Participatory Process for Local Development: Sustainability of Water Resources in Rural Communities: Case Manglaralto-Santa Elena, Ecuador

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Abstract

This paper describes the experience of a participatory process that has driven the development of rural communities facing water shortages, demonstrating that collaborative work is key to solve challenges and to achieve a sustainable development. In particular, the paper shows the Manglaralto's participatory process methodology including social, economic, environmental and cultural sustainability areas, and the technical and social adaptations and interactions that have been implemented. The aim of this paper is to describe with facts and events the participatory process and its impact on water management in Manglaralto in order to contribute to the creation of a long-term integrity of natural resources and human well-being. This participatory process has been considered a global example because it was a joint effort between stakeholders, like Manglaralto communities, the Board of Water Regional Manglaralto, International Atomic Energy Agency and the Academic Community-Escuela

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Superior Politécnica del Litoral. The main results of the participatory process have been the water satisfaction for the growing demand, the integration of technical knowledge with ancestral knowledge such as the rescue of ancestral techniques like “tapes” (dykes), the work of the water board at the technical limits of aquifer capacity, avoiding its overexploitation; and the communities’ empowerment in water management.

Keywords
Lack of water · Participatory process · Rural communities · Manglaralto

1 Introduction

It is widely known the document “Transforming our world: the 2030 Agenda for Sustainable Development” so it is considered as a top priority “Ensure availability and sustainable management of water and sanitation for all” (General Assembly 2015).

Water shortage is a major global environmental concern (Hoekstra 2016; Zhou et al. 2016). Nowadays the availability of fresh water resources is a challenge for many communities. Fresh water is becoming a scarce resource that limits the social and economic development in the world (GRID-Arendal et al. 2010; Setegn et al. 2014).

According to Shiklomanov (1998) the surface waters (lakes, rivers and wetlands) represent 0.3% of total freshwater resources on Earth; while groundwaters (aquifers) constitute 30.8%. Groundwaters have an important role in providing water for communities and the functioning of ecosystems (Shrestha et al. 2016). There are 2.5 billion people who rely exclusively on groundwater resources in the world. Also, it is estimated that 20% of worldwide aquifers are being overexploited, so it is reduced reserves of fresh water (United Nations World Water Assessment Programme 2015).

The efficient management of water resources has a major role in social and economic development of Latin America and the Caribbean, because areas with high economic activities are located in areas with low water availability (Peña 2016). At Latin American rural areas the water is supplied fully or partially by groundwater. In addition, it is estimated that there is less amount of water sources in rural areas than in urban areas (Domínguez et al. 2016).

Education and participatory governance are considered two key points for achieving sustainable development in a society. Education is focused on developing communities’ skills that allow them to face and solve their needs, e.g. the preservation of natural resources (Michelsen and Rieckmann 2015). While, the governance facilitates the interaction and negotiation of interests by strengthening the social and political ties to achieve sustainable relations between civil society, public

and private organizations. In addition, the participatory governance is focused on sustainable social and economic development through careful use of natural resources (Jorquera Beas 2011; Leal Filho et al. 2016).

Many participatory processes have been developed as instruments of education and governance for management of natural resources. Participatory processes have shown that for the management and sustainability of water resources, it requires an integrated management of stakeholders such as communities, associations, businesses, governments, NGOs and others actors (Jinapala et al. 1996; Turton 2000; Yavuz and Baycan 2013; Butler and Adamowski 2015).

In rural communities of Latin America and the Caribbean, participatory processes have been developed showing positive results. At the subbasin Toabré river in the Panama Canal a Sustainable Development Program was done through a participatory process. Fifteen participatory workshops were done with the participation of 114 communities (Autoridad del Canal de Panamá et al. 2004).

In the basin of Lake Fúquene in Colombia, Participatory Rural Appraisal Workshops were done using tools such as maps (social, economic, political), matrix ranking (conflicts, benefits, uses) and diagrams (Venn, economic flows, social) which allowed local and regional stakeholders (population, farmers, owners of slaughterhouses, mining awardees, fishermen, craftsmen and others) identify environmental problems, organizational relationships and conflicts generated by access and availability of water resources. Finally, consensual solutions were found through individual and collective actions for watershed management (Maya and Ramos 2005).

