INGENIEROS SIN FRONTERAS COLOMBIA: IMPROVEMENT OF THE WATER QUALITY IN THE COMMUNITY OF SANTA ISABEL DE POTOSÍ

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ABSTRACT

Santa Isabel rural community is located between the municipalities of Guasca and La Calera in Colombia; it was composed of different stakeholders that coexist around the "El Asilo" creek. The people collect water from this water source for consumption and daily use. The water comes from Chingaza moorland, one of top three of water generation ecosystems in the country. Given the close relationship between the community and the ecological system, the environmental damage of this creek has generated big problems in health and quality of life of the inhabitants. Through joint work with the community was proposed a project called "Improvement of the quality of water in the community of Santa Isabel de Potosi".

The group with the community is nowadays performing an analysis based on community-based decision-making taking into account the possible alternatives that could be implemented in order of diminishing in some percentage the impact of the issue and this way try to avoid the complete deterioration of the brook and the ecosystems in the area. Among the alternatives of intervention these are found: generation of a new method of community cooperation in behalf of the sanitation of the brook and the implementation of homemade filters in the improvement of the quality of the drinking water.

This paper presents the analysis of the problem taking into account different points of view such as the environmental as well as the organizational one, highlighting the fact that this is not an isolated issue but an evidence of the possible environmental disaster that Colombia could live if nothing is done at the right time. Also this paper presents how engineering and work with the communities has been able to define the guidelines of intervention that are going to allow the next stage of the project, putting in practice the solutions proposed in behalf of a better quality of life.
Keywords: Water, Community, Participatory Action Research, Active Learning, Integration

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INTRODUCTION

Ingenieros Sin Fronteras Colombia (ISF-COL) is an alliance between: Universidad de Los Andes and Corporación Universitaria Minuto de Dios. Its main objective is to improve the quality of life of Colombian vulnerable communities by application of engineering tools and participatory action research. The principal target of ISF-COL is the generation of projects proposals through the integration of its two principal participants: the community and the organization itself. However, this integration is complex to make because the thinking divergences and the different approaches.
One of its projects, it is called "Water Quality in the Santa Isabel Sidewalk", the motivation started since the first moment in when the necessity of the community who lives there was presented. The main problematic that was the project's trigger was the contamination of the water source of the community and the degeneration of the privileged ecosystem that is around the community of Santa Isabel Village: the Paramo.

The interaction and cooperation between ISF-COL and the community has been a powerful process where had been possible to identify community leaders, perspectives that are in the same direction than the ones of ISFCOL and motivation for the construction of a united project proposal. This paper first presents the context where the project is been developed, next, the theory methodologies used and finally all the process of communication and interaction where the theory and the real experience joins.

PROBLEMATIC SITUATION

Bogota, the capital city of the Colombian Republic, belongs to the department of Cundinamarca. The department it is characterized for being an environmentally rich and important region. Between the various special characteristics, it's important to highlight the existence of the one oddest ecosystem the Paramo. The Paramo it's an ecosystem found above 2.900 meters over the sea level and due to its special characteristics, can be defined as the principal generator of water in Latin America. Also, it's important to highlight that in Colombia are found 60% of the world's Paramos with an extension about of two million hectares.

A situation that increases the high influence of the worked proposed before, the fact of the lack of authorities and organization of the government entities that have the obligation of the regulation the practices that go against the environment. There are three main areas of work in this project; the first refers to the deforestation of paramo areas for economic reasons (potato crops and livestock); the second aspect is related to the mismanagement that has been given to the creek "El Asilo" by some locals; and third is the lack of cohesion of the community to work together and advance projects (see Figure 1).

One of the principal causes is that, even though it goes against the Colombian environmental laws, the paramo area such as the one in the village of Santa Isabel, great extensions of potato crops are found that are used for financial and economical aims; this

crops dry and modify the land in the highest parts of the mountain, taking to an end the processes of water rise and the birth of native flora and fauna.

Some activities go against the environment present in the village of Santa Isabel:

- Destruction of the round of the brook and its primary ecology
- Non-compliance of the minimum distance established for livestock
- Using synthetic solutions for the destruction of native plants
- Deforestation in the vicinity of the creek by planting potato crop
- Illegal taking of the waters of the creek
- Retention of water bodies of the creek in some plots

Figure 1. Brook problematic

This practices are practiced by some members of the community, as a result many people in the community are affected, for example, in times of drought at higher levels of the creek some habitants retain water in private wells, causing the decrease of the tributary flow, or the proximity of the creek to crops and livestock areas deteriorated the water quality. The entire population has the creek as a water resource, so thus deterioration affects people who do not have the resources or means to clean up the water for their consumption.

