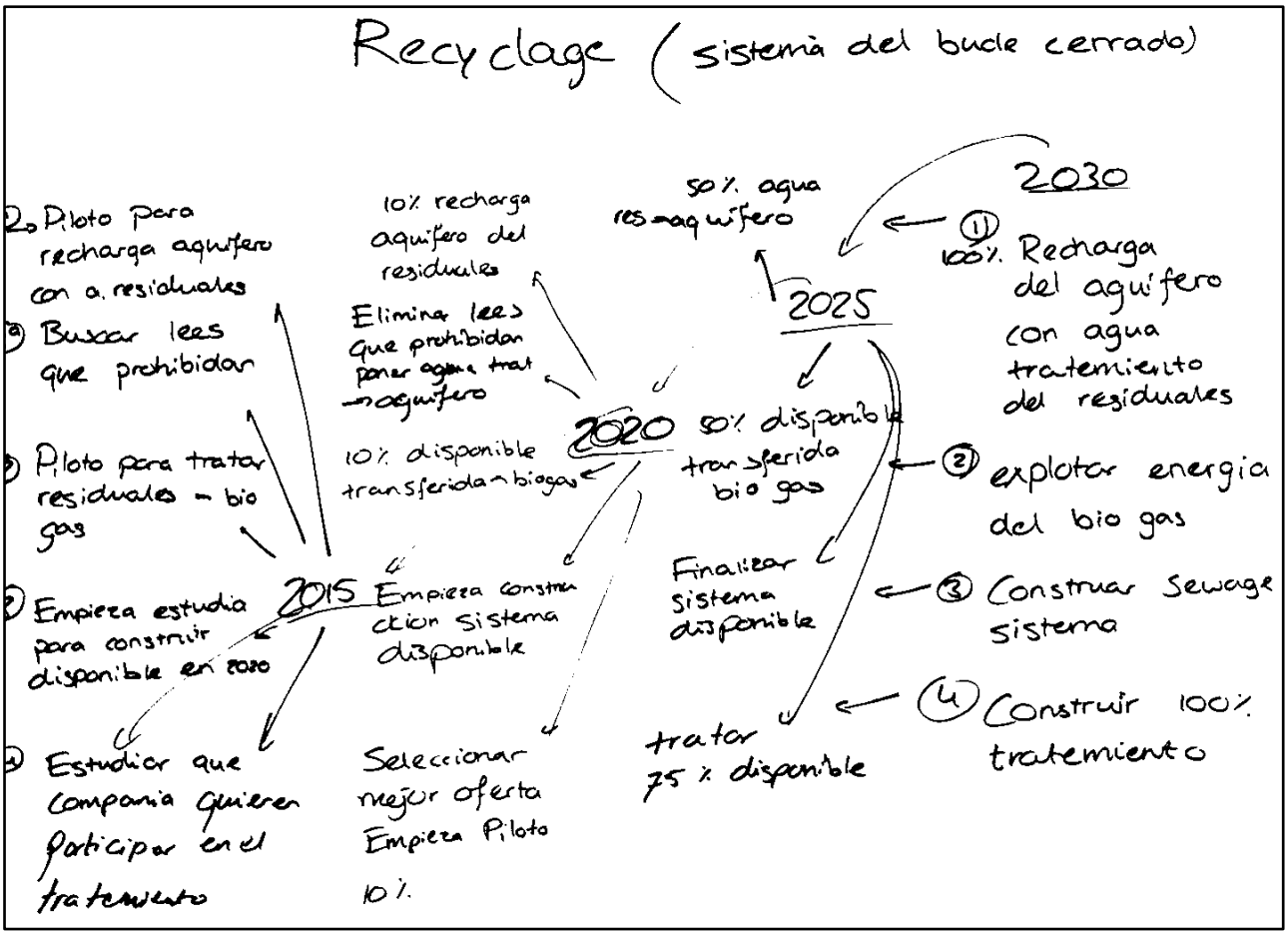
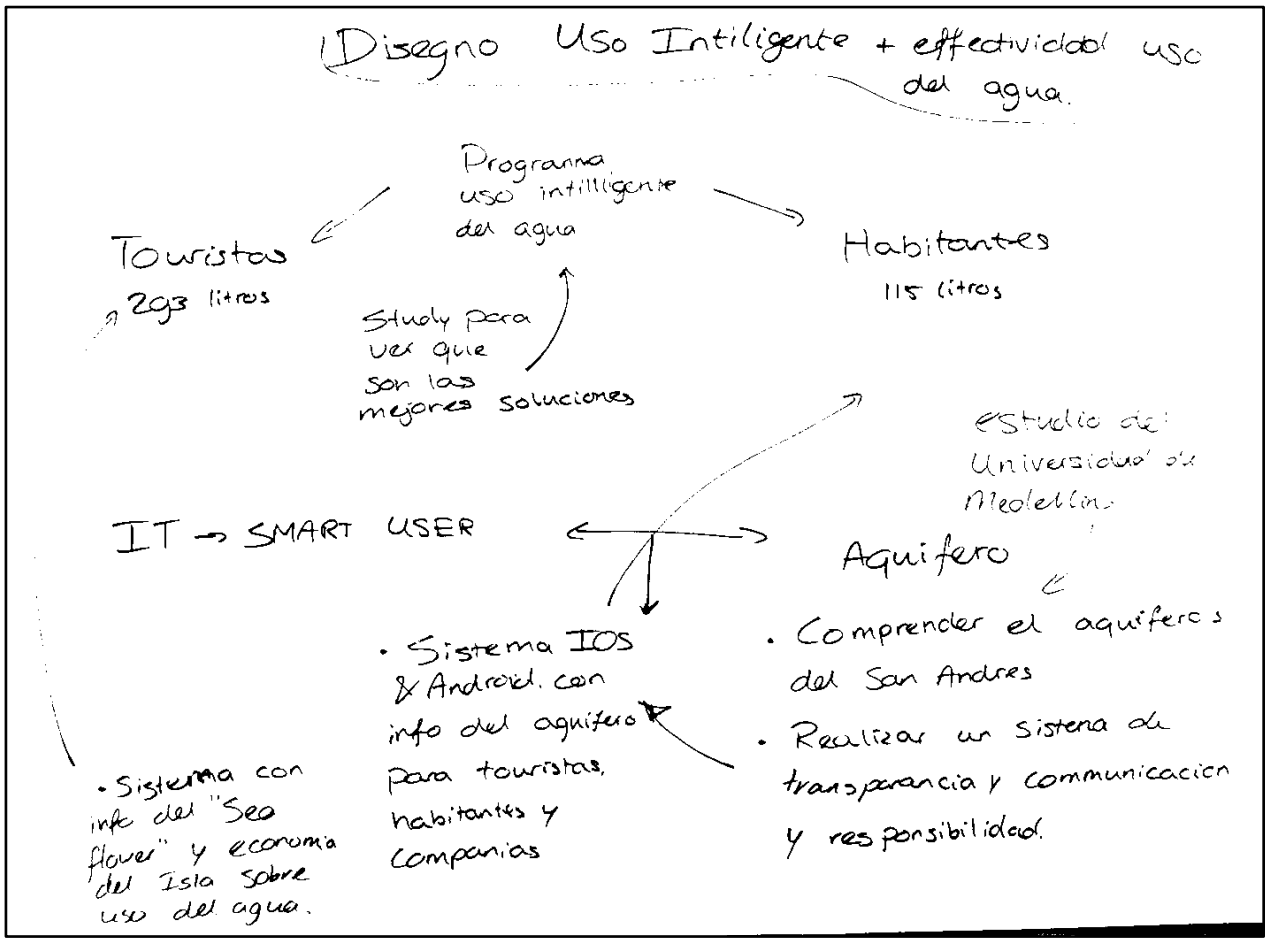


