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Local Participation in Forest Watershed Management: Design and Analysis of Experiences in Water Supply Micro-Basins with Forest Plantations in South Central Chile

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Abstract: The joint "International Forests and Water Conference 2018" highlighted among its main conclusions the need to involve the viewpoint and participation of local communities in the management and monitoring of forest watersheds. This topic constitutes a strategic and transverse challenge for the sciences and public policies in the current context of global climate change. As a contribution to this challenge, the aim of this research was to qualitatively describe and analyze a territorial intervention model based on two case studies. Both involve stakeholders from the public sector, forest companies, and rural communities within the framework of implementing a participatory process at a local scale. The first case study was based on the collective creation of a set of indicators for local water monitoring. The second case, through the incorporation of the social and local dimension, culminated in the collective creation of a forest watershed management guide. The research hypothesis was that the inclusion of stakeholders and local knowledge in forest watershed management is essential to create and/or strengthen local abilities that ensure the involvement of communities in water governance, surpassing the current informative and consultative approaches. The research methodology was qualitative, and the data collection strategies were focused on the compilation of the process, the participatory work, and gathering diverse local knowledge. The data analysis included content tabulation, including both local indicators and ones extracted from the guide. In both cases, the systematization process and the main empirical findings were included. Among the findings, it was observed that both the pilot of local indicators and the design of the forest watershed management guide confirmed that the main challenge of local participation is the effective inclusion of local knowledge in water governance. This ethical and methodological challenge must be approached more rigorously and with more commitment.

Keywords: water management; participatory monitoring; forest watersheds; social capital; water governance

1. Introduction

Chile contains some of the driest areas in the world, yet human activities in these areas require large volumes of water. The result is regions experiencing high water scarcity leading to environmental degradation, conflicts, and reduced industrial productivity [1].

This situation is a serious matter in Chile as the rural population can only access drinking water by constituting a community organization that allows its management. This is the only way the

population can access resources for infrastructure that guarantee the attainment of quality drinking water. The concept of "communities" in this study means rural settlements with small scale local economy that mainly produce wine and fresh produce. They occasionally sell their products on the formal market individually or collectively and have cultural traditions associated to the land. In the last few decades, water availability has been progressively worsening in Chile. This situation has caused conflicts affecting farming productivity systems and rural life. This phenomenon has advanced simultaneously with water rights privatization (1980), expansion of large-scale production activities, and depopulation of rural areas [2].

Industrial forest plantations are objects of socioenvironmental conflicts, especially in the so-called "countries of the South" [3,4]. Stakeholders and communities from different territories have reported that large-scale forest activity in Chile has had many consequences. Those concerning the impact of plantations in watersheds and their effects on local economies are highlighted [5].

Best management practices (BMPs) represent a compilation of technically feasible and politically acceptable ways of addressing the potential negative environmental impacts that can be associated with forest management and timber harvesting activities [6]. In Chile, forest operations and regeneration must be monitored as presented and authorized in the management plan [7]. BMPs for Chile's forests do provide detailed prescriptive processes for various forest impacts and aspects [8]

The main questions of applied research addressed in this study are associated with the obstacles and challenges for the design and implementation of water governance processes in Chile. Principally, failing to recognize different viewpoints and local knowledge regarding water affects its management and governance. This is especially the case where institutional views (private and public) are imposed in territories inhabited by communities from other economic and sociocultural spheres.

This research analyzed two case studies that serve as a critical reference for the methodological design of local participation within the framework of rural development processes in forest ecosystems. The first case study was based on the collective creation of a set of indicators for local water monitoring. The second case, through the incorporation of the social local dimension, culminated in the collective creation of a forest watershed management guide.

Therefore, through the local pilot and the forest watershed management guide, this research proposes to recognize the local perspectives and legitimize them using indicators that demonstrate the construction of knowledge and practices related to water.

In agreement with the proposals of Vargas [9] regarding the water situation in Latin America and those of Guzman [10] regarding the case in Mexico, the objective of this process is to guarantee the participation of all water users in its governance. Additionally, we expect that companies and local governments face the challenge to comprehend and recognize local evaluation from socio-ecological approaches and environmental knowledge.

The basis for the suggested analysis of local participation in water management comes from two sources. The comprehension of local perspectives related to environmental rationality, and the contemporary debates regarding best forest management practices.

For all the above reasons, this research hypothesis suggests that the stakeholders' participatory processes and local knowledge in forest watershed management guarantee the incorporation of communities in water governance, surpassing the current informative and consultative approaches. Consequently, the objective of the present research is to critically evaluate the issue of community and local knowledge systems' participation in the management of forest watersheds based on two applied research experiences in water management, and to identify the factors that can influence the lack of consideration of local participation as an effective tool for the development of the community. This objective becomes very relevant in the current situation of the country because a new bill on integrated watershed management has been introduced into Parliament (Chile, October 2018). This will require important regulatory changes regarding water in rural areas.