Given this, it is necessary to perform a community intervention to mitigate the problematic described. That is why ISF-COL for two years comes closer to the community, there has been a joint effort with the community seeking to identify the sources of the problems and achieving greater cohesion of the actors. In addition, there have been activities, workshops

and meetings with the community that have allowed participants to aware about current issues, to think short-term solutions and to identify leaders within the community.

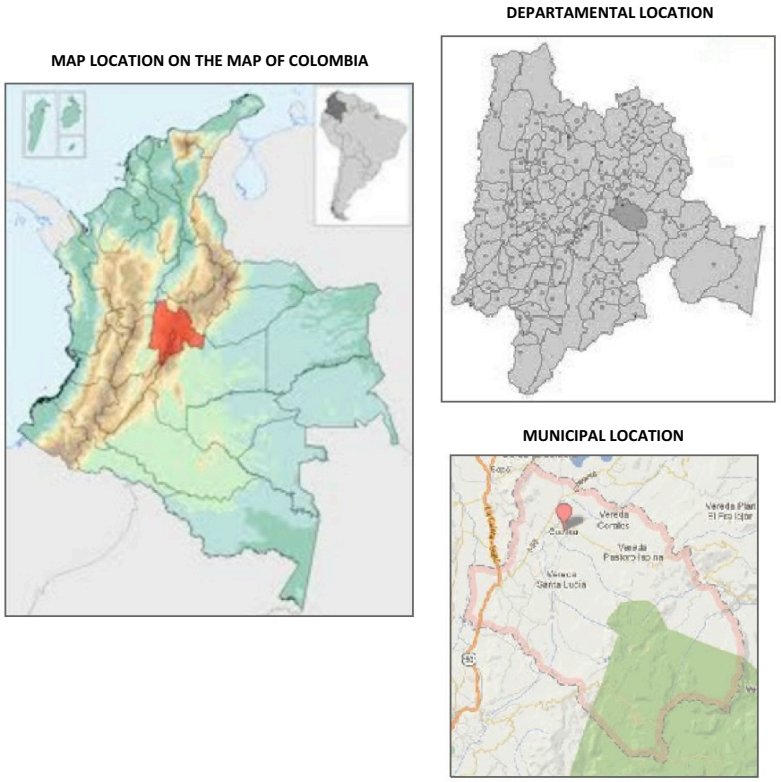


Figure 2. El Asilo brook location

OBJECTIVE

The main objective of this project is to provide a solution to the village of Santa Isabel community, which is being affected by water mismanagement of some members of the community and state neglect. So, the purpose of ISF-COL team is to work with the entire community and through engineering and other disciplines tools find the solutions that are sustainable, economically and culturally appropriate to mitigate these problems and improve the quality of life of the population.

Teachers make up the ISF-COL team and students of both universities (Universidad de los Andes y Corporación Universitaria Minuto de Dios) who decided together to generate an intervention plan with the objective of being able to make a more profound analysis of the situation. One of the principles of this research group is to learn about social dynamics and how can engineering improve community development and skills. This goal be achieved through a vision and holistic perspective of collaborative learning, learning is two-way, so the research team and the community learn from each other.

METHODOLOGY

One of the principal characteristics of the solutions proposed by ISF-COL lies in the fact that is that they must be built with the community with the goal of giving them total control of the solution seeking sustainability. The group with the community is nowadays performing an analysis based on decision-making taking into account the possible alternatives that could be implemented in order of diminishing in some percentage the impact of the issue and this way try to avoid the complete deterioration of the brook and the ecosystems in the area. Among the alternatives of intervention, these are found: generation of a new method of community cooperation in behalf of the sanitation of the brook and the implementation of homemade filters in the improvement of the quality of the drinking water.

Because of the experience of the group and joint work with the community, it was developed an intervention methodology for sustainable projects, this methodology are compound by many tools that are presented below:

CDIO Methodology

Researchers from various engineering schools have developed this methodological framework defined as Conception-Design-Implement-Operate (CDIO). In this framework, a group of researchers has added the observation phase (Ramirez, C. et. al, 2011). Based on the conceptual framework of Observation-Conception-Design-Implementation-Operation is to build collectively the analysis of a complex situation and proposed solutions to it.

In Figure 3 is a description of each of the phases of this framework:

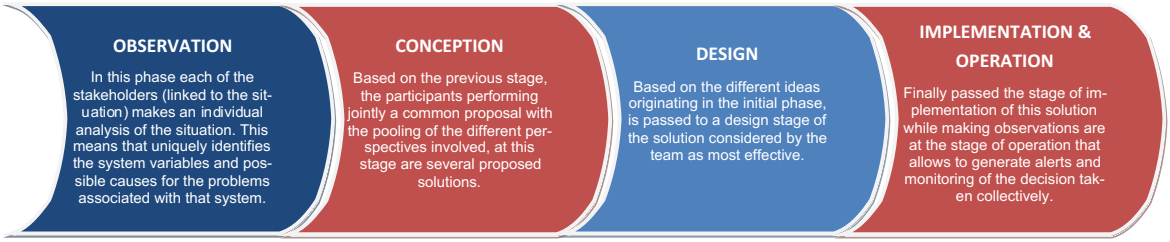


Figure 3. O+CDIO Model

From the above it is initially shows how individual perceptions and thereafter as collective solutions are built through participatory decision-making.