TABLE 11

2015	2020	2025	2030
Study towards artificial recharge aquifer	Institutions ready for implementing artificial recharge of aquifer	50 % of waste water putted into the aquifer.	100 % recharge of the aquifer with treated waste water
Search the laws that prohibit artificial recharge of aquifer	Eliminate laws that prohibit recharge of aquifer, be institutionally ready	50 % of waste water putted into the aquifer.	100 % recharge of the aquifer with treated waste water
Start studies and experiment with pilots towards feasibility biogas exploitation	Finalize institutional framework and have 10 % of the biogas turned into energy	50 % of the biogas turned into energy	Exploit all the biogas and turn into energy for the treatment process.
Start construction sewage system	40 % of households connected to the system	Finalize sewage construction	Maximize connections towards sewage system.
Study towards the possibilities of treatment systems	Implement 3 pilots of treatment system and choose the best one	Install best system	Power 100 % the treatment system with biogas + solar/wind power

Smart use(r)

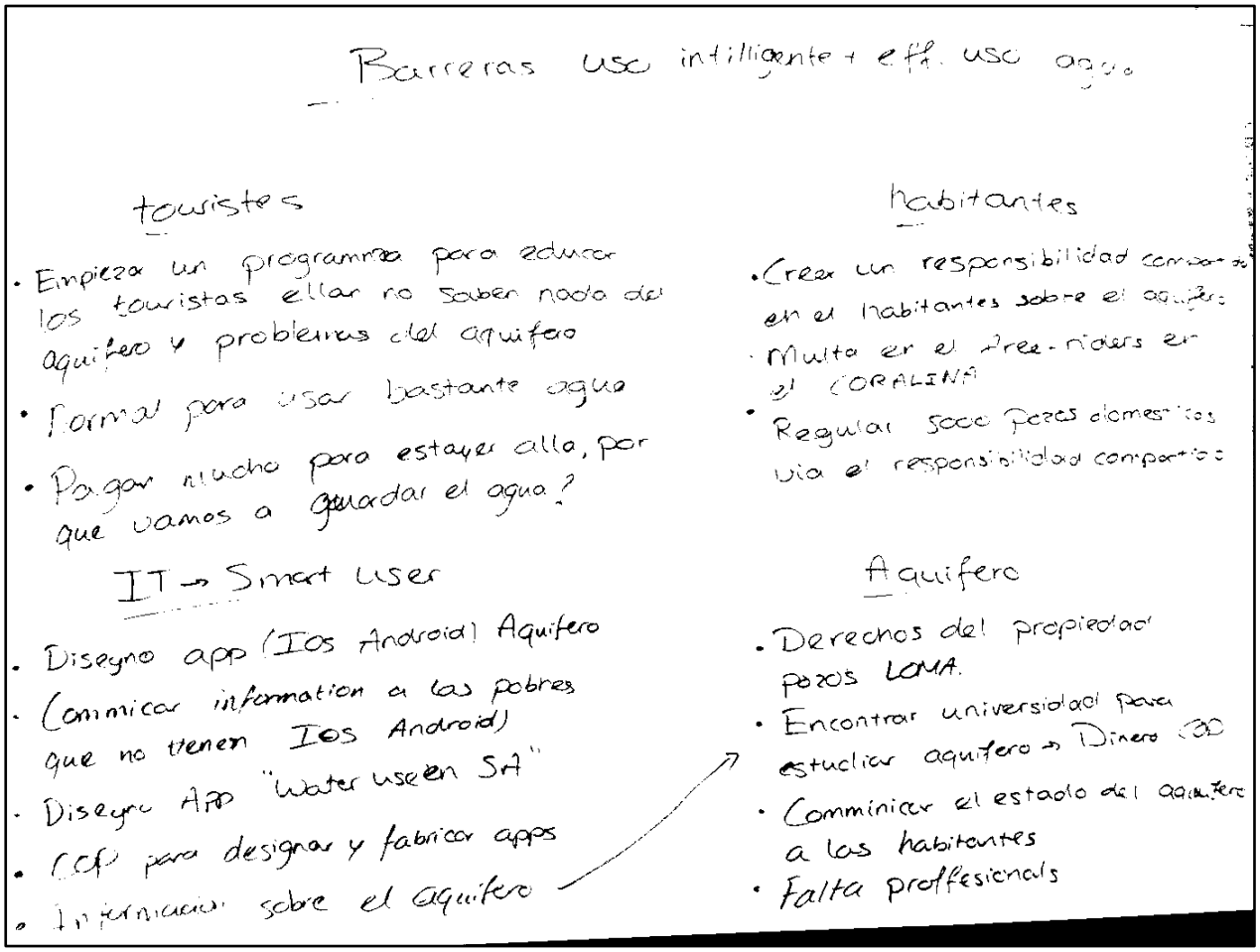
The enlarged water demand causes unsustainable harvesting of natural resources on the island of San Andres. The smart use(r) design focusses therefore to use water in a smart and efficient way. Therefore, the focus of this vision is on influencing behaviour. The design is split into two sub designs. The first subpart stresses the knowledge of the environmental agency and water harvesting companies of the aquifer. The group stated that “as long as we do not know how the aquifer works and react, we do not know how much water we can extract on a sustainable way”. Therefore a study was already recommended in the design to intellectually gain more knowledge on the way the ecosystem of the aquifer works. Furthermore, the knowledge gained is shared with the whole population of San Andres to create a shared understanding that leads to a shared responsibility. This system should be easily accessible from mobile devices such as iPhones and android phones. This is designed to cope with the disability to regulate the 5000 domestic wells that were dug in the Island of San Andres. The other part of the design stresses the recalibration of the use of water by tourist and inhabitants. Inhabitants use 115 litre water per day and tourist use the amount of 293 litres water per day. To minimize the water usage the people needs to be educated in the use of utilities in an island environment. The design opposes a study towards the way to maximize the effect of regulation and measures to minimize water use.



Changing behaviour- and in particular motivating more “sustainable” behaviour- is far from straightforward. When performing such a research it is imperative to take on a multidisciplinary approach that is required. The group was explicitly demanded to take the following line of reasoning with regard to (1) Technological, (2) Social and institutional barriers.

The participants did not understand or the communication was not clear enough about the requirements but the drawing resulted in the following barriers:

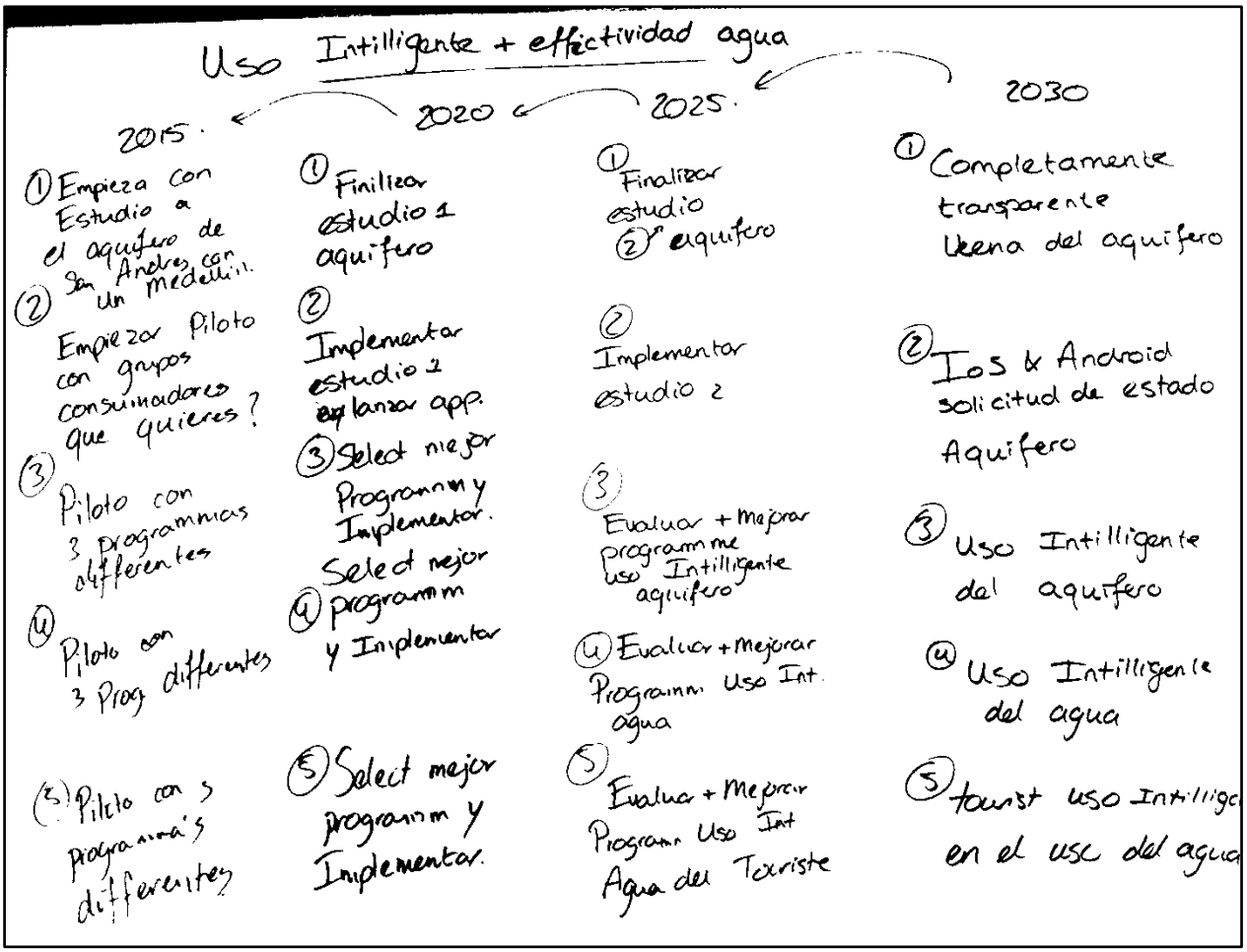
8. The behavioural change in water usage can be problematic. It is settled deep into the cultural habits of the inhabitants to use the water.
9. Tourists pay a lot for the stay in San Andres. The majority of the hotels in San Andres is set up as all inclusive resort, so the tourists demand a full service. Questions like, why should I save water can be expected from the tourists.
10. The 5000 domestic wells cannot be regulated from a Coralina perspective. Due to poverty the social control is limited. The poor neighbourhoods are socially isolated and neighbours cover each other if authorities come in to check or regulate.
11. The money to study the situation of the aquifer has to be drawn from Bogota. This is time consuming process and full of corruption barriers. The aquifer is a complex system and uncertainty will withheld.
12. The software tool that has to be



developed to share the information under the inhabitants needs to be accepted by them. Not all inhabitants have the access to computers.

13. The property rights in the hill block the metering of the San Andres aquifer.
14. All knowledge have to be flew in. no professionals are present on the island that can study the aquifer.

To emerge solutions for the identified barriers, the participants created the following drawing that backcasts from the desired situation in 2030.



From the seven identified barriers the timeline to the desired situation handles five barriers. These are translated and displayed in the table:

2015	2020	2025	2030
Search for partners to study behaviour aquifer and set up project plan	Finalize study part 1 towards aquifer	Finalize study part 2 towards aquifer	Complete transparent behaviour of aquifer
Start plan about user requirements for desired system	Implement 1st results study behaviour aquifer	Implement results of 2nd part study aquifer	IoS and Android possible to check status aquifer
Start 3 pilots for intelligent use of aquifer based on other countries experiences	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart use of aquifer
Pilots with 3 selected programmes based on experiences of other island nations	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart user of water by inhabitants
Start 3 different pilots with tourist groups to use water efficient	Select best programme en start implementing results study	Evaluate and implement results of evaluation	Smart use of water by tourists

Appendix VIII spread sheet "assessment of strategic objectives towards fundamental objective

			Minimize en	Maximize	Minimize	Maximize	Create a r	Create co	Maximize	Create sat	Realize m	Establish r	Sustainab	Realize affordable potable wate	
sustainabaility principle		values	1	2	3	4	5	6	7	8	9	10	11	12	Score
backcasting	Value focused thinking		0	0	0	0	0	0	0	0	0	0	0	0	
			2	2	2	2	2	2	2	2	2	2	2	2	
Rainwater harvesting	strategic objectives		4	4	4	4	4	4	4	4	4	4	4	4	
8 months 100 per cent dependent on rainwater harvesting	Maximize rainwater harvesting in wet periods		4	0	0	4	0	0	0	0	0	0	3	4	2,409230769
100 per cent dependent on RES to provide energy for pumping activity	Maximize RES in pumping activity		4	0	0	4	0	0	0	0	0	0	0	0	1,707948718
100 per cent possible to put the RES energy the other 8 months into the RET	Maximize flexibility applicability RES in wet periods		4	4	0	4	0	0	0	0	0	0	0	3	2,175897436
Recycling															
Exploit all the biogas and turn into energy for the treatment process.	Maximize utilization biosgas		4	3	0	4	0	0	0	0	0	0	0	2	2,068205128
Power 100 percent the treatment system with biogas + solar/wind power	Maximize RES installed at treatment system		3	1	0	4	0	0	0	2	0	0	0	3	1,952820513
Smart use(r)															
Complete transparent behaviour of aquifer	Maximize knowledge of aquifer behaviour		4	3	0	0	0	4	3	0	4	0	4	0	1,515
IoS and Android possible to check status aquifer	Maximize accesibility knowledge aquifer		0	0	3	0	2	0	4	0	4	0	3	2	1,147692308
Smart use of aquifer	Maximize use of natural capacity of aquifer		4	4	4	4	4	0	3	3	4	0	4	3	2,552051282
Smart user of water by inhabitants	Maximize consciousness about water use at inhabitants		3	2	4	0	0	0	4	0	0	0	4	4	1,914871795
Smart use of water by tourists	Maximize consciousness about water use at tourists		3	2	4	0	0	0	4	0	0	0	4	4	1,581538462
RES systems															
Maximize external investment in water system	Maximize external investment in water system		0	0	4	4	3	0	0	4	1	0	0	3	1,148205128
Full use of possibilities aerodizilinadors	Maximize use of aerodesalinizadors		3	0	0	4	0	0	0	2	0	0	0	4	2,104102564
Full use of possibilities artificial recharge	Maximize artificial recharge aqfuier		1	4	0	2	0	0	0	4	0	0	4	4	2,313589744
Create robust distribution system	Maximize robustness distribution system		3	1	4	0	4	4	0	2	0	0	0	4	1,602820513
Realize well equipped and educated persons to install and maintain Renewables energy systems	Maximize availability of educated work personell to install and maintain RES		0	0	0	4	0	0	0	4	0	0	4	4	2,004102564
Maximize renewables energy installed in desalination process.	Maximize renewables energy installed in desalination process.		0	0	0	4	0	0	0	4	0	0	0	4	1,620769231
		weights	0,14615385	0,092308	0,046154	0,150577	0,074615	0,1	0,084423	0,106731	0,076923	0,002885	0,05	0,0692308	