The methodology used was the critical examination of the design and pilot application of two experiences involving local participation: local water monitoring and the incorporation of the social

variable in a forest watershed management guide. The process of both initiatives involves an exercise of applied research and an interdisciplinary study focused mainly on (a) the design and participatory implementation of a local water monitoring process and its pilot application (case 1) and (b) including the social variable in the process of creating a forest watershed management guide in water supply basins involving different stakeholders (case 2).

Consequently, the main contributions of this research are the critical review of current approaches on local participation in water management and the design of tools that ensure the visibility of local knowledge and practices.

2. Materials and Methods

This research analyzed two case studies that serve as a critical reference for the methodological design of local participation within the framework of rural development processes in forest ecosystems. These cases include the design process of a local monitoring pilot and a forest watershed management guide. In both cases, the team from the Forest Institute of Chile and University of Concepción—with specialists from the forest and social sciences—designed and implemented an approach to local stakeholders, who have an impact on the water issues in the area (community, municipality, other public organizations, and forest companies). This approach was based on the premise that there are many different evaluative strategies regarding watershed management. They come from different cultural, economic, and institutional approaches that are represented by their inhabitants, municipalities, public organizations, and forest companies, respectively. In this scenario, big forest companies are the dominant economic power and forestry is the principal land use activity—a situation that is not always seen as compatible with other land uses such as agriculture and viticulture within the same area. This dominance causes socioeconomic and cultural impacts in the territory.

2.1. Theoretical Framework

2.1.1. Case 1

From the first source, the definition of socio-ecological systems [11] is used, which states that issues such as "water vulnerability" can be understood from the coupling of social and ecological subsystems [12] and the complex interaction among different types of users, knowledge, leadership, and social capitals present in the same territory. From this perspective, participation is initially understood as the action or the fact of "taking part in, having a part in, being a part of" [13]. Consequently, participatory monitoring is understood as an articulation of diverse stakeholders—from different economic and social backgrounds—emphasizing the value of relationships, interactions, and feedback that are created among them. In order to establish governance, this should be done under social capital conditions and recognition, which can be built and rehearsed through processes promoted by these types of approaches. Addressing this challenge becomes urgent given the vulnerability of Chile regarding climate change [14].

This scenario—where community participation has a more visible role in ecosystem management—poses some important scientific and political challenges, such as recognizing the factors affecting the success or failure of these initiatives. Therefore, addressing the topic of participatory management of forest watersheds—as complex socio-ecological systems—involves acknowledging a big paradox in Chile. Although water is a private resource in our country, in rural culture and productive localities, this resource is still considered a common resource.

Consequently, the transformations in water availability and the evidence of its progressive scarcity in the last few years have led local stakeholders to imagine new ways of preserving and protecting this resource. Via these new ways, it becomes evident that what Leff [15] defines as "environmental knowledge" would be the basis of local environmental management.

The environmental knowledge of the communities is where the consciousness of their environment is merged with the knowledge about the properties and ways to sustainably manage their resources,

their symbolic formation, and the sense of their social practices, where different processes are integrated in the exchange of environmental knowledge [15].

2.1.2. Case 2

The second source used in this analysis came from the literature on best management practices (BMPs) within the forest sector. BMPs are practical measures implemented to mitigate the impacts of human activities on water resources [16]. Most of the states, provinces, and local governments of every country, as well as land management agencies and private companies, have developed their 'own' BMPs. These recommendations are based on scientific studies and legal guidelines tailored to each country, as many decisions regarding natural resource management at site level are based on a range of different factors according to local contexts.

One of the strategies used within the BMP framework has been the design and application of manuals and/or guides that help the dissemination of the approach and specific measures. Regarding water management, the best management guides worldwide have focused their interest mainly on water quality [17], but there are fewer references to best management guides to approach the issue of water quantity. Most guides have been created so that the forest companies participate "voluntarily" in the application of these practices, with the exception of guides developed in South Africa (environmental guidelines for commercial forestry plantations in South Africa) and Australia (water quality, biodiversity, and codes of practice in relation to harvesting forest plantations in streamside management zones), where some of its guidelines have turned into laws. Another exception is the documentation developed by the U.S. Forest Service, an entity that manages a significant number of plantations and forests. Similarly, guides developed in New Zealand were mainly focused on water quality and the protection of riverside areas [18,19].

Nowadays, private corporations and public organizations face the challenge of updating their tools to guarantee the participation of the population in development processes. In the case of the companies, it was observed that although they apply internal protocols to implement information and consultation processes, they are not enough or fail to guarantee the absence of conflict [20]. The public institutions lack coordination mechanisms that ensure governance where communities can assume a more active role in social-environmental processes [21].

2.2. Description of Case Study

2.2.1. Case Study 1

Characterization of Study Areas

The area of the study was the Batuco micro-basin, located in the commune of Ránquil, in an area called inner dryland (a territory without irrigation located in the eastern side of the Chilean Coastal Range) known as Itata Valley in the Ñuble Region, Itata Province in South-Central Chile.

The Batuco micro-basin (Figure 1) is mostly located in the Itata Bajo sub-sub-basin. Because of the heavy erosion affecting the Coastal Range, the river located in the Itata Bajo sub-sub-basin suffers heavy siltation of its course and river estuary [22].