Syntegration

To define collectively the decisions made from the design phase to the implementation phase researches uses (and adaptation) of some of the Syntegración procedures. We propose a methodology derived from participation Syntegración methodology, which originated in the early nineties because of the investigation of the British professor Stafford Beer (1994).

In very simple terms, Syntegración protocol is a set of rules that a group of people agree to continue to address a collective and participatory discussion of a topic of their interest, and of which each can hold very different views, in order to design communication mechanisms that facilitate participatory and equitable dialogue among participants.

Syntegración protocol facilitates the construction of agreements of multiple feedback loops between all participants. This means that, even though each participant can only attend directly to the full discussion of a maximum of six of the twelve songs, all, however, will have the opportunity to learn about the issues that are discussed at every meeting. This is possible because of the way they are distributed participants in the discussion topics and the sequence in which these meetings are carried out (Beer, 1994).

Below is a chart to understand the distribution and sequence of meetings is representing the original protocol Syntegración by an icosahedron (see Figure 4), the largest regular polyhedron.

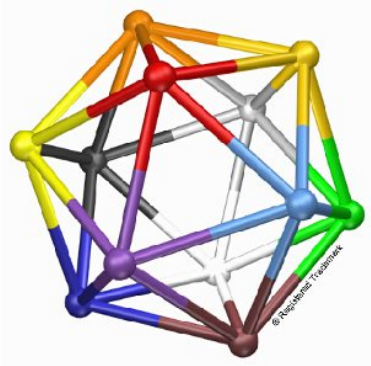


Figure 4. Icosahedron

To use the icosahedron as model protocol participation is required to make the following equivalences:

- Each vertex represents a topic of discussion,
- Each edge represents a participant,
- Two opposite vertices point to two issues that may be discussed simultaneously.

To give an example of this, some of the vertices of the icosahedron, the critical issues are the broad strategic and solution of the problem situation complex, built collectively by the participants.

The methodology is highly participatory, as observed in the interaction of the edges of the icosahedron (or participants), with different roles, allowing the construction and coordination of issues in which the contributions of each participant not only important but vital for the success of the process.

It should be noted here, the phenomenon of "reverb" presented in this methodology. About the third day of the year, in the original protocol, the interaction of the actors in each of the topics, in different roles, allows similar ideas flow from one topic to another group and facilitating concerted conclusions.

Moreover, the dynamics is a facilitator for generating new ideas by decision makers. Some activities give you a big hint of playful protocol. Among them are concluding rules for participation, adoption and respect of the different roles that each participant in the different groups.

In addition, two dynamics ensure the feedback of results. At the end of each meeting, documents the ideas, findings and results and placed in media (memos, online documents, wikis, etc.) available to all participants. Therefore, at any time can be consulted by any of the participants, the findings of the group or any of the other groups (Hernandez, 2007). The result allows us to identify problems - processes - proposals as priorities and strategic proposals to follow.

Analytic Hierarchy Process

Especially when faced with decision problems in complex systems, and in particular social systems, it is possible to identify several objectives simultaneously. Some one of the recommended methods to address this situation is the Analytic Hierarchy Process (AHP). AHP is a method where the problem is formulated through a hierarchical structure, which allows you to select the best alternative within a set of possible alternatives. Thus, the better the structure of the problem, the better the quality of the hierarchical structure (Castillo, 2006).

This process allows decision makers to model a complex problem in a hierarchical structure showing the relationships between the goal, objectives or criteria, sub-goals and decision alternatives. Besides structuring a complex problem, AHP can incorporate both objective and subjective considerations (expert opinion, community contributions, etc.), which can result in a participatory process, through its peer comparison methodology (Forman & Selly, 2001).

According to Saaty (1994) AHP process is based on three basic principles: decomposition, comparative judgment and synthesis of priorities. The principle consists of decomposition

hierarchical structure in complex aspects, the principle of comparative judgments used for pairwise comparison between aspects of the same level with respect to a priority level to determine the beginning and end of synthesis to determine a priority which global decisions are made regarding the decision alternatives. Given the characteristics of the AHP described can be used in complex social problems from a systems perspective and participatory.