Appendix VIII entire process survey

Survey backcasting workshop “Towards a sustainable water management for San Andres in 2030”

Open questions:

1. What did you think about the interviews?
2. What was your general opinion about the workshop day?

Questions with Likert scale score where the following scores are displayed under each question; 1 (none) , 2 (low) ,3 (medium), 4 (high), 5 excellent

1. What do you think was the added value of workshop day in general?
2. To what extend did the backcasting workshop generate normative options for the future and analysing these on their environmental improvement, opportunities, and other consequences
3. To what extend did the backcasting workshop succeeded in putting attractive future visions or normative scenarios on the agenda of relevant societal and political arenas?
4. To what extend did the backcasting workshop emerged A follow-up agenda containing activities for different groups of stakeholders contributing to bringing about the desirable future?
5. To what extend did the workshop contribute towards stakeholder awareness and learning with respect to the options, the consequences, and the opinions of other stakeholders?
6. To what extend did the research generated stakeholder support and commitment with respect to vision, designs, analysis, and commitment to the follow-up agenda

Last question: Any other comments?

Appendix IX“Full plan for san andres

Maximize use of natural capacity aquifer (2.6)

The most valued and important value of the participants is to maximize the use of the natural capacity of the aquifer. The natural filter is the most efficient as storage capacity for rainwater harvesting and the most efficient desalination filter. The backcasting session provided the following means towards the strategic objective (table 12)

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Smart use of aquifer	Strategic objective	Maximize the use of the natural capacity of the aquifer
Trajectory backcasting	Evaluate and implement results of evaluation	Means objectives	--
	Start 3 pilots for intelligent use of aquifer based on other countries experiences		Maximize information and knowledge on aquifer behaviour
	Select best programme en start implementing results study		Maximize chance on success by selecting best programme.

MAXIMIZE USE OF NATURAL CAPACITY AQUIFER

The use of the natural capacity of the aquifer demands perfect information about the natural behaviour and capacity of this resource. The basis for this information is available within CORALINA, but exact modelling and precise forecasts lack. Different studies in different rounds need to be extracted in order to enable this information stream. Firstly, CORALINA has to search a capable team or organisation that creates a dynamic model of the aquifer and is able to perform forecasts up to a reasonable failure error. The search for state of the art technology or modelling skills all around the world and tender is executed by the environmental agency that tenders the package towards the most applicable partner. The strategic objective “maximize artificial recharge” and “Maximize knowledge about aquifer” are straight coupled towards this objective and therefore treated in the same paragraph to get an overall policy recommendation. The strategic objective “Maximize knowledge about aquifer” is a means

objective in above stated elaboration. In another session it was stated as strategic objective with valued importance factor of 1.6 one of the top 10 important values. The strategic objective is back casted into means objectives in table 13. These means objectives are elaborated upon under the table with an advice for implementation and possible coalitions that are derived from the individual value assessment.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Complete transparent behaviour of aquifer	strategic objective	Maximize knowledge of aquifer
Trajectory backcasting	Finalize study part 2 towards aquifer	Means objectives	Maximize knowledge of aquifer
	Finalize study part 1 towards aquifer		Maximize knowledge of aquifer
	Search for partners to study behaviour aquifer and set up project plan		Maximize actor support for realization aquifer transparency project

MEANS OBJECTIVES AQUIFER

Especially the market parties (Sweet water, Pro Activa) coupled with CORALINA executives were interested in managing the aquifer more precisely through a dynamic metering tool that provides information about the exact status of the natural resource. The core value of the commercial parties “continuity“ is closely linked towards the status of the aquifer. Actual business models for bottled water production highly depend on a healthy aquifer. Coupled market resources and knowledge of CORALINA enable the studies towards a dynamic understanding of the aquifer. Possible opponents to generate a better understanding of the dynamic behaviour of the aquifer are not identified through the value elicitation. All involved parties support the strategic objective. CORALINA and the commercial water entities are considered frontrunners and have to take the lead in enabling the research.

maximize Rainwater harvesting in wet periods (2.3)

The historical way of harvesting water is deeply bedded into the habits and culture of the Islanders and therefore awarded the second place in important value towards a sustainable water management for San Andres. The support to maximize rainwater harvesting in dry periods is high through all the involved stakeholders. Therefore, the possibilities to maximize this sustainable resource are elaborated upon through presenting the means objectives. The means objectives are derived from the backcasting workshop as shown in paragraph 3.4.

MEANS OBJECTIVES RAINWATER HARVESTING

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Widespread adoption of rainwater harvesting	strategic objective	Maximize rainwater harvesting
Trajectory backcasting	Create artificial recharge aquifer	Means objectives	Maximize artificial recharge aquifer
	Scale up rainwater harvesting at households		Maximize storage capacity households
	Money incentives to store rainwater in communities		Maximize fiscal incentives for community storage

The identified means objective “maximize artificial recharge aquifer” is also a strategic objective on its own. This objective is therefore elaborated upon in table 15. The next mean is “Maximize storage capacity households”. Almost 95 % of the houses have storage capacity through a cistern. These small scale storages are not sufficient to cope with the longer dry periods and the capacity needs to be extended. This objective can be coupled towards the next one and merged into storage of water in communities. Large scale water storage enables cost efficient building of structures, but emerges regulation on the other hand. Native consumers with help from the local government could apply for Inter-American Development Bank (IADB) resources to evolve plans and community storage and decentralized distribution. Possible opponent is Pro Activa that values a large distribution network and this system would undermine their business model. Option to deal with this possible opponent is to engage Pro Activa in the business model through tariff structures and other regulations around community storage and supply.

Maximize artifical recharge aquifer (2.2)

Backcasting	Example	Value Focused Thinking	Example
Component of future vision	Create artificial recharge aquifer	strategic objective	Maximize artificial recharge
Trajectory backcasting	Create knowledge about the process of artificial recharge	Means objectives	Maximize knowledge artificial recharge aquifer
	Scale up artificial recharge		Maximize artificial recharge (in cubic meter) aquifer

MAXIMIZE ARTIFICIAL RECHARGE

The means objective of “scale up artificial recharge” was awarded the 3th highest score in the supported importance table. The backcasting of this variable is not detailed. The thesis stresses the development of the framework and therefore the analyst does not intervene in this situation. The findings will be taken into account in the discussion in chapter X). Clear goal of the participants is that the knowledge of artificial recharge needs to be explored. This can be done by mapping existing projects in the world that are currently executing artificial recharge and selecting the most promising design. This design needs to be evaluated towards applicability in close cooperation with the research group that created a dynamic model of the aquifer in San Andres. If the artificial recharge is applicable, pilot projects could be executed and after evaluation scaled up towards maximum amounts given certain restraints adapted from the modeller. The organisations that highly value this objective are the market parties that bottle water and the commercial consumers. Possible opponents can be found in CORALINA, native consumers and government as the procedure can destroy or change the natural biosphere of the island. Therefore, commercial parties need to team up and create a lobby to convince the possible opponents.