The main flow of the micro-basin goes from south to north to the water intake area, which is where the water pumps supplying the community of Batuco are located. In the higher area of the micro-basin located at the south, there are agro-forest plantations that belong to small-scale forest owners. In the middle and lower part, there are forest plantations (*Pinus radiata D. Don*. and *Eucalyptus globulus Labill*) that belong to middle-scale forest owners and the big forest company (Figure 2).

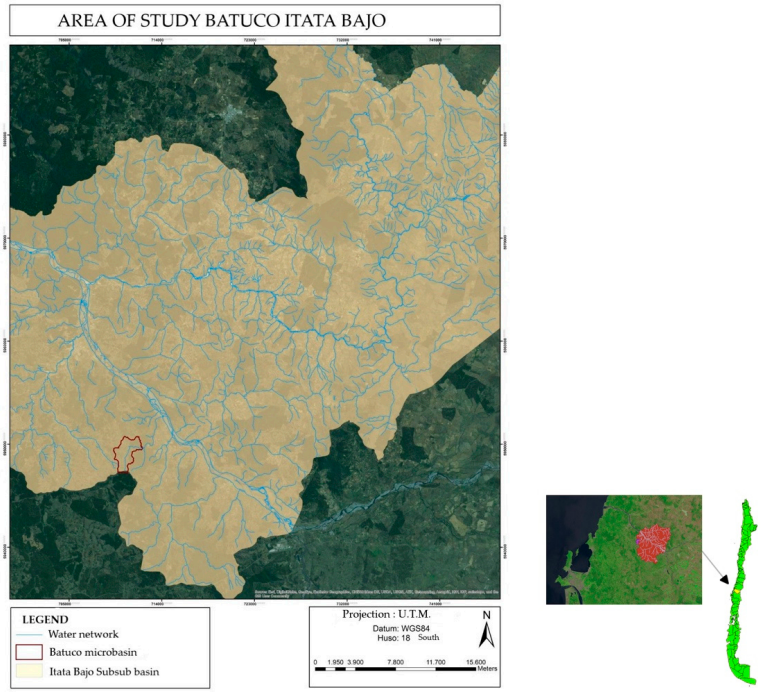

Figure 1. Location of Batuco micro-basin (red) in Itata Bajo sub-sub-basin (light brown). Source: compiled by authors of MOP [22] and www.bosquesyagua.cl.

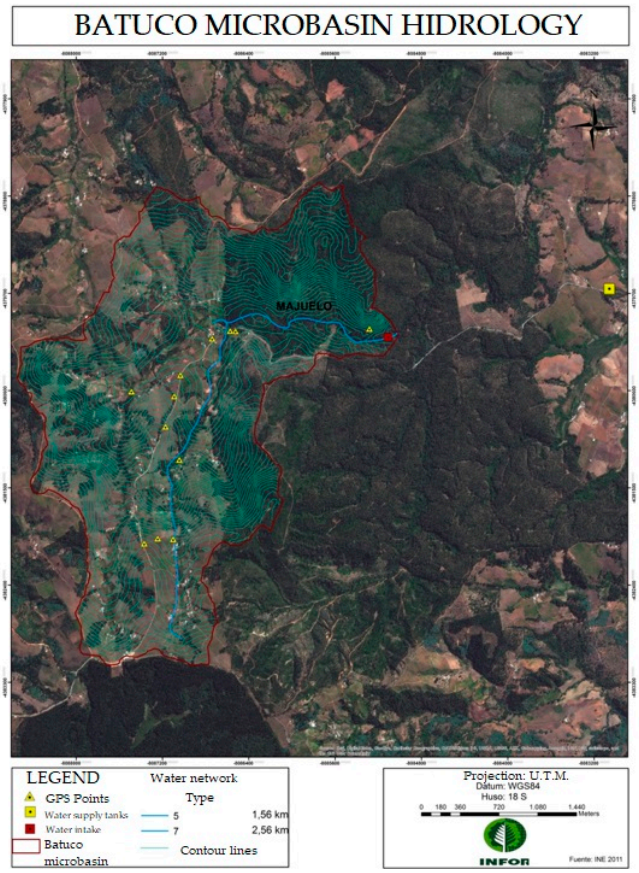

Figure 2. Water supply system (light blue), water intake area (red dot), and supply pumps (yellow square) of Batuco Water Committee, Global Positioning System (GPS) points (yellow triangle). Source: Compiled by authors from www.bosquesyagua.cl and field study.

Characterization of the Consulted Population

Ránquil is a highly rural commune, comprised mainly of forest plantations, and has been declared a socio-economically underdeveloped zone (Zona de Rezago Socioecónomico) [23]. The water supply of the community of Batuco—in terms of quality and quantity—depends greatly on the temperature and the water regime, as well as the agriculture and forestry practices carried out in upstream areas. In terms of production, the local population works on agriculture and viticulture at a small scale.