The pairwise comparison matrix based on the idea of simplifying the decisions made to reduce them to just one aspect of the problem, where each pair of alternatives aspects or confront each other, to determine their importance or performance with respect to every aspect of a level. If the comparison is made between aspects, the criterion is the importance in the hierarchical structure, while if the comparison is between alternatives has to decide on the preferred if the problem had only one aspect or goal. (Castillo, 2006)

Saaty (1994) constructed two scales, a comparison between aspects of importance (see Table 1a) and a performance comparison between alternatives by taking the elements A and B (see Table 1b).

Scale	Description [a]	Description [b]
9	**A** is absolut important than **B**	**A** is extremely preferred than **B**
7	**A** is demonstrated important than **B**	**A** is very strongly preferred than **B**
5	**A** is essential important than **B**	**A** is strongly preferred than **B**
3	**A** is weak important than **B**	**A** is moderately preferred than **B**
1	**A** is equal important than **B**	**A** is equally preferred than **B**
1/3	**B** is weak important than **A**	**B** is moderately preferred than **A**
1/5	**B** is essential important than **A**	**B** is strongly preferred than **A**
1/7	**B** is demonstrated important than **A**	**B** is very strongly preferred than **A**
1/9	**B** is absolut important than **A**	**B** is extremely preferred than **A**

Table 1. AHP – Saaty Scales

CASE STUDY: SANTA ISABEL DE POTOSÍ

Taking as reference the problems exposed in the Santa Isabel village, the investigators of ISF-COL started the research process with a line of research based on adapted version of O+CDIO methodology to the problem situation in Gusca - Cundinamarca, see Figure 5.

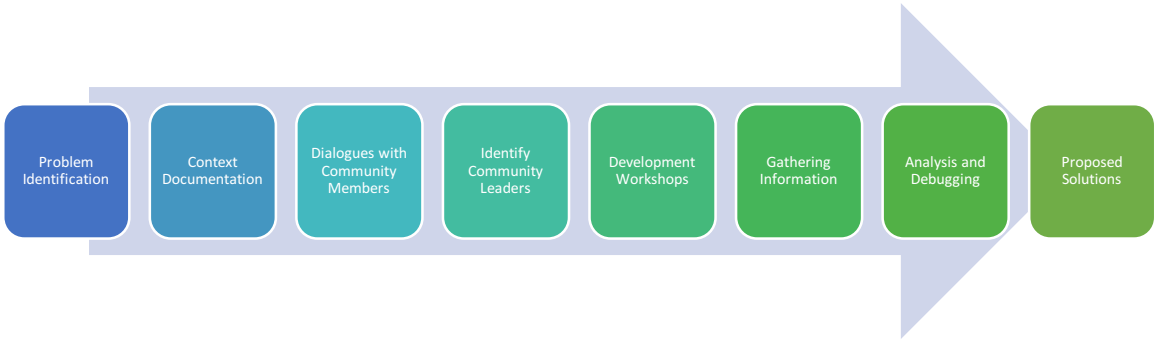


Figure 5. ISF-COL Research Process in the village of Santa Isabel

Problem Identification

The motivation for this type of project can have different sources of origin, e.g. own community requirement for a solution, a third identifies the problem or the same research group identifies the issue. Each source represents a different process. If the community is the one that requires the intervention, it greatly facilitates the process of the research group, because the community is who decided to work with investigators. But if it is an outside or the initiative of the group the access to the community takes hard work and effort.

The project called “Improvement of the Water Quality in the Community of Santa Isabel de Potosí” emerged of one of the ISF-COL researchers, who heard from one resident about perceptions of community about the changes in the small river "El Asilo", water tributary from which the community obtains drinking water. This water resource has suffered certain changes: the flow has been reduced drastically, waters reach lowlands too muddy and now there are long periods of drought during the year.

Another topic that was heard by the researchers was the lack of union of the community, mainly the absence of initiatives in front of the degeneration of the paramo ecosystems and the actual state of the brook. Individually is clear the position in front the wrong practices that there happen, but there is no union or any organization with the purpose of improving this situation.

In this context and taking into a count the experience of ISF-COL in situations like this one, there was a strong motivation for the development of a project with these characteristics and that could work for the improvement of the life quality of this community using engineering tools.

Context Documentation

It is important to gather as much information about the problem and understand its context. That is why the problem must be understood as a system. The first step in this is to establish it and to identify actors and their relationships. ISF-COL implements TASCOI (Espejo et al., 1999). TASCO is useful to describe the system around, so through the collection of the

main components of the project the equipment will generate a more focused and precise process.