There are other cases of participatory processes in watersheds at Latin America and the Caribbean that achieved their objectives, such as the case of the Chira-Piura basin in Peru and the Amarillo-Copán basin in Honduras-Copan, among others (Gobierno Regional de Piura-ANA-GTZ/PDRS 2009; Orellana et al. 2010).

The Manglaralto rural parish is in the Ecuador's coastal region to the north of the Santa Elena province. It is divided into eighteen communities with a total population of 34,457 inhabitants until 2015, according to projections of Instituto Nacional de Estadísticas y Censos (2010). Manglaralto is considered as a tourist sector of Ecuador. Some of the main attractions are beaches, restaurants and handicrafts (Gobierno Autónomo Descentralizado Parroquia Manglaralto 2015). Most of the employed population engages in agriculture, cattle raising, forestry and fishing. On the other hand, it has an unemployment rate of 47.20% and a poverty rate by unsatisfied basic needs of 88.20% (Gobierno Autónomo Descentralizado Parroquia Manglaralto 2011).

In the Manglaralto rural parish, 92.67% of households are supplied with fresh water by wells, 3.34% by the water delivery truck, 2.26% of rain water and 2.26% by albarradas and rivers, in contradistinction to national average in Ecuador, where 45.92% of the rural areas are supplied of fresh water by public water company, 24.87% by rivers, 22.97% by wells (groundwater), 3.16% by albarrada and rain water and 3.08% by the water delivery trucks (Instituto Nacional de Estadísticas y Censos 2010).

It is important to note that there is no public water company in Manglaralto. The main source of water at Manglaralto is groundwater. It is obtained from the coastal aquifer called Manglaralto, administered by the Regional Water Board, Junta Regional de Agua Potable Manglaralto (JRAPM, acronym in Spanish), which provides fresh water to households in Manglaralto through pipe networks (Herrera 2016).

The availability of water in Manglaralto is limited so it is not satisfied the need of water for the population and economic activities (Herrera 2016). In this situation, since 2005 the Escuela Superior Politécnica del Litoral (ESPOL) through the Earth Science Applied Research Center, Centro de Investigación y Proyectos Aplicados a las Ciencias de la Tierra (CIPAT-ESPOL, acronym in Spanish), has generated possible solutions to increase the disponibility of water in Manglaralto; because it has the potential to develop sustainable ways of living and working in communities (Shiela et al. 2016).

The water supply in Manglaralto is a challenge over time. The demand of water of the tourism sector grows, but the warehouse (coastal aquifer) has a storage limit. The technical part alone is unable to solve this situation, so it is important to cover social aspects. Through participatory processes based on participatory action research, changes are generated in management that seeks continuity of water supply. The internal social fabric and strategies born of participatory processes of social interaction allowed the technical issues can be realized, either in an established way or with innovative operations because they are based on ancestral knowledge that is mixed in the daily work or the way of power achieved by hand.

The report of the World Commission on Environment and Development (1987) has stated "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This paper applies the concept of sustainability of the report of the World Commission on Environment and Development, in addition, it brings together four components: social, economic, environmental and cultural.

The paper describes the experience of the Manglaralto's participatory process highlighting activities done and the impact on water management according to techniques of innovation and sustainability used; providing a methodology focused in four areas of sustainability: social, economic, environmental and cultural, that has achieved the increase of availability of water and the empowerment of Manglaralto's communities on water management in order to contribute to the creation of a long-term integrity of natural resources and human well-being.

2 The Manglaralto's Participatory Process Methodology

2.1 Antecedent

Manglaralto rural parish was created in 1861. By that time, the fresh water was distributed by water delivery trucks. In 1970, the price of fresh water fluctuated

between 20,000 and 25,000 sucres per m^3, which currently amount to $0.80 and $1 respectively (Saeteros 2014). It was considered as a high price according to the socioeconomic conditions of the sector.

The government created the Water boards management Law in 1979, that allowed to parishes to create communal water boards. Thus, Manglaralto population was organized to the creation of a water board and to manage the water resources of the Manglaralto coastal aquifer at Manglaralto basin. The basin has 13.238 ha of extension, while the coastal aquifer has an area of 508 has (Herrera 2016).