Of the 284 people living in the Batuco area, only two have access to drinking water and one-third of the population does not have a sewage system [24]. The study began with a total of 30 people, and was subsequently reduced to twelve. A total of 35 monitoring forms were validated and analyzed from September to December of 2016. Considering the qualitative nature of the methodology, the sample is significant as it illustrates how local community members understand water, its importance, and its corresponding risks and expectations.

2.2.2. Description of the Process

Local Participation in Monitoring of the Batuco-Ránquil Micro-Basin

Local water monitoring was understood as a social process that emphasizes the local cultural worldview regarding water. This vision comes from the criteria built and shared by the people living in a territory currently facing water scarcity. These criteria help to create and reproduce environmental knowledge. The design of the participatory process in Batuco involved using environmental knowledge as the main viewpoint towards the beginning of the networking process, dialog, and participatory construction. For all the effects, environmental knowledge was the framework used to establish and comprehend the worldview regarding water and its management from daily life experiences. Consequently, this perspective contributed legitimacy and coherence to the identified indicators and their scope according to the local living experience.

The work plan suggested by the team of specialists from the Forest Institute of Chile and the University of Concepción was consensual and adapted to the time and language determined by the local organization. The work plan included five phases:

Phase 1: Setting agreements. After an exchange of ideas regarding the benefits and implications of the process, the members of the Water Committee of Batuco decided to accept the challenge. Then, the first work plan was proposed and agreed upon during the months of September to December of 2016. Interviews with the representatives of the Committee and dialog with the assembly permitted the development of this stage. Alongside the agreement setting process, there were conversations among the other stakeholders present in the basin; that is, the municipality, forest company, medium-scale forest owners, neighborhood organizations, and farmers from the Chicura area (higher area of the basin).

Phase 2: Creation of indicators. The members of the Committee were invited to identify and share the criteria they used to evaluate the water availability and supply on a daily basis. These criteria were defined as local indicators as they constitute the shared references surrounding water in the local environmental knowledge systems. The methodology used was a meeting held at the organization headquarters; people were invited to a motivational storytelling session and collective meditation to reflect on the history of water in the territory. The sharing of personal and family stories evoked memories and emotions. Afterwards, these were transformed into criteria that would become the local indicators. In order to identify these criteria, special attention was paid to the emphasis given to specific variables and to the causal relationships established by the behavior of those variables and water availability.

Phase 3: Validation of indicators and creation of the monitoring form. A preliminary version of the local monitoring form was created based on twenty-two indicators lifted from phase two. After the term "form" was deemed the most appropriate for the local language, then its contents were reviewed, and its application was prepared. In this phase, the indicators were specified and adjusted to the local language, attempting to confirm their understanding and avoid any confusion.

Phase 4: Setting agreements for the application and systematization. To test the form, each family was asked to complete the form weekly and then deliver it to the president of the Committee, who was trained to systematize the data in order to obtain results. The methodology used included meetings and interviews with key stakeholders, as well as meetings with the Committee's leader and board.

Phase 5: Pilot application. In this phase, a total of 35 forms were completed. Members of the organization who participated in the process and all the phases completed the form once a week and then delivered it to the president of the Committee, according to the agreement.

Initially, the pilot included the presentation of the obtained results in a large meeting with the rest of the stakeholders—who were part of the local socio-ecological system—including the municipality and the forest company. Although this phase was not completed, because of scheduling issues and stakeholders' desire to meet separately, the presentation of this experience and its results could help to recognize the importance of local environmental knowledge in sustainable forest management, specifically regarding the participatory management of the local socio-ecological water system.

2.2.3. Case Study 2

Incorporating the social variable in the creation of a forest watershed management guide, called "Guide for Best Management Practices in Forest Watershed Management". The following is a description of the three stages of the process of the incorporation of the social variable in a proposal of best forest management practices to protect the water resources in water supply watersheds.

Characterization of the Consulted Stakeholders

Involved the participation of local stakeholders, as well as professionals and specialists from public organizations, academics, and forest companies. There were 61 participants in total (28% forest companies, 18% academics, 16% local stakeholders, 15% small- and medium-scale forest owners, 13% public service, and 10% forest union associations).

Description of the Process

Stage 1: Consultation with key stakeholders. The objective of the process included analyzing a draft of a BMP guides created by the Forest Institute of Chile based on the review of international and domestic BMP guidelines to incorporate social demands from stakeholders regarding forest management in water supply watersheds. The process was carried out during 2015 and 2016.

The participation of relevant stakeholders was ensured, including forest companies, small- and medium-scale forest owners, forest contractors, members of the academia, public services, local government, and communities.

Stage 2: Design of the guide. After the reception of comments finished, the structure, language, and graphics of the guide were designed by creating a content sketch of the different chapters. The sketches were presented to the aforementioned stakeholders to guide the language and messages to be understood by a wide variety of stakeholders.

Stage 3: Validation workshops. Four workshops were conducted including stakeholders from big companies, small- and medium-scale forest owners, members of the Water Committee of the Bío Bío working group (a public and private committee of the Region), and specialists and students of the Social Sciences program of the University of Concepción. The goal of these workshops was to validate the aspects related to the scale of application and the relevancy of content to different stakeholders.