TASCOI's mnemonic means (Espejo et al., 1999):

(T) - Transformation: What inputs converted into what output?
(A) - Actors: Who is involved in carrying out the activities entailed by the transformation?
(S) - Suppliers: Who are the suppliers of the inputs to the transformation?
(C) - Customers: Who are the ones receiving the outputs of the transformation?
(O) - Owners: Who has in the system an overview of its transformation?
(I) - Interveners: Who, from the outside, is defining the context for the system's transformation?

TASCOI tool to describe the problem in general, but requires first-hand information to answer the above questions. First, researchers must gather existing information on sources of information at their fingertips. After the group has an informational framework, they should be visit to the community. At this stage occurs the first approach, this equipment must be documented, clear and build trust with population. The first dialogue with the community should be friendly, like a talk between known and it has to be about general aspects, do not emphasize or suggest the problem. In the dialogue should not be used technical terms or terms that average people do not understand.

The team must perform an analysis of the information collected in the community dialogues, TASCOI questions are resolved based on that analysis. The next step is to validate and verify information with the community, so the team had to visit to some community members. If the information is verified, the research team structures the system and identifies the key actors, which were selected by group to hold the first substantive approaches. Otherwise, the new information should incorporate to the basic model and repeating the cycle until its validation and verification, see Figure 5.

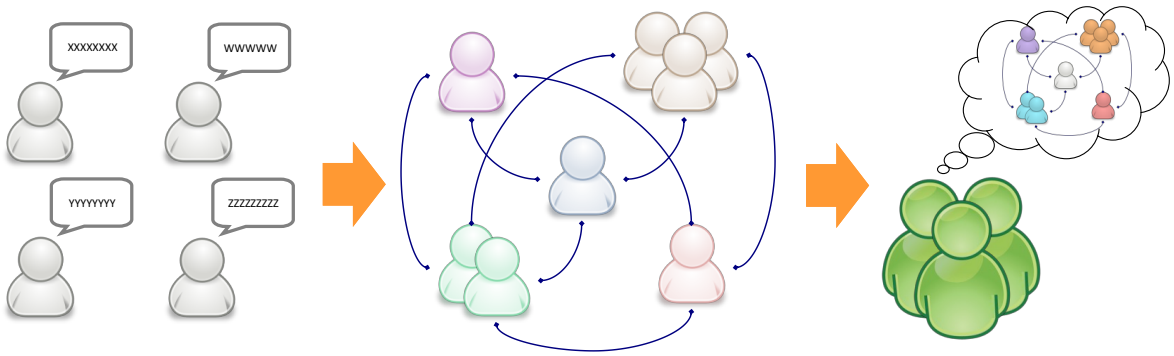


Figure 6. System analysis

Dialogues with Community Members

In order to understand the problem from different perspectives, individual interviews were conducted with a representative sample of the inhabitants of the village, with people affected and not affected by the current problems. In the interview the researchers set out the main characteristics of the household, the generality of housing, treatment and use of water resources and routine activities of population (work, education, etc.).

Based on the information collected, researches established the approaches that people had about the current problems of the creek. One of the striking results was the failure of the majority of population, because they do not identify any problematic, instead of the poor state of the creek's condition and gastrointestinal diseases in the population (for the study case was identified 18% of population). This can be explained by the indifference of the population about the current state of the stream, can also be explained from the fact that most of the village residents are senior citizens and for them the broken remains being as they knew it in his youth, clean, clear and unpolluted.

The previous exercise shows that one of the main objectives of the project should be the awareness of the population about the problem, in order to the habitants does not oblivious that problematic and start taking action on this issue. Another important aspect that was found in this phase is that within the community there is disintegration and many people do not know each other, so researches have to join the people for the teamwork does not hampers the progress of the project.

Identify Community Leaders

This is one of the most important stages, the process of identifying local leaders is key because it ensures that the community feels identified, this effect is potentiated if the leader is from the same community. A foreign agent without a community leader does not have the power to call and to achieve plausible progress in solving problems.

This is why it is necessary to identify as early as possible these leaders. Their involvement in the research process greatly facilitates the work of the research team in the community. However, it requires that the research team did not base their opinions or inferences in judgments of community leaders, sometimes these can be influenced and biased the research.

Who is a community leader? Sometimes is so easy identify a community leader, instead of, There are certain features which are associated with this type of leadership, see Figure 6.

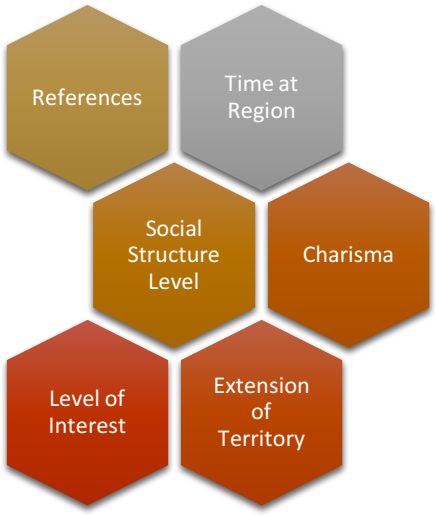


Figure 7. Communitary leader features

Development Workshops

The development of community workshops promoting the integration of the participants, in many communities the residents do not maintain good relationships and do not even know each other. In the design of the workshops, researchers should include activities for all ages, but the focus of the workshop should not change between groups. Activities should seek to link the community with the problems, empowering each of the habitants and recognizing each of their valuable contributions.