The Manglaralto Regional Drinking Water Board or Junta Regional de Agua Potable Manglaralto (JRAPM, acronym in Spanish) was created thanks to the encouragement of the parish's Father, Stäheli Othmar (Swiss priest) and the support of all communities. The water board was legalized by the Ministerio de Desarrollo Urbano y Vivienda (MIDUVI) of Ecuador in 1980. Then, they have legalized The Olón Regional Drinking Water Board in 1982 and The Valdivia Regional Drinking Water Board in 1987; so the Manglaralto rural parish has a total of three water boards currently.

The JRAPM is in charge of the distribution, control and collection of water resources for the inhabitants of five communities of the Manglaralto Parish: Montañita, Cadeate, Liberator Bolívar, Río Chico, San Antonio and to the parochial head. Currently, the JRAPM is composed of six members, three men and three women. Each member represents to each community linked to the water board. It is important to highlight that the water board members are democratically elected.

2.2 Stages of Participatory Process

The Manglaralto's participatory process was made during the years 2005–2015 through action-participatory research methodology with reference from studies of

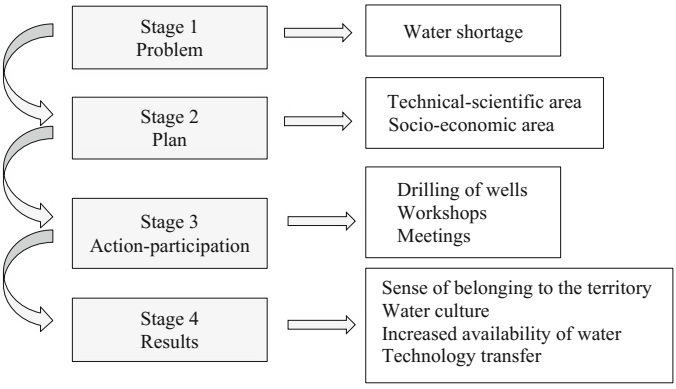

Fig. 1 Stages of the Manglaralto's participatory process. *Source* the authors

Bonilla et al. (1972), Fals Borda (1981), López Cabanas and Chacón (1999) and Becerra and Moya (2008). It was composed by four stages as it is shown in Fig. 1.

2.2.1 Stage 1: Problem

Manglaralto's population had availability of water for 8 h per day in 2005, about from 6:00 a.m. to 10:00 a.m. and 2:00 p.m. to 6:00 p.m. This did not satisfy the need of water of the population. Also it was evident an increase of business and tourists at the parish, who also had demand the water resource.

Some people bought water from water delivery trucks. However, the water price of delivery trucks was very costly. As a result, water demand was not fully covered so population did not have water for their basic needs.

But the problem was not only the lack of water, but the administration of the water board. The water board had reached 25 years of management and they were continuing at the same way management. Although JRAPM work was excellent in those years because they managed the water with limited resources, they needed new techniques to distribution, control and collection of water resources, i.e. new technologies.

2.2.2 Stage 2: Plan

Academic researchers of CIPAT-ESPOL proposed the development of a project to characterize coastal aquifers in Santa Elena. It would be a starting point to drill water wells for exploitation in order to satisfy the water needs.

National and international support was requested to carry out the project. Given the efficient efforts of CIPAT-ESPOL and JRAPM, they got support from the International Atomic Energy Agency (IAEA) of the United Nations. Since 2006, the IAEA sponsored two projects called Characterization of Coastal Aquifers on Provincia of Santa Elena ECU/8/02 and Application of Isotopic Tools for Integrated Management of Coastal Aquifers RLA/8/041.

Activities were concentrated in social, economic, environmental and cultural areas; based on two objectives principally: increasing the availability of water and empowering communities in water management. Figure 2 shows some activities of the participatory process according to sustainability pillars.