3. Results

3.1. Case Study 1: Local Monitoring of the Batuco Micro-Basin

The participatory process for the creation of the local monitoring system resulted in a total of 20 indicators concerning local environmental knowledge surrounding the water issues (Table 1). These include four main dimensions regarding the community's water management.

Table 1. Local indicators regarding the water situation in the area.

Socioenvironmental Effects	Governance	Local Practices	Biological Changes
There is not enough water to fight fires.	As the Water Committee, we are not in periodic contact with the forest companies.	At home, we are careful with the water; we don't waste it.	There is not enough native vegetation to protect the watershed.
We couldn't take good care of the vegetable garden for lack of water.	As the Water Committee, we are not in periodic contact with the municipality.	We don't have techniques for efficient irrigation.	The water changes every day, especially the color.
There is not enough water in the river to swim in the summer.	I participate in neither the actions concerning available water protection nor solutions for water-related issues presented at the local organization.	In summer, we had to go swim somewhere else because the river didn't have any water.	We store some water in case of an emergency, but it goes bad.
There are new houses that require more water availability.	No actions have been taken as a local organization towards water protection (cleaning, projects, agreements).	We didn't have enough water to water the plants.	We heard someone got sick from drinking the water we have.
	If a neighbor needs some water, we don't have enough to share.	There is not enough water for the kids to play and cool down in summer.	It rained and the water started to contain sediment.

The participatory process resulted in a total of 20 indicators. These are divided into four main dimensions regarding water use and conservation, as follows:

(a) Socioenvironmental effects: identified from the cohabitation in the territory and its history of economic and ecological changes.
(b) Governance: as a dimension that requires being analyzed collectively (among different stakeholders with productive and sociocultural interest and presence in the basin).
(c) Local practices: evidence of interaction dynamics with water and other elements that are part of the sociocultural system of the territory (organization, weather, technologies, trusts, community, and others).
(d) Biological changes: identified from the experience of direct observation and cohabitation of the community and water in the same ecosystem.

The 35 forms were input into an Excel spreadsheet. Then, their importance was determined by identifying the different dimensions these indicators contained about the relationship with water and its usage. Through this identification, it was possible to determine that negotiation of agreements and working with other stakeholders were relevant aspects for the community. Moreover, these indicators show a complex socio-nature relationship with water, where solidarity and community values, threats, and aspects compiled from the daily coexistence with water are part of one ecosystem.

The previous findings confirm the importance of qualitative approaches. From this perspective, there is no need for a standardized answer to find statistic validation; on the contrary, the goal is to identify the local knowledge. Quantitative validation is obtained from the research and experience. This is systematized through tools and organized from an intensive approach from a specific number of key actors.

On the basis of the identified indicators, it can be concluded that the water situation in the area is determined by the following factors:

- Various threats: Lack of sufficient water to face fires, which is a threat to the population, especially considering the fire that affected the community in previous years. This becomes even more serious after the great forest fire of January 2017 and affected the country's forest territory.

- Changes and evidence gathered from the experience with water: Evidence of the impact of rain on the land and lack of vegetation coverage around the watercourses that supply the community. Progressive reduction of water quantity in the river faced by the locality, which impedes the recreational use of said water.
- Importance of family and community networks: Usage of domestic and family mechanisms that assist in the protection of water by efficient use of the available water.
- Concern about water governance in the territory: Insufficient periodic communication between the stakeholders of the community and public and private stakeholders present in the territory. Lack of initiative concerning exchange and local public investment in water use efficiency
- Critical factors: The increase in urbanization without proper planning, regulation, and monitoring amplify the available water demand.

It must be critically highlighted that from the initial number of participants (30), the entire process was concluded with the participation of 12 subjects, who became the main characters of this knowledge building process. The analysis of this situation showed a community lacking organization and not entirely committed to the present and future of water in their locality. Although this does not mean a lack of community spirit established by family, historical, and relational variables, it does show a lack of motivation and value of the organization as a relevant political agent in the management of their resources. On the basis of this experience, this opens a new set of questions towards a future vision concerning the challenges of participatory work in water management. The aim of the research was to identify the factors that can influence the lack of consideration of local participation as an effective tool for the development of the community.

3.2. Other Local Stakeholders' Visions Regarding the Process

Other public and private stakeholders that are part of the socio-environmental system of the basin did not have an active participation throughout the process. More specifically, the research team could identify the following:

Local government. Despite the initial interest of the municipality, there was a slow response to information requests and work meetings. One of the reasons was the great number of existing activities in the municipality, and the few professionals to answer these requirements.

Forest companies. Although the company is certified by international standards in sustainable forest management (which demand the consideration of local knowledge and the communities' well-being), their representatives stated that local indicators cannot always be considered as "objective evidence" and "technical management". The company remains self-referent and complicates the creation of watershed management processes. Nevertheless, they valued the knowledge of the communities' issues and the participation of independent entities towards the creation of these processes. This exemplifies the gap between local environmental knowledge and company management.

Medium-scale forest producers. Given the community involvement as a source of employment, they state a higher degree of familiarity. However, they did not know how to contribute to these processes in a productive manner, even considering that their location in the micro-basin can affect the water supply that the community of Batuco receives.

