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**MANAGEMENT OF ENVIRONMENTAL ACTION PROJECTS WITH VULNERABLE COMMUNITIES
IN BOLIVIA: UNDERSTANDING, LEARNING, PROPOSING**

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Bolivia's chaotic development has led to alarming environmental pollution over the last 50 years, and is exposing rural communities to an increasing socioeconomic and environmental vulnerability. This situation has provoked, in recent years, a phenomenon of migration due to land use change. During this time, many academic and international cooperation environmental projects have been implemented to help these vulnerable populations, but they have had a limited impact due to the complexity of the situation. The Integrated Water Management component of the CReA Project, funded by VLIR, seeks to find solutions to increase the resilience of communities to water-related problems with an integrated and sustainable vision. The transdisciplinary projects developed are carried out with and for the communities, with the support of other national and international actors. The project "Agua y Vida en La Maica" works in a vulnerable agricultural area of the municipality of Cochabamba and established, with the community, a work based on 3 fundamental axes: "Understanding" through research, "Learning" through knowledge exchanges and "Proposing" with the development of tools adapted to the reality of the community.

Keywords: environmental action projects; vulnerable communities; transdisciplinary, integrated water management

**DIRECCIÓN DE PROYECTOS DE ACCIÓN AMBIENTAL CON COMUNIDADES VULNERABLES EN
BOLIVIA: ENTENDER, APRENDER, PROPONER**

El desarrollo caótico de Bolivia ha llevado a una contaminación ambiental alarmante en los últimos 50 años, y está exponiendo a las comunidades rurales a una vulnerabilidad socioeconómica y ambiental creciente. Esta situación ha provocado, en los últimos años, un fenómeno de migración de la población por el cambio uso de suelos. En este tiempo, muchos proyectos de acción ambiental, académicos y de cooperaciones internacionales se han implementado para ayudar a estas poblaciones vulnerables, pero han tenido un impacto limitado por la complejidad de la situación. El componente de Gestión Integral del Agua del Proyecto CReA financiado por el VLIR-UOS, busca encontrar soluciones para aumentar la resiliencia de las comunidades frente a problemas relacionados al agua con una visión integral y sostenible. Los proyectos transdisciplinarios desarrollados se realizan con y para las comunidades, con el apoyo de otros actores nacionales e internacionales. El proyecto "Agua y Vida en La Maica" trabaja en una zona agropecuaria vulnerable del municipio de Cochabamba y estableció, con la comunidad, un trabajo basado en 3 ejes fundamentales: "Entender" gracias a la investigación, "Aprender" por intercambios de conocimiento y "Proponer" con la elaboración de herramientas adaptadas a la realidad de la comunidad.

Palabras clave: Proyectos de acción ambiental; Comunidades vulnerables; Transdisciplina, Gestión integral del agua

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1. Introduction

Since the transition to a democratic model in the country in 1982, Bolivia still faces sustained political and economic issues. Thus, Bolivia didn't reach a clear economical resilience due to long interruptions in the country's development. This uncertainty causes severe distress to its population and affects its vulnerability (Morales, 2001). For 10 years, Bolivia increased high public spending and domestic credit to maintain rapid economic growth. Due to the international context, these measures increased public debt. On the other hand, the country's economic growth has contributed substantially to the reduction of poverty and extreme poverty in Bolivia (Arauz, 2019). The last studies show the recession situation in Bolivia was exacerbated during the COVID-19 pandemic, leading to a rebound in poverty (World Bank, 2023).

The region's economic development, specifically Bolivia, is based on extracting non-renewable natural resources (agriculture, mining, hydrocarbons) (Kohl and Farthing, 2012; Rosario Filho, Satoris, and Scala, 2021). To accompany this process, the Law of Mother Earth of Bolivia, which was approved on December 21, 2010, aims to "recognize the Rights of Mother Earth, as well as the obligations and duties of the Plurinational State and society to ensure respect for these rights ". The law recognizes that human beings have to take into account the coexistence with everyone, especially the impact that our actions have on Mother Earth (Pachamama) to live and take decisions.