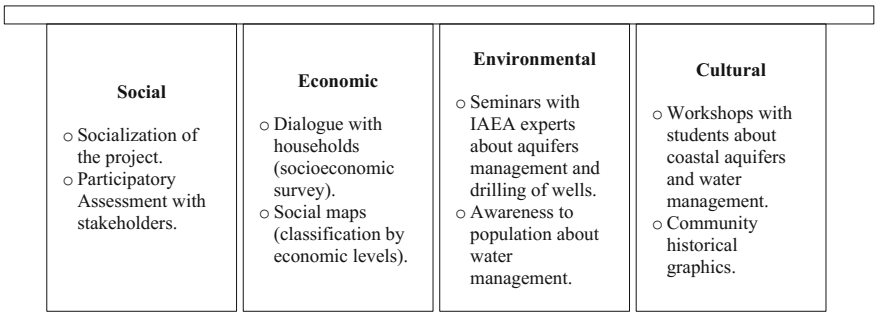

Fig. 2 Activities planned at Manglaralto's participatory process. *Source* the authors

2.2.3 Stage 3: Action-Participation

The process participatory has included a broad kind of stakeholders, such as the population of rural communities, technicians water board, researchers, professors, students, NGOs and government. Figure 3 shows the relation between stakeholders and the way how they are involved in the process.

Manglaralto communities, CIPAT-ESPOL and JRAPM were the managers of the process, the responsibles of organizing and controlling the activities. The Center for Applied Social Development of Escuela Superior Politécnica del Litoral (CEDESA-ESPOL by its acronym in Spanish) and students of ESPOL University were collaborators of the process. They support in different activities like socializations, awareness campaigns, techniques studies at coastal aquifer, and others.

The IAEA was the sponsor, which had provided resources for the execution of projects. Also, it was the in charge to control the activities and to do visits with technical experts that gave advices in order to reach projects goals. The Undersecretary of Control and Nuclear Applications, the official organization in charge of management of activities linked to radioactivity at Ecuador, was a consultant actor.

The participatory action research (PAR) methodology was focused principally on action for social intervention by the enabling dialogue and mediation on the management of coastal aquifer between different stakeholders, encouraging the participation of the most sensitive and disadvantaged groups in decision-making.

Various activities of participatory action research like meetings, round tables, seminars, workshops, awareness campaigns, courses, briefings, lectures, open houses, theater plays, gradual evaluations by the community were developed. Workshops about water management and Manglaralto coastal aquifer were developed at communities as a source of information and participation for improving the water management. Activities of participatory action was a joint work of IAEA, CIPAT-ESPOL, JRAPM, CEDESA-ESPOL and communities. In addition, some training workshops for projects staff (CIPAT-ESPOL and JRAPM) were developed by IAEA for integrating knowledge about aquifers management, drilling of wells and other techniques. Table 1 shows some events of the participatory process, like workshops, conferences, courses, trainings and socializations.

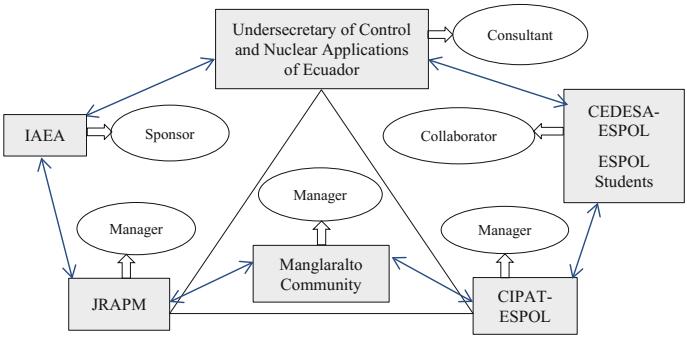

Fig. 3 Stakeholders in the Manglaralto's participatory process. *Source* the authors

Table 1 Events developed

Year	Activities of participatory action	Description
2007	Technical visit	Technical coordination workshop for the Regional Project RLA/8/041 "Development of tools for the integrated management of coastal aquifers. Phase I"
2007	Conference	Ibero-American conferences on desertification and sustainable use of water in drylands. Cartagena de Indias-Colombia
2007	Workshop	The importance of the management of the Water Resource in the Peninsula of Santa Elena
2008	Training	Surface and underground water balance and isotopes in the National Electric Energy Company (ENNE). Honduras
2008	Training	Training in the groundwater area. Ibero-American Center for Industrial Development (CIDIAT, by its acronym in Spanish). Mérida-Venezuela
2008	Course	Chemical and isotopic characterization of groundwater and its application in the study of aquifers
2009	Socialization	Contribution to environmental services. Socialization to publicize ECU/8/02 and RLA/8/041 project activities
2009	Course	International Course on Underground Hydrology in Coastal Areas
2010	Technical visit	Mr. Raúl Ramírez, Technical Officer for Latin America of IAEA
2011	Socialization	Scientific forum-water matters: making a difference with Nuclear Techniques
2013	Course	The use of isotopes as tracers in the water cycle, from the atmosphere to aquifers
2014	Lecture	Isotopes in the water cycle
2015	Workshop	Hydrogeology and integrated management of coastal aquifers