The workshops are places where people exchange their views and concerns. It is necessary that the participants knew the environment; also, it has to be comfortable and wide-open, but not outdoors. Also, if the activities require the formation of groups, these should be as heterogeneous as possible in gender, age, occupation, location, and other features, see Figure 7.

Figure 8. Second workshop with community

ISF-COL has developed three workshops with the participation of the community, but has also held meetings with some special people. These workshops and meetings aim to integrate the population about the current problems and empower their role in the settlement process. The workshops have been implemented as a means to extract value judgments and conceptions of the different perspectives of the community. This information about the evaluation criteria of the community will be important for the later stages of the methodology.

These workshops are the places where we present the progress and results achieved by the community and the research teamwork. These meetings should not be long or boring, should be interesting and provide incentives to encourage the participation of the community. Finally, the process must be very narrow escape, for example personal invitations explaining the generalities of the workshop and casting interest to the participant about the activity.

Gathering Information

The research team should collect information to establish indicators and measurements have about the current situation, to measure the impact of the proposed settlement. It is necessary that the research team to set goals to achieve for those metrics. The implementations of technical or laboratory evidence of a quantitative nature are desirable at this stage.

The results of these tests can reaffirm or redefine the project research hypotheses, to validate the information in the earlier stages of the process and to provide a quantitative overview of the project. Below is some of the information collected for the case study.