It has been highlighted that poverty in Bolivia is aggravated by a number of serious environmental problems (water pollution, air pollution, soil erosion, deforestation, and natural disasters) (Miller and Villaroel, 2019). Moreover, the climate change effects lead to an increase in the vulnerability of Bolivian population. Indeed, low-income populations of developing countries are the most exposed to climate change impacts (Oxfam, 2019).

In the last 20 years, the global situation in Bolivia led to an increase in the environmental vulnerability of Bolivian communities, and the phenomenon of population migration was accelerated. A key factor in these issues is linked to water management. Even though the Government has made significant progress to improve the coverage of drinking water distribution and sanitation facilities and created this public space to analyze and make decisions, Bolivia is still among the worst ranked countries of Latin America and still has problems about legitimacy and suitability of representatives in the decision forums. (Proyecto CReA, 2017). The main impacts of this problem are social conflicts, food production problems, public health and waterborne diseases, and deterioration of aquatic ecology impacts/effects (Miller and Villaroel, 2019). Water is a scarce resource and has always been a controversial issue in Bolivia. In the past, it was extremely difficult to find agreements on how the resource should be regulated and who should have legal rights to it (Proyecto CReA, 2017).

The deterioration of the quality and quantity of water resource is strongly linked to the lack of understanding of the nature and complexity (multi-sector and multi-actor) of the water problems. In addition, climate change and extreme weather events request new and urgent response mechanisms to face the water challenges, both in the urban and rural areas (Soruco et al., 2015; Bauer et al., 2018; Kinouchi et al., 2019; Whitt, 2022). Meanwhile the water problems are usually faced as monodisciplinary problems, so that all the solutions that will be developed will be incomplete, as they are not integral solutions but focus on the short term (Brandt et al., 2013).

2. Goal

Develop a work methodology to improve the integrated water management in vulnerable communities of Bolivia using La Maica area as a case study.

4. Bases for project methodology

4.1 Community approach and communication process

Reaching out to the communities is essential to communicate and make visible the existing problem, identify the stakeholders, and generate alliances, through these proposed action plans that address the identified problem (Conrad and Daoust, 2004). Based on the situation of the communities, the approach to the communities was done in stages (Benavides et al., 2019). Contact was initiated with a small team of university researchers associated with stakeholders (mainly NGOs) requesting a meeting with community leaders to explain the project and its objectives. Several meetings were needed to discuss the interest and degree of involvement of the communities through their leaders (Hahn et al., 2023). The communication process was decided through meetings with the authorities of the community respecting the social organization.

4.2. Project construction and participation process

Once approval was obtained, collaborative workshops with the community members were organized to collect information, on the environmental situation and water issue perceptions of the communities and to classify the general problems identified by the community. Then the academic team with its stakeholders identified the points to be worked on in future years based on the previous prioritization and their capability (Bryson et al., 2013). A work proposal was elaborated and presented initially to the leaders and then to the community. Once the proposal was validated by the community, a work agenda was drawn up.

For project construction, project portfolio management (PPM) is a technique commonly employed to align a portfolio of projects with strategic objectives. (Kaiser, Arbi, and Ahlemann, 2015). This project used the PPM methodology, as it provides robust features that helped track the priorities of each project area. The response times, the feasibility of a project, the actors to be involved in an integral vision, and the prioritization of the community were evaluated. Interdisciplinary teams of academics and stakeholders were built to assess their degree of involvement (Hahn et al., 2023). Several components were included in the proposals such as stakeholder interaction, information generation, communication processes and the generation of knowledge and technology transfer material. In each proposal, the team project with the community identify criteria for the evaluation of materials as support tools for the sustainable development of the community (Baffo et al., 2023). A continuous redesign of the participation process and degree of involvement of the different stakeholders was needed and planned due to the different phases and interests of the project (Bryson et al., 2013; Hahn et al., 2023).