Maximize flexibilty renewables energy systems in wet periods (2.1)

This strategic objective is the derivative of the Renewables energy groups finding that desalination is efficient during the dry season. The capacity of renewables installed is unutilized during the wet season that endures 4 months. The participants back casted this opportunity as follows:

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	100 % possible to put the RES energy the other 8 months into the RET	strategic objective	Maximize flexibility RES in wet periods
Trajectory backcasting	Demand for change in putting energy into the grid	Means objectives	Maximize legal potential for feed electricity into grid
	50 % of the renewables energy during wet months is put into the grid.		Maximize KwH feed in to the grid during wet period
	80 % of the renewables energy during wet months is put into the grid		Maximize KwH feed in to the grid during wet period

MAXIMIZE FLEXIBILITY RES IN WET PERIODS

The participants identified a legal barrier to feed electricity into the grid in periods were the desalination plants are not 100 % demanding the total energy capacity of the renewables installed. Therefore a procedure should be initiated that emerges the legal framework that enables the feed in of electricity into the San Andres's grid. There are numerous technical barriers on that road, but participants focused and nominated the legal barrier. The government together with the electricity company contractor EEDAS can play a role in a lobby towards the National government to emerge this legal transition. The other means objectives are more of a roadmap perspective to scale up the possibility for feed in of electricity into the grid and can be seen as future objectives for the company that exploit the RES system.

Maximize use of aerodizilinadors (2.1)

The aerodizilinador is a mechanic driven desalination device, which harvest the energy needed for the process from the sun. It was tested in the northern desert of Colombia en the participants rewarded the device several times with a location in the designs. The aerodizilinador was considered interesting for the more remote locations on San Andres. Almost all of the inhabitants live close to the water so the device can be located all around the island to provide fresh water to inhabitants. The Aerodizilinador harvests water from the ocean and therefore relieves the pressure of the water demand on the aquifer. The participants visioned the following process:

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Full use of possibilities aerodesalinizadors	strategic objective	Maximize use of aerodizilinador
Trajectory backcasting	Start process with CORALINA in order to permit aerodesalinizadors Finish study and start pilot with aerodesalinizadors Evaluate pilot and scale up production water trough wind	Means objectives	Maximize transparency in legal procedures for windmills Maximize availability data on applicability aerodizilinador Maximize amount of aerodizilinador on San Andres

MAXIMIZE USE OF AERODIZILINADOR

The first means objective is identified in the unclear and not transparent legal procedure that the government of san Andres dictates for the permitting process of wind turbines. Coralina has the legislative power over the installation of wind turbines, but decision making around the permits for wind turbines is surrounded by vagueness and unclear procedures. Coralina plays a central role in defining transparent permitting procedures with clear thresholds. This can be executed in close cooperation with the electricity contractor: La empresa de Energía de Archipiélago de San Andrés (EEDAS). EEDAS is looking for an opportunity to invest 70000 dollars into a social project around water supply in a remote area in San Andres. This market party could be an excellent opportunity for Coralina to provide feedback on the procedures and improve them.

The second means objective is found in collecting data and experiences with the aerodizilinador in order to evaluate the applicability of the device towards other locations on the island. If the second means objective validates the applicability of the aerodizilinador, the third means objective is to scale up the production towards maximum feasible amount of aerodizilinadors .

Maximize use of biogas (2.1)

The direct disposal of waste water into the sea generates a negative externality. This problem be solved by adding a plant that treats the water before it flushes into the sea. The participants identified that the required energy to exploit the plant can be harvested from the burning of the rest product biogas. This biogas needs to be extracted from the waste and can be used either for empowering the treatment plant or compressed for mobility purposes. The pathway towards this strategic objective is structured as follows:

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Exploit all the biogas and turn into energy for the treatment process.	strategic objective	Maximize use of biogas
Trajectory backcasting	Start studies and experiment with pilots towards feasibility biogas exploitation	Means objectives	Maximize theoretical and empirical knowledge about biogas
	Finalize institutional framework and have 10 % of the biogas turned into energy		Minimize legal barriers for implementation of bio gas infrastructure
	50 % of the biogas turned into energy		--

MAXIMIZE USE OF BIOGAS

The recycling and waste treatment in San Andres is of a very low level. There is no experience with such processes. Therefore, the introduction of this technology faces a first mover problem. The total institutional framework needs to be installed. Next studies need to be extracted towards the applicability and feasibility of the bio gas harvesting and exploitation. A combination of the Universidad Nacional with market parties with empirical knowledge on the exploitation of biogas could fill the knowledge gap. The institutional framework needs to be generated by Coralina and the local government.

Maximize availability of educated work personnel to install and maintain Renewables Energy Systems (1.9)

The participants identified an upcoming need in the installation and maintenance of the renewables energy systems. Nowadays a good mechanic is hard to find in San Andres and the professionals are flown in from Bogota to do the difficult operations. To change this situation and possibly emerge an export product from San Andres the participants generated the following scheme:

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Realize well equipped and educated persons to install and maintain Renewables energy systems	strategic objective	Maximize availability of educated work personnel to install and maintain renewables energy systems
Trajectory backcasting	Create education for 5 persons towards installing and maintenance of renewable energy systems	Means objectives	Minimize time towards educated personnel to install and maintain renewables energy systems
	Finalize education and evaluate market		Maximize knowledge about market demands in San Andres
	Create an education system that fulfils market demand towards educated personnel for Caribbean area.		Maximize export of skilled personnel from San Andres towards the Caribbean.

MAXIMIZE AVAILABILITY OF EDUCATED WORK PERSONNEL TO INSTALL AND MAINTAIN RENEWABLES ENERGY SYSTEMS

The first identified means objective is to minimize the time towards the availability of personnel that is equipped to install and maintain renewables energy systems. The company EEDAS is building a zero energy office, that harvest all the energy needed through solar panels. This demonstration project is well structured in finance and technology perspective, but qualified engineers to install the panels are flown in from Bogota and this enlarges the costs for installation and maintenance. To minimize these costs and emerge a structural solution the participants proposed an education on the island that delivers local engineers that are able to install and maintain the renewables energy systems. The government of San Andres is interested to emerge such an institution together with EEDAS or the local electricity provider, to meet market demands and facilitate the transformation towards renewables energy systems. Secondly, the group identified a possibility to export the knowledge towards other Caribbean islands in close proximity. This would create employment awareness and knowledge on the island that pushes the transformation towards a sustainable water situation in 2030.

Maximize RES installed at treatment system (1.9)

Nowadays, the treatment of the waste water in San Andres does not exist. Waste water is flushed through a 19 meter submarined device. The strategic objective “Maximize utilization biogas “is part of this objective and all the outcomes of the earlier elaborated objective also fit in this scheme. The advantage is that there is no existing plant, so the new plant can be constructed with state of the art technology and empowered by sustainable energy.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Power 100 % the treatment system with biogas + solar/wind power	strategic objective	Maximize RES installed at treatment system
Trajectory backcasting	Study towards the possibilities of RES driven treatment systems	Means objectives	Maximize knowledge about RES driven treatment systems
	Implement 3 pilots of treatment system and choose the best one		Maximize empirical knowledge about various sorts of plants
	Install best RES system		---

MAXIMIZE RES INSTALLED AT TREATMENT SYSTEM

The participants chose for a knowledge driven exploration that is validated through piloting. First state of the art RES driven treatments plants are evaluated on applicability and feasibility in San Andres. This research is executed by the Universidad Nacional in close cooperation with Coralina and Pro Activa that provide data. The piloting phase is financed by Coralina and the actual service and business model can be executed through Pro Activa.