Source Herrera (2016)

Awareness campaigns were developed at schools primarily because children have the power for reaching the water sustainability so they were a key actor at participatory process. Awareness campaigns were organized by CIPAT-ESPOL in collaboration with JRAPM and CEDESA-ESPOL. Each one lasted approximately 3–4 h. Table 2 shows some of the schools and communities where the awareness campaigns were developed.

2.3 Stage 4: Results

One of the main results of the participatory process is the strengthening of the sense of belonging to the territory. The project was an initiative for that the community feels identified with its environment and committed to finding solutions to solve the problems afflicting it in their daily lives.

Table 2 Awareness campaigns developed

Year	Community	School	Participants	
			Adults	Children
2010	Manglaralto	Alfredo Sanz Rivera	45	275
2011	Cadeate	Franz Wasarva	110	67
2011	Libertador Bolívar	Casa Comunal	95	38
2011	Río Chico	Dionicio Gonzabay	25	56
2012	San Antonio	Vicente Rocafuerte	24	247
2012	Manglaralto	Colegio Manglaralto	53	321
2013	San Antonio	Vicente Rocafuerte	29	156
2013	Montañita	José Mejía Lequerica	37	88
2014	Cadeate	Franz Wasarva	17	155
2014	Sitio Nuevo	Eloy Alfaro No16	21	67

Source Herrera (2016)

Manglaralto communities were self-advocates of the project, providing a constant participation during the process. In addition, the efficiency of community-technical relationship enabled the successful performance of planned activities.

Another very important result is the acquired water culture. Manglaralto communities created and developed attitudes and skills for efficient management of water resources. They improved their actions regarding the management of water in their daily activities.

It has increased in more than twenty-one thousand users of water in 10 years as shown in Table 3. Also, there is an increase in the availability of water through the drilling of new wells. Currently, there are thirteen wells in Manglaralto as shown in Fig. 4, which has promoted the access to quality water for the population.

Experts of IAEA, CIPAT-ESPOL research team and JRAPM developed techniques to improve management of Manglaralto coastal aquifer by transferring technology. Ten training workshops were provided by the IAEA to projects staff and there were 12 visits of technical experts for giving advices and reviewing the project. In addition, the participatory process included 15 events, 12 socializations and 15 awareness campaigns aimed to the community of Manglaralto, primarily students in schools and colleges in order to expand and expose the facts of water management and the coastal aquifer.

On the 3rd of July, 2011, Yukiya Amano, Director of the IAEA, made the official visit of the project and congratulated to the project managers for the results

Table 3 Evolution of water users and number of wells in Manglaralto

Year	Users	Wells
2005	2000	2
2010	17,587	9
2015	23,586	13

Source Herrera (2016)