4.3. Mono, inter, and transdisciplinary project phases

Participation of the stakeholders has emerged as an appropriate approach for enhancing natural resources management (Luyet et al., 2012). During the different stages of the projects, stakeholders have planned roles. Depending on the stages, the actors change, and the activities can be mono, inter, and transdisciplinary (Brandt et al., 2013; Kyaw and Sakakibara, 2022). The academy is the permanent actor of the stages, but it can have different roles: reflective scientist, process facilitator, intermediary, knowledge broker, transacademic interface manager... (Hilger, Rose, and Keil, 2021). The community is not involved in all the stages, but it is agreed that it will be constantly informed of the progress of the process. For all the projects, in order to avoid the mistakes of previous environmental action projects in Bolivia, it is important to monitor and follow up on the processes before, during, and after the end of the projects.

5. Methodology proposal

The methodology of the environmental action project “Agua y Vida en La Maica” oriented to water management is presented below.

5.1. The approach through common times and languages

The success of environmental action projects is mainly based on the ownership of the project by the community. This involvement of community stakeholders depends on the stakeholders' understanding of the problem, its importance, its effects, the time frame for solving the problem, the roles of the community, and the impact it will have on their lives. Therefore, dialogue and communication are paramount at each stage (Brandt et al., 2013).

In Bolivia, the academy is considered to be disconnected from the reality of society and has few links of trust with civil society, public services, and the business sector. The main connections that exist are at the level of international cooperation and NGOs. When in contact with the communities, an atmosphere of distrust towards the university has been felt. Academics are considered as an intellectual believed elite from urban centers, that do not know the reality of vulnerable rural communities. Therefore, strategies have been needed to create academy-community links based on trust (Tejedor and Segalas, 2018; Kliskey et al., 2023). Thus, the approach process was planned to be on 2 years organizing events like workshops, meetings, and expositions.

Regarding the communication process, the steps for working with communities are well-established and hierarchical. First, contact has to be made between the head of the project and the leader of the community. Then the authority transmits to his or her team. The project team has to present the project to the rest community leadership team. Only with the approval of the leadership team, the project team can be introduced to the community through a public meeting that is organized on the first Sunday of every month. At this meeting the community votes if they agree so that the project team can present a work proposal or an activity. Thus, the cycle starts again. For external communication, the team project needs the approbation of the leaders of the community. It's important to mention that, as a request of the community, a written document has not been made with the authorities, but the agreement has been made verbally between the project leader and the head of the community.

Another problem that has become evident in the project process is the communication issues between different actors. In several cases, it was noted that the dialogue was complicated between the actors due to personal issues, vision, politics... Thus, on different occasions, the academic team had to play the role of mediator or spokesperson for some stakeholder (Hilger, Rose, and Keil, 2021). For example, in the project, the UCB team was the mediator between the community of La Maica and the company SEMAPA, the municipal drinking water and sewerage service in Cochabamba moderating different workshop to establish a constructive dialogue. In these meetings, it was identified the use of different terminology for the water management concepts. Thus, a workshop including all the stakeholders, was organized by the academics to standardize the concepts and key terms of the project (Fam and Sofoulis, 2018).

Moreover, it is necessary to consider that in the different rural areas of Bolivia, the population speaks native languages (Quechua). It was an aspect that was not initially taken into account. Most of the leaders speak Spanish but in the general population, they are much more reactive to speech in native languages (Siew et al., 2016). Therefore, on certain occasions, it was necessary to request to translation services.

The time was also an important factor in approaching the communities (Deutsch et al., 2021). The academy and rural communities work on different timeframes. Therefore, after the initial meetings with the stakeholders, it was necessary to permanently re-evaluate the work schedules. Similarly, it was necessary to make the community understand that the joint work

schedule requires commitment from all the parties involved. Several months were necessary to be able to present the projects, taking into account all the approval cycles. After the first entries in the community, it was considered relevant to reduce the objectives of the projects, so that realistic projects can be proposed for all the actors.