Maximize consciousness about water use at INHABITANTS (1.8)

A sustainable system can only become reality if all components transform in that direction. The consumers of water need to be educated and guided towards the end goal. Former research showed that the original inhabitants of san Andres are really experienced in dealing with scares water availability. However, if the population is served with continuous water, they start to overuse and abuse this resource. Therefore, the inhabitants need to be educated to fit in the new system.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Smart use of water by inhabitants	strategic objective	Maximize smart use of water by inhabitants
Trajectory backcasting	Pilots with 3 selected programmes based on experiences of other island nations	Means objectives	Maximize empirical knowledge about smart use of water programs
	Select best programme en start implementing results study		Maximize chance of smart use by implementing best system
	Evaluate and implement results of evaluation		--

MAXIMIZE SMART USE OF WATER BY INHABITANTS

Emerging behavioural change is far from straightforward. It takes long term vision to enforce this change. The participants generated the try and pick strategy. Three programs that excel elsewhere are adopted and put into practice in three different homogenous groups. These groups are monitored and the best practice for the island is derived out of the three pilots. The three promising procedures are slected by the Nacional University, where after the process is accompanied by Pro Activa. The implementation of the best practise is escorted by Pro Activa.

Maximize RES in pumping activity (1.7)

The whole process of pumping water accounts for 4 % of the total energy bill in San Andres. The municipal pumps take 3 % for their account and domestic pumps use the other 1 %. Investment in RES powered water pumps can decrease operational costs for the water system. The participants came with the following plan to bridge this gap.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	100 % dependent on RES to provide energy for pumping activity	strategic objective	Maximize RES driven pumping activity
Trajectory backcasting	Pilots to install RES in the water pumping activity	Means objectives	Maximize empirical knowledge about RES driven pump systems
	50 % dependent on RES to provide energy for pumping activity		Maximize amount of RES pumps in pumping activity
	80 % dependent on RES to provide energy for pumping activity		

MAXIMIZE RES DRIVEN PUMPING ACTIVITY

This strategic objective is back casted on an implementation scale. Goals are set by certain time limits by participants. First 3 pilots need to be selected that are installed on the municipal pumping stations. These are evaluated by Pro Activa in their applicability and feasibility. Pro Activa is the company that finances the process. Eventual cost cuts are beneficiary to Pro Activa.

Maximize renewables energy installed in desalination process. (1.6)

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Maximize renewables energy installed in desalination process.	strategic objective	Maximize renewables energy installed in desalination process.
Trajectory backcasting	Install pilot Elemental water makers towards desalination in dry months	Means objectives	Maximize empirical knowledge about system
	Evaluate pilot and research possibilities of scale up or decentralized production		Maximize scale of RES driven desalination
	Finalize process with Colombian government to change subsidies for electricity		Minimize legal barriers for RES driven desalination

MAXIMIZE RENEWABLES ENERGY INSTALLED IN DESALINATION PROCESS.

Innovation in the renewables driven desalination industry emerged state of the art technology that requires other preconditions that conventional systems. The elemental water maker is such a system. Participants included this innovation by rewarding a small scale commercial pilot project to this company. The company EEDAS is willing to invest in this pilot project and Coralina is involved to guide and accelerate the permitting process. Next, the pilot is evaluated with the regional government to index the possible capacity of the system and opportunities that are generated. The national law poses barriers to emerge a water supply system if the pipelines of the local water service system pass the location of the consumer. Therefore, the system is piloted in remote areas. To scale up the system a lobby is created from Coralina to remove these barriers towards large scale clean water production for San Andres.

Maximize robustness distribution system (1.6)

The San Andres water distribution system is clearly one of the core problems. Major leakages and poor maintenance and information streams make it hard to manage and/or improve. Pro Activa is the owner of the bad distribution system that was financed from state funds. The participants created the following scheme to improve the current situation and transform into a desired situation:

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Create robust distribution system	strategic objective	Maximize robustness of water distribution system
Trajectory backcasting	Start plan for restructure water distribution system, enable change of institutions , start building small scale pilot project	Means objectives	Maximize political support for new water distribution system
	Start building pilot project water infrastructure, reform Pro Activa towards new distribution		Maximize modularity of new water distribution system.
	Start measuring leeks and losses in the system locally		Maximize information flow from system regarding losses

MAXIMIZE ROBUSTNESS OF WATER DISTRIBUTION SYSTEM

Firstly, the old system needs to be thoroughly revised or completely removed. Political pressure and agenda building need to be encouraged in order to get the attention of the central government in Bogota to fund the complete new system. The construction of the same system would be a waste of money and therefore the modularity of the system needs to be maximized. Different parts need to work separately and need to be coupled and partly decoupled when leakages happen. The best entity to manage and lead this process is Pro Activa. This company feels the pain of the old system and knows all the failures that have been made. The last means objective is to maximize information from the distribution system. The old system is a black box. The water enters and the meters are connected to the houses, but internally nobody knows what happens. The new system should provide the utility company with up to date flow of water streams throughout the system to maximize management of the system.

Maximize consciousness about water use at tourists (1.4)

The tourist needs another approach then the inhabitants. Tourists consume up to 3 times more per month then inhabitants. Due to the all-inclusive hospitality culture in San Andres tourists feel that everything is free and don't mind nature. The needed behavioural change is difficult to attain. Given the time period of almost 20 years the research is able to comply with these behavioural changes.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Smart use of water by tourists	strategic objective	Maximize smart use of water by tourists
Trajectory backcasting	Pilots with 3 selected programmes based on experiences of other island nations	Means objectives	Maximize empirical knowledge about smart use of water programs
	Select best programme en start implementing results study		Maximize chance of smart use by implementing best system
	Evaluate and implement results of evaluation		--

MAXIMIZE SMART USE OF WATER BY TOURISTS

The participants of the backcasting came up with the study and pick strategy to transform the tourists into smart users in the system in 2030. Therefore, the University needs to maximize the theoretical knowledge about excellent programs elsewhere and implement 3 programs into pilots in different hotels. The thresholds and goals for the water use are defined by Coralina. The best system is then implemented with strong collaboration with hotel chains that have a great benefit in decreasing utility costs.

Maximize accesibility knowledge aquifer (1.2)

One of the major problems in managing the aquifer in San Andres are the 5000 private wells that are not regulated. The knowledge gained in the research towards the aquifer of San Andres is an opportunity to create a shared understanding about the actual state and behaviour of the aquifer. Inhabitants and hotel owners need to be educated in understanding the information flow, where after demand side management theory is applicable towards the participants.

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	IOS and Android possible to check status aquifer	strategic objective	Maximize accessibility knowledge aquifer
Trajectory backcasting	Start plan about user requirements for desired system	Means objectives	Maximize user friendliness of tool
	Implement 1st results study behaviour aquifer		Maximize ease of implementing information into tool
	Implement results of 2nd part study aquifer		---

MAXIMIZE ACCESSIBILITY KNOWLEDGE AQUIFER

The group identified the need of modern data streams towards inhabitants to inform them. The actual goal was to maximize the accessibility of information towards the different target groups. The generation of this data stream is only effective if users like to use this tool. Therefore, an interactive designer is hired by Coralina to build and structure this tool, which is pillared on the requirements of the consumers.

Maximize external investment in water system (1.2)

Backcasting	Outcome	Value Focused Thinking	Result
Component of future vision	Maximize external investment in water system	strategic objective	Maximize external investment in water system
Trajectory backcasting	Start with the participation of investors to finance plan	Means objectives	Maximize financial feasibility of water system
	1st invest round. Companies San Andres, IADB, other investors		Maximize external investment in 1st round water system
	2nd investment round		Maximize external investment in 2nd round water system

MAXIMIZE EXTERNAL INVESTMENT IN WATER SYSTEM

The standard model of public procurement emerged concern about the level of public debt and the inefficiency of executing projects. Private parties can solve this lack by complementing substantial financial, technical and operational tasks in the project. The participants recognized this need and therefore included possible investors in the start of the project. Investors are thoroughly experienced players in this field and can add skills to the table by identifying opportunities and risks and private money in the first and second investment round. The investment party can be included in the implementation workshop and the public service entity of the government is the best party to make the connection.