Better communication between the community and the wine farmers from the Chicura area. This study discovered a disconnect between the community of Chicura and the wine farmers of the area, specifically the need for better communication to maintain the social and productive watershed management. The population of the higher part of the basin consists mostly of wine farmers. Their industry currently uses overhead irrigation, which is an inefficient use of water, and agrochemicals for pest and disease control in the ravines, which can affect other water users as they can enter the surrounding watercourses.

3.3. Case Study 2: Design of a Forest Watershed Management Guide

On the basis of the developed participatory process, new topics were incorporated to the guide's draft suggested by INFOR. The stakeholders considered the draft to be highly technical and stated that it did not incorporate enough social aspects. After taking into account the stakeholders' feedback, the guide included background information related to the water cycle, forest hydrology, and water issues. The main part of the document was a list of BMP suggestions to prevent, mitigate, and monitor the impacts of forest activity on water, because the operational aspects offer a greater probability of impact. Basic monitoring checklists were included in the appendices to evaluate the water management sites. The final chapter included a glossary of terms used in the guide and a list of supplementary references (Figure 3).

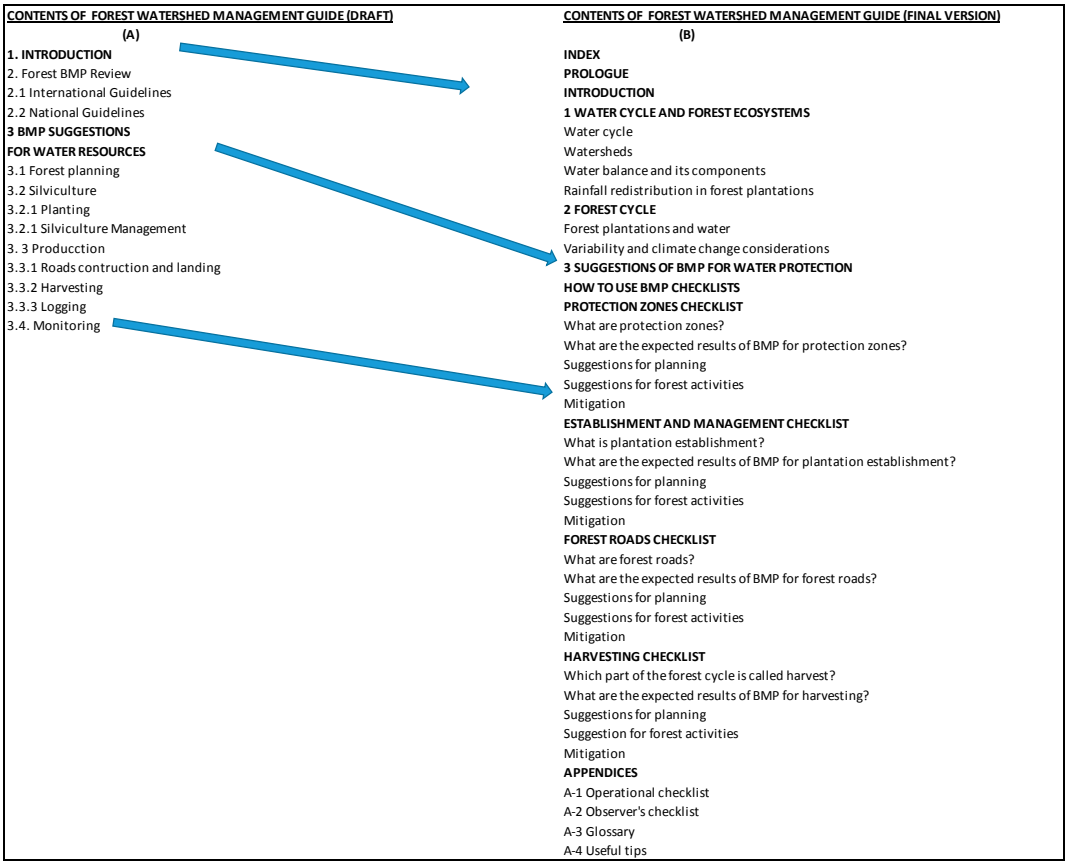

Figure 3. Changes in the forest watershed management guide after stakeholders' consultation. Draft (**A**); final version (**B**). BMPs—best management practices.

Stakeholders suggested the need to incorporate basic concepts into the guide, such as information related to the water cycle, forest ecosystems, and climate change, for the general public. By including this information, the guide serves as training for communities and reduces information asymmetries to achieve an inclusive governance. Another important aspect was explaining the good practices recommendations so the guide can be read by stakeholders and local communities and not only by specialists.

Moreover, the guide incorporated aspects that promote social participation in each appendix. Among them are local governance, knowledge exchange among entities, collective identification of issues between the company and water users, timely notice of anomalies affecting water, awareness of workers towards preservation of land and water, and effective communication channels. The aforementioned topics clearly indicate the influence of different voices in its development, specifically social and local stakeholders (Table 2).