5.2. Collaborative work organization

In the different first proposed works, the transdisciplinary component was in each stage of the process. By implementing the projects, it was evidenced that the transdisciplinary component cannot be recurrent at each stage of the project because it involves diverse competencies (Landström, 2017). In addition, it was highlighted that each activity depends on the characteristics of the community, the problem to be worked on, and the willingness of the different actors to participate. However, collaborative processes can be implemented in various steps of the project through the evaluation from the head of the project and the stakeholders. For example, in environment quality study, data generation may require methodologies with very specific skills needing high-precision material (analysis in specialized laboratories, modeling...), consequently transdisciplinary work is not an evident option. However, the community can participate in certain stages of this data collection (sampling, recognition of the area) (Figure 2) (Ajmal et al., 2020).

Figure 2. Identification of water irrigation canals with farmers of Maica Central area



Source: own elaboration, 2019.

A key point for the success of “Agua y vida en la Maica” project is that, despite the fact that all the actors are not participating in all stages, progress and results must be communicated within the entire team and the community. Therefore, within the different implemented projects, key moments for the return of information have been planned in team meetings and public meetings with the community, generating adequate communication strategies and material.

5.3. "Understanding", "Learning", and "Proposing" axes

As previously mentioned, the “Agua y Vida en la Maica” project includes various complementary components in order to have a real impact on the community and to ensure project achievements and sustainability. Three key components that require mono, inter, and transdisciplinary work were implemented with the community: "Understanding" through scientific research, "Learning" through knowledge exchanges, and "Proposing" through the development of tools adapted to the reality of the community. These three pillars are interdependent but interconnected at each stage of the project. It's important to mention that the components are not unilateral between the stakeholders, and it is necessary to build a trust connection between the actors to reach each step of the project (Kliskey et al., 2023).

The research component is very important to be able to make these real changes because it is linked to the generation of data (Kurniawan et al., 2022). In Bolivia, there are many environmental diagnoses carried out by universities, international cooperation, and public services. But in most cases, the information is not published or is not available. Moreover, the results are very specific and only show a fraction of the reality. In order to respond to the needs of environmental action projects, it is necessary to strengthen the academic actors in Bolivia (Nieto-Caraveo, 2005). In this case, at UCB, the entire research axis was restructured in order to sustain this kind of project. The strengthening of the university goes towards the training of the research staff and the investment in material resources of the research entities.

Regarding the structure of the research projects, it has to follow a series of steps. Given the complexity of integrated water management, biogeographical, physicochemical, socio-cultural, economic, and politic factors are involved. Working in parallel with all these components requires large human resources and can quickly lead to the saturation of the community. Consequently, it can conduct to a decrease in the degree of involvement of the stakeholders (Hahn et al., 2023). Therefore, sequential work allows a better response and community awareness of environmental problems. In the case of the "Water and Life in Maica" project, as a baseline, an environmental diagnosis of contamination began the study (2 years). The second phase was to evaluate the impact of this contamination on ecosystems, agricultural activities, and public health (3 years). The last stage of the project resides in economic and governance studies of water management (2 years). At each stage, the academic members worked closely with the community through collaborative moments and feedback (Figure 3).

Figure 3. Meeting to return research results to the Maica Central community



Source: own elaboration, 2019.

In the learning component, it is important to highlight that knowledge transfer is done among the different actors: from the stakeholders to the academy, from the academy to the stakeholders, within the academic team, and within the community (Fam and Sofoulis, 2018). The successful multilateral knowledge exchange is the base of sustainable environmental action projects (Schönenberg et al., 2017).

In the first meetings with the community, ancestral knowledge related to water management and water imaginaries were systematized (Lane and Sulas, 2022). This information was then translated into a scientific language to understand the water management system in the study areas and to prepare the research projects.