Appendix X survey on goals process

Question 1. What did you think about the interviews?

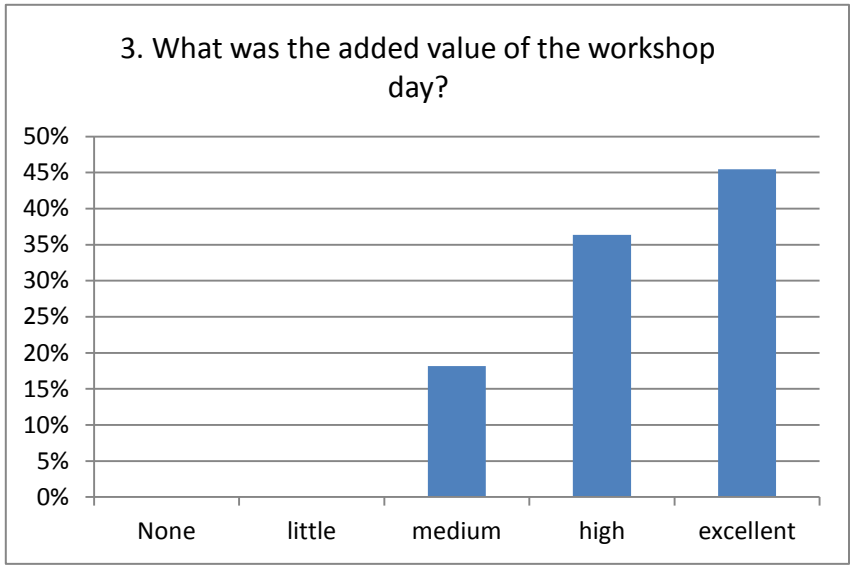
1. Excellent work, clear and oriented to the subject in question.
2. The interviews were very dynamic, in which each group presented their point of view, achieving the main objectives of the meeting. It is important to continue directing this topic for short-term results and progressing in stages. Since changes in government policies, it is important that the community and other government entities achieve compliance each stage of the project.
3. Fueron buenas, completas y bien enfocadas (They were good, complete and well focused)
4. Very to the point. Somehow very difficult to think strategically.
5. That it was just to fulfill a requirement as student.
6. They are a very important part of the planning stage, since they give fundamental demographic information for the project.
7. Solid
8. Took me a long time to understand the questions
9. Well scoped, but somehow badly organized
10. The interview opened my eyes towards the problems that we might have on our island
11. que son muy importantes para recopilar información de primera fuente (that are very important to gather first-hand information)

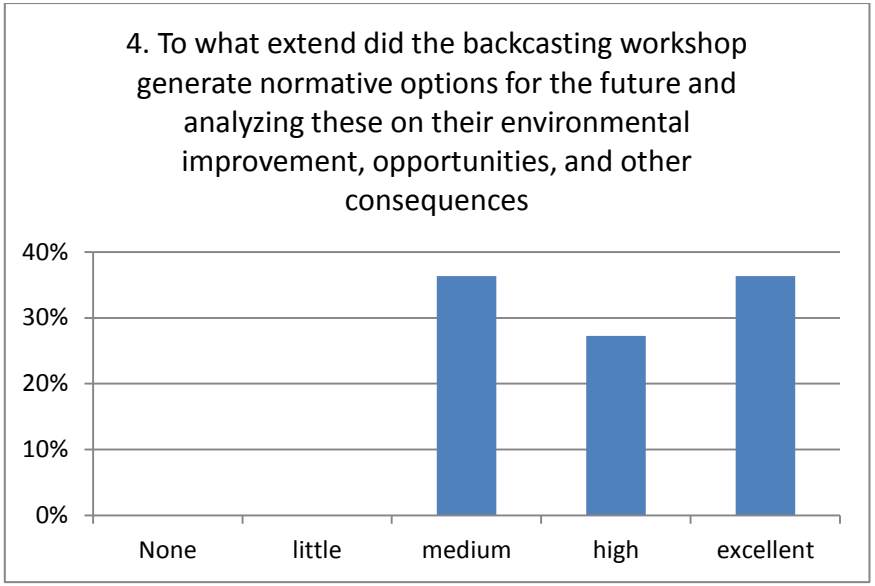
Question 2. What was your general opinion about the workshop day?

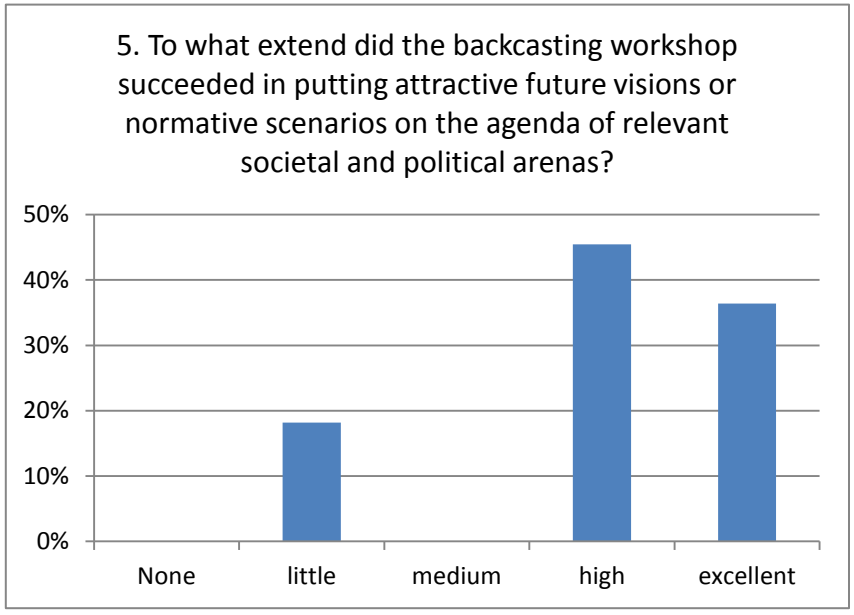
1. A great experience, the different actors bring different point of views, clearly opening a discussion space to find the right answer
2. There was a great effort to seek assistance from companies that are directly related to water processing on the island I have attended other meetings related to issues call for a new vision for the Islands and assistance is always very low. I believe that here were people participated and was a first step, which is to be conscious of water use and the way in which we can put a bit in such a complex issue
3. Que se plantearon buenas propuestas pero , pero debió ser más concreto (That raised good proposals but, but should have been more specific)
4. Very good, but too long. The last part i could not concentrate anymore
5. Appropriate, tune in with the today's problem of our island
6. Very interactive and sufficient information. Well executed.
7. well organized. bit cold
8. The workshop started great with a game we have never seen. Presentations were to the point, but the strategic thinking was kind of difficult for me
9. The workshop should be spread over 2 days, the one day was really to much information on one day!
10. The workshop worked really well in bringing people together that are facing the same problems