Table 2. Summary of social aspects incorporated into the guide.

Chapter	Social-Environmental Issues
Prologue	"Given the territorial sensitivity of the water issue, this guide aims to be helpful, not only for professionals and forest workers, but also to promote the involvement of people from rural areas by giving them tools. In this way, they can carry out effective and appropriate social monitoring regarding forest practices, and also contribute to establishing relationships among the different stakeholders..."
The Cycle of Water and Forest Ecosystems	This chapter develops the concepts in simple words, allowing different stakeholders to familiarize themselves with the topics related to the water cycle, the meaning of watershed, forest plantations, and water problems.
Suggestions for Protected Areas	- Identify the areas that can affect the downstream water quality, plan activities alongside the community and the conservation state, verify the areas of protection and water bodies, inform the community of any anomalies and the corresponding adjustments. - Identify topics of interest for the community (water intake area for rural drinking water, sites of cultural interest, etc.) alongside the population. - Inform the users and community about the location, characteristics, and management measures of the protected areas. - Keep an updated record of the community and water users in order to notify them about any damage that could significantly affect the water conditions.
Recommendations for the Establishment of Forest Plantations	- Raise awareness among workers and the community about the importance of protecting the land and water. - Timely notifying the community about the type of product, date, and place of application when using chemical products, as well as in the case of misapplication.
Suggestions for Forest Roads	- Consult the community to obtain local information. - Attempt to build a good relationship with the community and stakeholders to support planning and avoid conflicts. - Keep contact information records of community members that can be affected. - Establish a contact channel with the community that can potentially be affected by road usage, especially people located in downstream areas.
Suggestion for Forest Harvest	- Establish a contact channel with the community that can potentially be affected by harvest activities, especially people located in downstream areas. - Attempt to build a good relationship with the community and stakeholders to support planning and avoid conflicts. - Notify those affected immediately in the case of damage to pipes or water supply structures. Establish a type of compensation with the affected parties.
Monitoring Appendix: Implementation Guide	This appendix provides a checklist for forest owners or company supervisors. This list aims to identify the presence of water intake areas, wells, watersheds, water users, or others in the property blueprint and verify if there is damage caused by forest activities and follow up for their repair.
Monitoring Appendix: Observer's Guide	This appendix is a checklist to be completed by community members or other stakeholders based on how they perceive issues concerning water quantity and quality and damages caused by forest activity in the micro-basin. Furthermore, this appendix allows the evaluation of water use by its consumers and if there is communication from the forest company that carries out activities inside the micro-basin.

The consulted stakeholders incorporated suggestions regarding effective local participation, such as identifying topics of interest for the community, consulting the community to obtain local information, and attempting to build a good relationship.

4. Discussion

4.1. Case 1

The indicators obtained from the members of the Water Committee of Batuco are related to relevant elements in integrated watershed management; some of these include the identification of risks associated to forest fires, water scarcity, low water quality, and limitations in agricultural production. These indicators can be helpful and useful for different stakeholders that work in the area. For example, they can help local governments to achieve more effective actions towards prevention of forest fires, assigning water supply trucks, and promotion of efficient irrigation techniques. Indicators related to communication issues among communities and forest companies in the area can be useful for private companies to improve social management plans. Moreover, these indicators can be helpful for forest certification companies to detect communication gaps with local communities and can serve as evidence for certification companies while auditing.

The opinion from other public and private stakeholders regarding the monitoring process carried out with the Batuco Committee showed some communication gaps among stakeholders. The study evidenced various issues affecting the Committee, such as the need to strengthen local government actions and the uncertainty mentioned by private stakeholders on how to contribute to these actions. Additionally, the need to raise awareness among people living upstream regarding the effects of their action on people living downstream and the importance of improving the efficiency of their production practices were identified.

From a socio-ecological perspective, the connection of interests and cohabitation of diverse productive scales put a strain on the conditions for watershed sustainability. Consequently, it is crucial to pay attention to the acknowledgment of different social capital types in the territories, all essential to the proper operation and sustainability of the system [11]. Here lies the importance of environmental knowledge in forest management and, in this case, water management, accounting for the urgency to create governance systems in which the stakeholders have a more active role and fulfill their duties more effectively. Other processes in countries like Colombia, Canada, Slovenia, and Hungary prove that the encouragement of community participation is an aspect that should not be addressed only from a specialized planning perspective, but also through the creation of a network among different stakeholders, the acknowledgment of local environmental understanding, and the establishment of training initiatives for leadership and other abilities [25–29]. For the Chilean case, a study carried out by the Forestry Engineer Association for the Native Forest of the South of Chile (AIFBN) had similar findings regarding stakeholder participation [30]. However, this study did not include tools to recognize or identify local knowledge.

In both cases present in this research, qualitative tools were used to promote and guarantee local participation (local diagnosis, local monitoring form, and watershed management guide) aiming to orientate and collect the stakeholders' views concerning the use, problems, and maintenance of the micro-basin that supplies water to the community. The scientific novelty of these research findings is the broadening of approaches on local participatory water management and their current use. Its development is promoted by recognizing local knowledge systems and practices regarding water, which are essential to this management [31]. An epistemological open-mindedness from the specialists is required in the design of tools for integrated watershed management involving different stakeholders and water users in the territory as specialized observers.