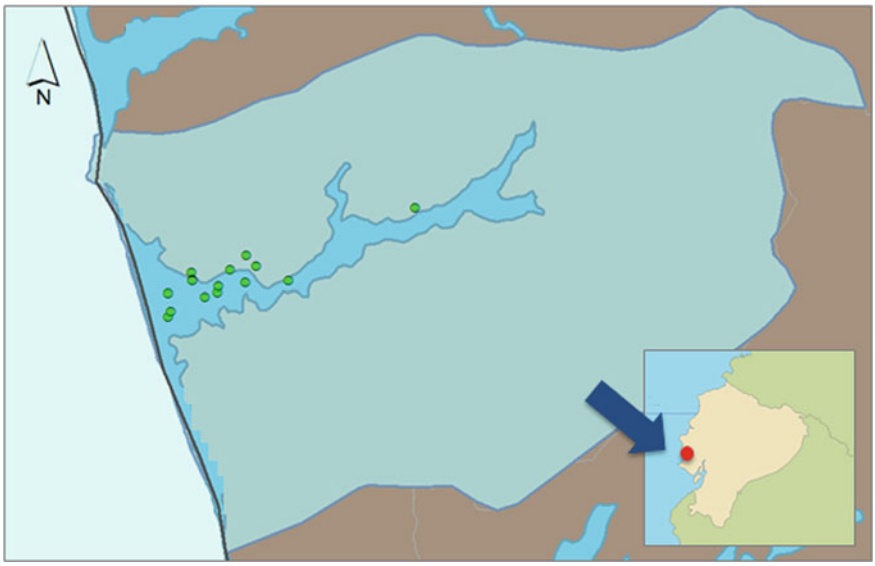

Fig. 4 Location of Manglaralto basin at Ecuador. *Source* the authors

obtained. On the 21st of September, 2011 the Manglaralto project was presented in Scientific Water Forum "Water Matters" where Manglaralto case was considered a world example (Macneill 2011; Herrera 2016).

After the success of projects in Manglaralto there are an increased number of candidates who compete for managerial positions in JRAPM. So people are most involved in water management and the coastal aquifer issues.

Manglaralto communities are in search of the collaboration of public and private entities in activities for the development of their community. Universities and research centers, as CIPAT-ESPOL, have developed projects in Manglaralto, not only focused on water resources management. As a result, there are relevant academic contributions, such as fourteen undergraduate, master and doctoral theses and twenty-seven publications (Herrera 2016).

2.4 Limitations

When people face water scarcity, the dialogue becomes difficult. There are demonstrations on public roads to protest, there are closed roads, and population is suspicious and incredulous when someone discussed them a project that can contribute to the solution of the problem, so they do not lend their support to the fullest. However, in most cases when the dialogue begins and communities work together to face water scarcity an agreement is reached, needs for water are satisfied and improves water management.

The quantity of events, socializations and awareness campaigns developed was a limitation. More educational workshops for the entire province, not only the communities where JRAPM provide water, are required; considering that it is a community resource and its poor management affects all population.

JRAPM is who takes decision and the work is done by consensus, but the decision has the risk of being policy or conjunctive. So the PAR methodology has the limitation of not representing all stakeholders. In general, the methodology leads to consensus, but the water board representative could do what he considered as correct at any time.

The water board improves its technical facilities with the monthly charge to water users. There are users who do not pay the bills of water on time and the board does not deny them water use. However, water cannot be free for the population, it is necessary to pay for it to appreciate its value. In addition, paying for the water service becomes a key element of sustainability, as the managing board maintains its self-management and services based on this payment. The community also maintains its active participation when services are maintained.

3 Conclusion

The Manglaralto participatory process demonstrated that the integration of labor between government-university-industry-community with the assistance of international cooperation led the satisfaction of water needs of communities through sustainable use of water resources, contributing to the creation of a long-term integrity of natural resources and human well-being.

Collaborative work among stakeholders through participatory action research methodology is a key to solve environmental challenges. The methodology is adaptable and change according to the dynamics of people and resources, so stakeholders were incorporated in decision making and activities developed. As resulting the water satisfaction for growing demand was achieved by the increase of the number of wells from two to thirteen wells in 10 years, the integration of technical knowledge with local knowledge allowed the rescue of ancestral techniques like “tapes” (dykes) so in Manglaralto communities have been made artesian tapes, and communities’ empowerment in efficient water management.

The number of users of water resources in Manglaralto is increasing. It is important to highlight that the increase is not only in population but in facilities, condominiums, hotels, hostels, restaurants, shops and businesses in general. Future researches will be necessary to develop a better management of Manglaralto coastal aquifer, being the coastal aquifer system is working at the technical limits of its capacity. The thirteen wells are a limit for Manglaralto coastal aquifer. No more wells can be made.

The main study that needs to be done for sustainability is about recharge. All this requires that participatory processes continue as a driving symbol that generates adaptations and solutions. The recharge is an urgent measure, so the tapes "dykes" become an important strategy.

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