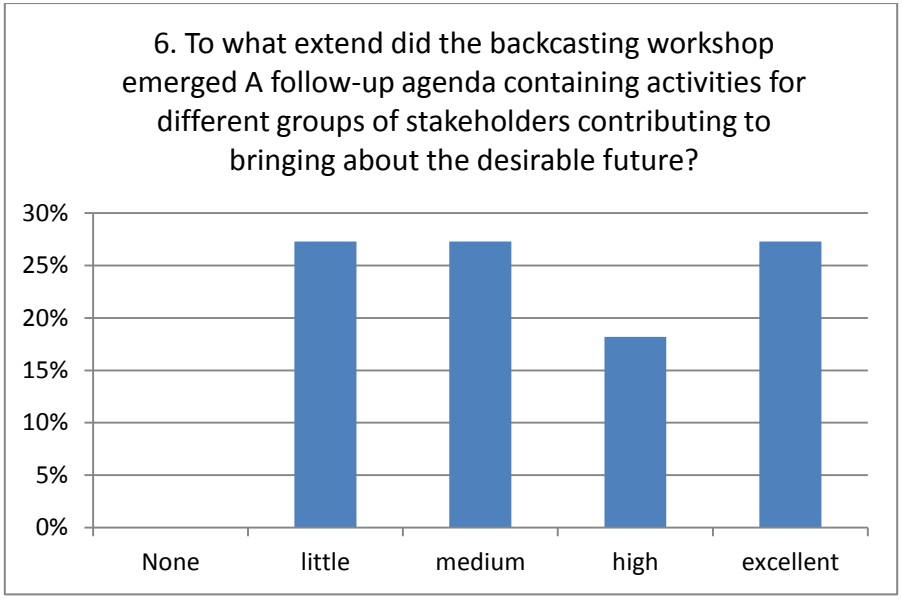
11. Que fue enriquecedor conocer los pensamientos y deseos de otras personas y profesionales hacerca del problema de abastecimiento del agua en la isla de San Andres.(It was enriching to know the thoughts and desires of other people and professionals hacerca the problem of water supply on the island of San Andres.)

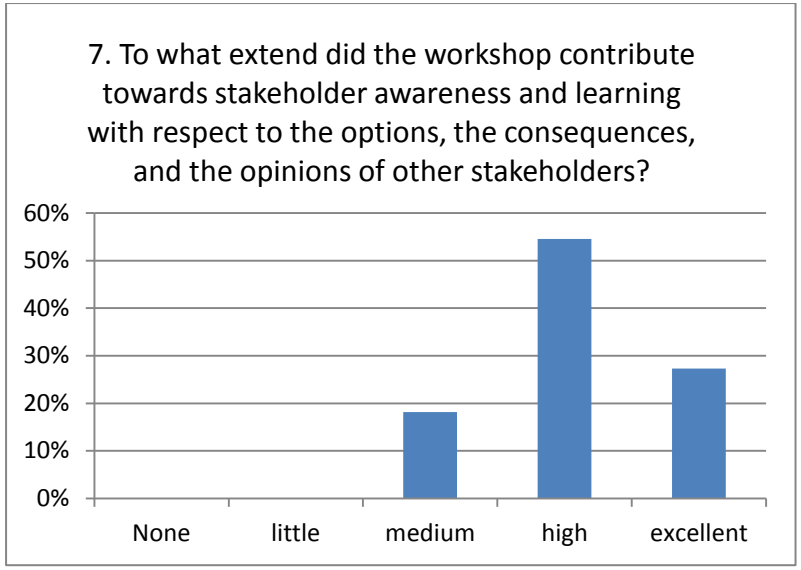
    Question 3 till 8 are elaborated upon in figures:

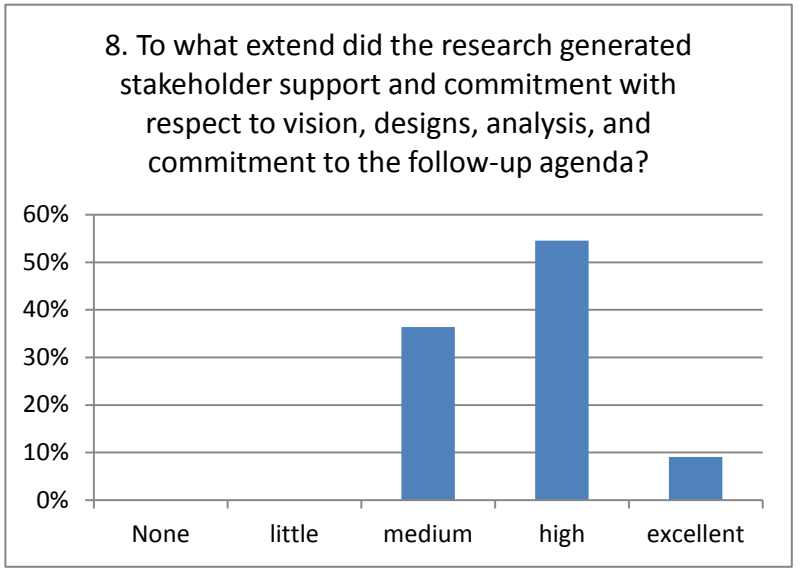

3. What was the added value of the workshop day?
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
None
little
medium
high
excellent


4. To what extend did the backcasting workshop generate normative options for the future and analyzing these on their environmental improvement, opportunities, and other consequences
40%
30%
20%
10%
0%
None
little
medium
high
excellent


5. To what extend did the backcasting workshop succeeded in putting attractive future visions or normative scenarios on the agenda of relevant societal and political arenas?
50%
40%
30%
20%
10%
0%
None
little
medium
high
excellent


6. To what extend did the backcasting workshop emerged A follow-up agenda containing activities for different groups of stakeholders contributing to bringing about the desirable future?
30%
25%
20%
15%
10%
5%
0%
None
little
medium
high
excellent





Question 9. Do you have any other comments or suggestions for the researcher about the process?

1. *Que todo lo propuesto se haga realidad* (I hope that all the proposed comes true)
2. I believe is important continue with this project, because involves the sustainability of the Islands.
3. *Que se hubieran presentado experiencias positivas de otras regiones para poder seguir modelos* (That the analyst should have presented other models that we can copy and implement.
4. The water problem is soaked with corruption; this is going to be the first problem we tackle!
5. Very interesting project for the Island.

Appendix XI Contract Aquire LTDA and EEDAS SEA.

EEDAS S.A. E.S.P.

EMPRESA DE ENERGÍA DEL ARCHIPIÉLAGO DE
SAN ANDRÉS, PROVIDENCIA Y SANTA CATALINA – S.A. – E.S.P.
NIT. 900.190.527-8

CONTRATO No. 022 DE 2013

CONTRATANTE: **EMPRESA DE ENERGÍA DEL ARCHIPIELAGO DE SAN ANDRES, PROVIDENCIA Y SANTA CATALINA S.A. E.S.P**

CONTRATISTA: **ACQUAIRE LTDA.**

OBJETO: **CONSULTORIA PARA EL DESARROLLO Y APLICACIÓN DE ENERGIAS ALTERNATIVAS**

PARA REALIZAR: **AERODIZILINADOR**

PLAZO: **OCHO (08) MESES**

Entre los suscritos, **EMPRESA DE ENERGÍA DEL ARCHIPIELAGO DE SAN ANDRES, PROVIDENCIA Y SANTA CATALINA SA ESP – EEDAS S.A E.S.P.**, Empresa de Servicios Públicos Mixta, debidamente inscrita en la Cámara de Comercio de San Andrés, según consta en el certificado de existencia y representación Legal con matrícula 00029369 y NIT 900.190.527-8, Representada Legalmente por **FRANCISCO RAFAEL PALACIO GARCIA**, identificado con cédula de ciudadanía N° 8.689.881 expedida en Barranquilla, quien en adelante se denominará **EEDAS** y por la otra **ACQUAIRE LTDA.** Sociedad Comercial legalmente constituida tal como consta en el certificado de existencia y representación Legal con matrícula 00910368 y NIT 830.053.267-8, Representada Legalmente por **JUAN FERNANDO GUTIERREZ BECQUET**, identificado con cédula de ciudadanía N° 3229056; quién en adelante se llamará **EL CONSULTOR,** se ha convenido suscribir el presente