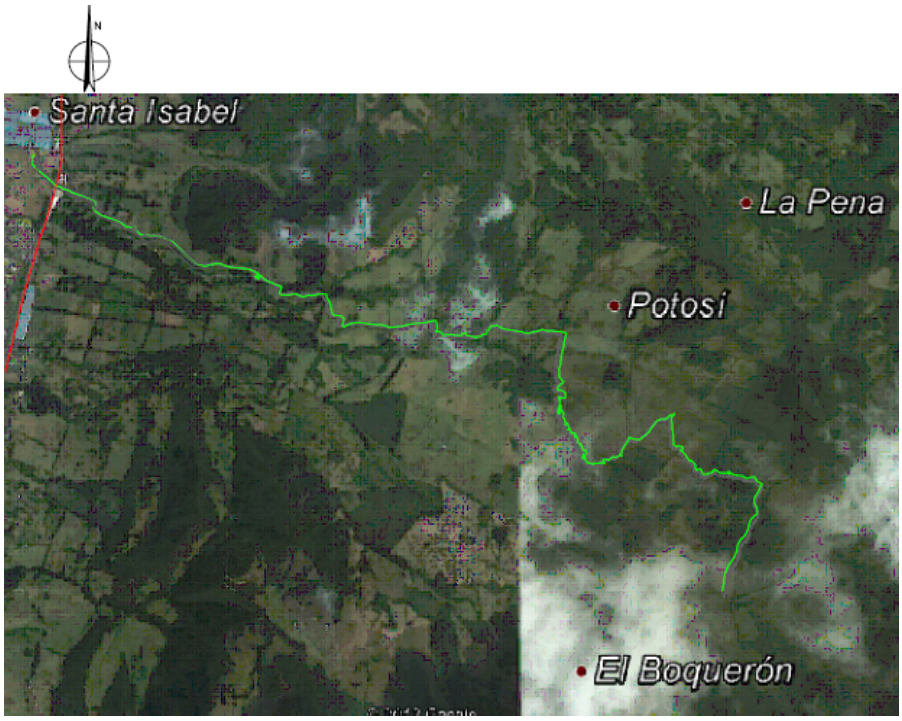


Figure 9. "El Asilo" Brook route

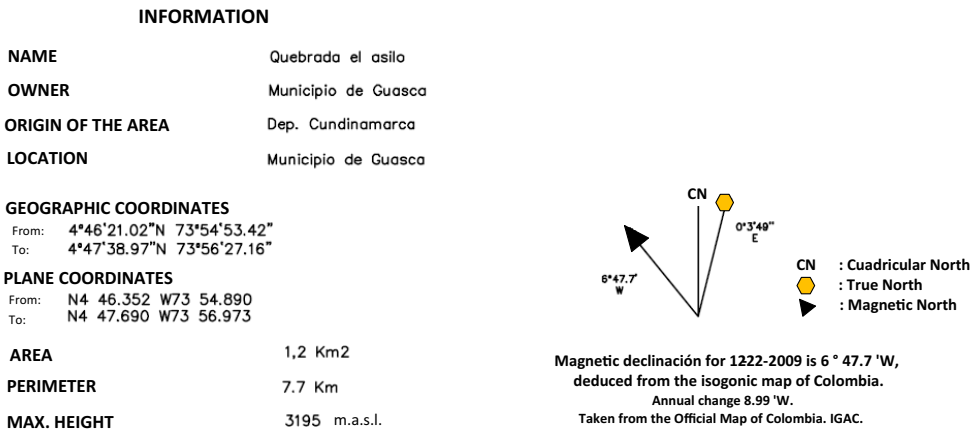
GPS Point	N	W	High (ft)
A	04°46.887'	073°55.176'	8111
B	04°46.782'	073°55.276'	8174
C	04°46.767'	073°55.305'	8306
CULTIVO	04°46.858'	073°55.343'	7898
PTO 1	04°46.766'	073°55.308'	8619
PTO2	04°46.804'	073°55.322'	8554
PTO 3	04°46.830'	073°55.322'	8569
PTO4	04°46.851'	073°55.337'	8599
PTO 5	04°46.910'	073°55.365'	8266
CASA 1	04°46.884'	073°55.373'	7753
CASA 2	04°47.189'	073°55.751'	8107
CASA 3	04°47.452'	073°55.738'	9163
CASA 4	04°47.457'	073°55.736'	9664
CASA 5	04°47.223'	073°55.989'	9568
CASA 6	04°47.259'	073°56.229'	9837
CASA 7	04°47.306'	073°56.361'	9534
CASA 8	04°47.312'	073°56.380'	9540
CASA 9	04°47.339'	073°56.396'	9158
CASA 10	04°47.424'	073°56.553'	8756
CASA 11	04°46.445'	073°56.644'	8731
CASA 12	04°47.470'	073°56.695'	8697

CASA 13	04°47.469'	073°56.699'	8748
CASA 14	04°47.496'	073°56.742'	8986
CASA 15	04°47.507'	073°56.762'	9106
CASA 16	04°47.526'	073°56.799'	9233
CASA 17	04°47.543'	073°56.794'	9272
CASA 18	04°47.544'	073°56.790'	9407
CASA 19	04°47.603'	073°56.921'	9337

Table 2. GPS database of families.

Parameter	Result #1	Result #2	Result #3	Units	Method
Alkalinity	4,8	1,6	2,6	mg/L CaCO3	SM 2320 B
Fecal Coliforms	<30	43	23	NMP/100mL	SM 9221 E
Total Coliforms	230	23x1^2	290	NMP/100mL	SM 9221 B
Biochemical Oxygen Demand (BOD)	<1	<1	3,1	mg/L-O2	SM 5210 B Y SM 45000-OG ACCREDITED
Chemical Oxygen Demand (COD)	"7,96"	16,1	10,8	mg/L-O2	SM 5220 D ACCREDITED
Total Nitrogen (KJEDHAL)	<1,1	1,1	<1,1	mg/L-N	SM 45000-Norg C y 45000-NH3 C ACCREDITED
Turbidity	3,46	3,73	1,81	N.T.U	SM 2130 B
Observations:	(<) Value between limit of detection and limit of quantification. ("") Value less than the detection limit.				

Table 3. Diagnostics of water of "El Asilo" brook



INFORMATION

NAME	Quebrada el asilo
OWNER	Municipio de Guasca
ORIGIN OF THE AREA	Dep. Cundinamarca
LOCATION	Municipio de Guasca

GEOGRAPHIC COORDINATES
From: 4°46'21.02"N 73°54'53.42"
To: 4°47'38.97"N 73°56'27.16"

PLANE COORDINATES
From: N4 46.352 W73 54.890
To: N4 47.690 W73 56.973

AREA	1,2 Km2
PERIMETER	7.7 Km
MAX. HEIGHT	3195 m.a.s.l.
MIN. HEIGHT	2616 m.a.s.l.
ASCENT	42 m
DESCENT	618 m
SLOPE	−7.5%
HIDRIC RESOURCE	Watershed
AVERAGE TEMPERATURE	13°C – 15°C

Figure 10. Geographic results for "El Asilo" brook

Analysis and Debugging

It is necessary to analyze and debug the gathered information. The analysis proposed by ISF-COL is multidisciplinary. This ensures a comprehensive and holistic concept for the problem from different approaches of the disciplines and the community. It is also required present the results to the community, this activity helps to community to understand the problematic too. In many cases, this stage gives a pathway to build the first approximations to the final solution.