Within the different projects, the return of information from the university to the community is a critical moment to sustain the knowledge exchange (Bracken and Oughton, 2006). As it mainly consists in training the population on scientific information, the adapted language is primordial. Thanks to the community feedback, the project communication has been based on visual

methodologies. These strategies are linked to senses and allow to transmit cognitive–affective information to have a more receptive impact (Savolainen, 2022). In addition, a study carried out by Saavedra Tellez (2022) in the Maica area concludes that the perception of contamination by communities is related to the senses (mainly smell and vision), which confirms the need to base communication and training processes on this factor.

In the Maica area, the development of a project logo with the community was very useful to involve people and improve the investment degree of the community. During the pandemic, a drawing contest was organized open to young people of the area on the theme of water and life in Maica.

Figure 4. Drawing of the contest about water and life in LA Maica adessed to young people from the Maica area during the pandemic



Source: own elaboration, 2022.

The figure 4 presents the drawings of the winners, which contain many similar elements: the sun, the mountains, the river, and the crops. Based on these elements, a logo was created (Figure 5), which was validated by the community leaders. This logo is used in all the communication material of the project.

Figure 5. Logo of the project "Water and Life in Maica" based on the work of the winner of the drawing contest.



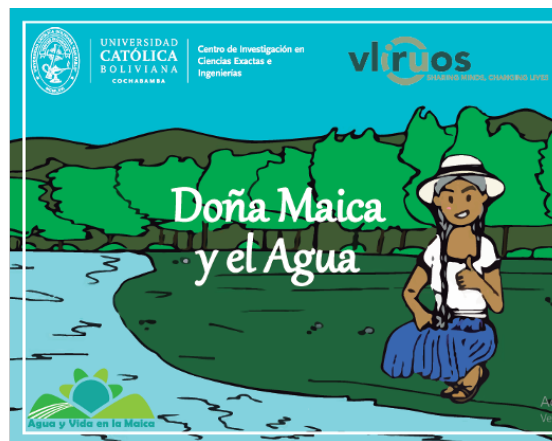
Source: own elaboration, 2021.

Moreover, printed and video materials were developed with the community to explain the data in a simple way and have a wide dissemination of the information. For example, a tale in Spanish and Quechua that explains what pollution is and how it affects life in the area was elaborated and then a video of the tale was made with the voice of community members (Figure 6). The visual methodology of the project work was key to positioning the institution and connecting it with the community, but also for the transfer of knowledge (Ley et al., 2020).

Figure 6. Doña Maica y el agua tale



Noqa kani uj chay yakuta jap'ina caj, Mama Mayka sutiy, imaraikuchus noqa
jallp'a llank'a kani, wakajmichiy ima, chayrayku yakutapuni mask'ani,
ajina qarpanaypaj, alfasta, sarasta, tukuy k'omertapis wakaspaj.
Ajinata ruayku ayniypipeqa qolqeta tantanaykupaj.



Source: own elaboration, 2022.

Regarding the internal training of the communities, it has been very effective to be able to work with teachers and young people through the educational units of the area. Some information generated by the research and transmitted to the population has been worked on with the teachers so that it is included in their work plan (Figure 7).

Figure 7. Group work (students and teachers) on research topics at the Bolivia B school in la Maica Quenamari.



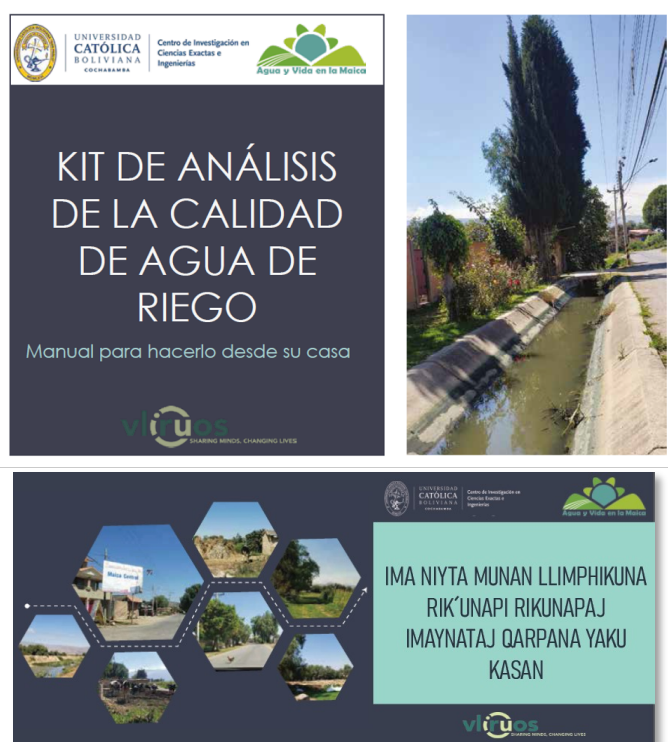
Source: own elaboration, 2021.