Another aspect to consider is the fact that sometimes information is poor quality. The technical team must be very precise to establish the measurements and the quality of these. In many cases resources are wasted in useless information obtained could be spent on achieving clear progress in the project.

The community and researchers must set goals they want to achieve. These goals are part of the steps to be achieved with the implemented solution. It must be achievable, measurable, clear and periodically monitored.

From these goals, some activities are becoming significant to mitigate the effects of the problem and are easily identified by the community. However, in some cases the relationship is not direct and researchers need to devise a creative space of solutions.

Proposed Solutions

For this, multidisciplinary teams are created among members of the community and research team. Each of the groups to structure one or more concrete solutions to the problems, they must be economically viable, culturally and must be sustainable. It is desirable to incorporate innovation, science, and technology.

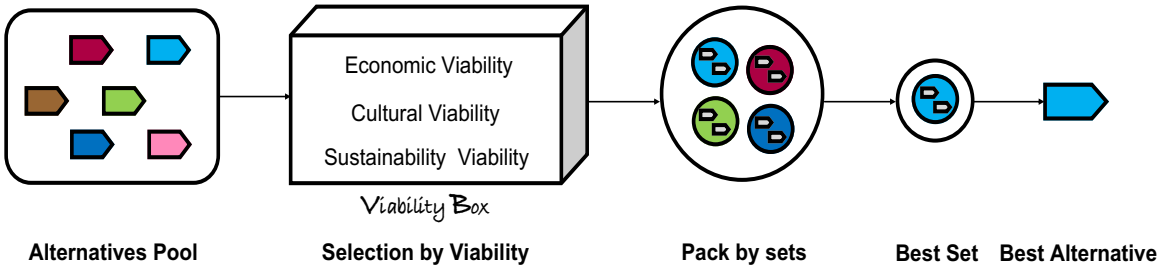


Figure 11. Best alternative selection process

A research group considering the viability criteria checked the alternatives, see Figure 8.It an alternative approves those three criteria, and then the researches pack similar alternatives. After, AHP is used to evaluate those sets and finally chose the best alternative, based on the evaluation criteria defined by the community and built by researchers from the analysis of the previous stages. The result is a viable alternative that incorporates holistically and value judgments of both the community (further) and the research group.

COMUNICATION PROCESS

It is important to highlight the importance of an effective communication process with the community before, during and after the implementation of any project, since the quality of the links established between researchers and community dependent results and effectiveness of the efforts. Based on the work experience and the case study shown above, are evidenced below desirable skills that should encourage participants in the process, these are show in Figure 9.

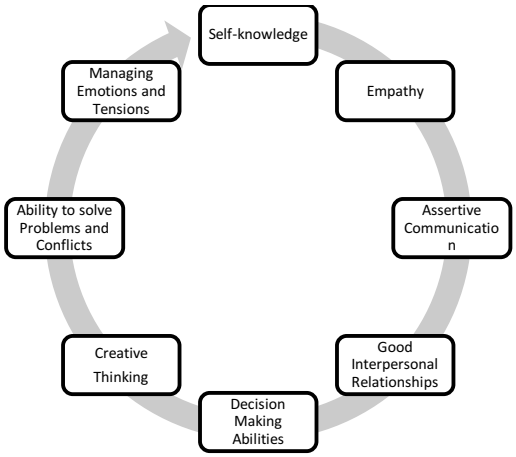


Figure 12. Desirable skills in communication process

RESULTS & CONCLUSIONS

The project has left many lessons about working with the community, and the work process that should lead to achieving it, among these are highlighted as follows: i. Community should be the cornerstone of the project, ii. With community, leaders should always keep good communication, iii. The research team must implement relevant and attractive incentives to stimulate community participation, iv. Information presented to the community must be clear, and it must be in the terminology and words used by the community, v. Project sustainability will depend only on the attraction that attains the development process and community interest generated by the project, v. Communication processes and community activities should promote the skills described before.

ISF-COL has made great efforts to join the community, has identified three community leaders in the region, and has identified the problem largely and finally made three integration activities with the community. Now most people know each other, the community shares more and they talk more about the problems and possible solutions to it. People have taken their own initiatives, for example recycling, perform maintenance on septic tanks, respect the primary vegetation derived from the brook, among others.

Product of the research process has become aware 19 families (about 86 people) from the village on the current problems and has been involved in the proposed solutions. ISF-COL team ensuring the viability and sustainability of the long-term, enduring the process in multidisciplinary tools, accompanies this discovery process solution.

The proposed methodology has proven that the interaction between academia and communities is possible and has measurable learning outcomes for both. About proposed case study, the community and the academy built together a framework

for the problem and are currently designing jointly solution alternatives, which will be evaluated by AHP methodology for this final implementation.

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