This transmission in cascade teacher-student-families allows an appropriation of knowledge by the population, an important factor to strengthen the resilience of the community (Ley et al., 2020). In the educational units of La Maica, educational material is being generated to include new educational tools generated from the research work. Therefore, the stakeholders of the project trained academic staff on the generation of knowledge transfer material. On the other side, teachers of the community are being trained on the use of educommunicational material generated by the research projects as educational tools.

The last component of the project corresponds to the generation of tools to solve the problems related to water issues in the area. Research and knowledge transfer are very important in this process as a comprehensive and realistic vision of the problem is needed (Ajmal et al., 2020). Moreover, to ensure the sustainability of the solution, the technology transfer has to be made in an adequate way.

In the project, a homemade irrigation water analysis kit has been developed with a double validation: analytical and collaborative (Figure 8) (Rodríguez Villaroel, 2021). Unfortunately, the use of this kit could not be sustainable in the community since an adequate transfer was not achieved. The community members have seen the tool as a brake on their activities. Therefore, the community leaders propose another strategy through the youth of the area. At the moment, this tool is used as educational material to support science education in educational units of the Maica area. It is expected to evaluate the degree of acceptance of the tool by the community members using this new strategy and the impact of the kit on the management of water and crops in the study area.

Figure 8. Irrigation water quality analysis manual cover pages.



Source: own elaboration, 2021.

The character of free access and replicability of these tools in other areas at a national and international level is a fundamental parameter to strengthen the resilience of vulnerable communities in the region (Archibald et al., 2023).

6. Conclusions.

Based on what was previously presented, it can be concluded that environmental action projects, like the “Agua y vida en la maica” project, include many factors and actors in order to have a real impact on the vulnerability of communities. It has been shown that the academy is one of the multiple actors with diverse roles within the project. In addition, the times of these

projects require a long-term planification to be able to establish trust links with the community, define the problem, design a project, implement the activities, and follow up after the project.

The structure and operation of the projects have to be well-defined and clear for all the actors, but a certain flexibility is needed. The incorporation of inter and transdisciplinary methodologies requires a permanent dialogue between the actors and the negotiation of commitments.

The implemented environmental action projects have generated many changes in terms of the vision of research projects in the university, in the communities, and in the institutions in Bolivia. nevertheless, the great challenge of this work is to be able to awaken public services to the need for these multi-stakeholder projects to improve the resilience of vulnerable communities. The political issue is a great brake on the implementation and sustainability of these projects in Bolivia.

Regarding the three components proposed in this project ("Understanding", "Learning", and "Proposing"), the diversity of the available strategies allows adapting to the variability of the situations. These components are interconnected and transversal in each step of the project. Therefore, an evaluation and a systematization of each experience are necessary to be able to establish key points of collaborative work with communities in Bolivia.

Each actor has to be able to get out of their comfort zone to understand the extent of the environmental disaster in Bolivia and the effects on vulnerable communities. Therefore, dialogue processes are necessary and have to be bilateral in order to resolve these problems.

The "Agua y Vida en la Maica" project is very ambitious regarding the political forces involved in the integrated water management, but the links established between the different actors, and the results achieved in recent years suggest that the culture of environmental action projects in Bolivia is turning towards a long-term collaborative integrated vision.

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