Consequently, it is gradually becoming necessary and appropriate to include perspectives from an environmental-scientific logic with approaches that recognize the role of local environmental knowledge in critical ecosystem management, such as water supply basins in South Central Chile. Accordingly, recent studies suggest the incorporation of local management systems in biodiversity using these types of tools [32]. From the aforementioned background, it can be inferred that the argued proposal is part of a sequence of contributions in development. All of them agree with the need to effectively involve the communities in the management of watersheds. The opportunity to systematize

and publish the progress regarding this topic will contribute to the consolidation of a key aspect in water governance.

4.2. Case 2

The guide includes, throughout its chapters, instructions that incorporate interaction with the communities that use water from the basin, acknowledging them, not only as users, but also as key stakeholders for its management. The main implementation of this approach is the appendix called "Observer's checklist", which legitimizes the participation and influence of local knowledge in water governance. The incorporation of the community's monitoring is an innovative aspect at a national and international level. A recent review of the effectiveness of BMPs in the United States points to the need for a better understanding of the implementation of practices and a permanent review of them [33].

At a national level, there are many BMP guides developed by public entities, universities, and forest companies for operational purposes. After reviewing a total of 12 documents, once again there is an absence of instructions that integrate the social aspect—only two of them included the suggestion to consult with downstream users [18]. There was no reference to the importance of identifying and establishing a connection among stakeholders, which, according to this study, is vital in organizing water governance in any territory. For this reason, the guide, created from a perspective based on socio-ecological systems and environmental knowledge, helps to fill the gap and begin a new stage for the design of tools for participatory watershed management. The main hypothesis of the new stage states that local stakeholders and inhabitants are key agents in the design and application of monitoring.

The BMP guide was conceived by the stakeholders as a tool to draw attention to the communities and their criteria for water and forest management. Therefore, a review of other approaches previously identified in other international guides was conducted. It was observed that social aspects are only addressed regarding activities such as recreational fishing, landscaping, and entertainment [18]. Social indicators in international standards for forest sustainability are not as present as the environmental ones [34,35]. The social aspects of forest management are not seen as part of the same complex system as the sociological systems suggest. These aspects were seen as challenges in the case studies to review the proposals for the BMP guide. A recent study carried out by professionals of the U.S. Forest Service draws attention to the need to consider the relationship between the forest ecosystem services and the human systems regarding future forest management of water resources [36].

The importance of a collective process of setting indicators for BMPs is mentioned by various authors, emphasizing the adaptive approach these indicators must have [37–40]. This was crucial for the construction of the best practices guide, as it illustrates how local knowledge and its socio-environmental issues can be included in forest watershed management.

This confirms that local environmental knowledge and local perspective can be also included as voluntary tools for environmental management as BMPs. This widens the effect of these tools by supporting local governance processes, especially in cases involving water supply watersheds in areas affected by water scarcity. Also, it contributes to processes of climate change adaptation, enhancing local communities' resilience because they are the most affected by its impacts.

5. Conclusions

Regarding the BMP guide, the main finding was the consent of all stakeholders to expand its action scope. According to stakeholders, the first draft was highly technical and did not include the perspectives of local stakeholders.

The guide's prologue attempted to approach the complexity of the relationship of forest plantations with water and territories. It also described that the guide was designed not only for specialists, but also for the people affected by forest activities in forest watersheds. The importance of local participation in watershed management was highlighted in this section. Secondly, the guide integrated informative

chapters about water cycle, industrial plantations, and climate change to reduce the asymmetries of information that make local participation difficult.

Each BMP recommendation involved proper free and informed consultation and effective communication channels. Furthermore, a local monitoring checklist was included to be completed by community members or other stakeholders near watersheds. The guide contributed to a more inclusive watershed management by using a more binding and trust-based consultation process instead of only an informative one.

The process of design and implementation of the two aforementioned cases enabled identification of the following specific issues: (a) institutional inadequacy (private and public) to recognize the importance of local knowledge and its influence in water management, (b) the evident asymmetry between local communities and forest companies in terms of power impedes the creation of governance opportunities, and (c) the weakness of tools such as forest certification systems. Even though these systems have contributed to improve the relationship between companies and local communities, they have failed to guarantee safe and permanent access to water for communities near forest plantations.

This brought along some challenges in the field of socio-ecological management, of which some highlights are as follows: (a) the importance of collecting and integrating the environmental knowledge of stakeholders from the locality, their economic trajectory, production scale, social and parental dynamics, and identity referents, among other key variables; (b) the need to establish new contexts for institutional and local knowledge exchange, and to start a dialog regarding water management of the territories, transformations, and new challenges for rural areas; (c) the importance of creating training opportunities regarding participatory water management focused on creating governance around the available resources. This is especially the case in case 1, where local practices and social relationships are essential to access water and shared knowledge about its usage and conservation.

It is evident that the design of methods and tools for participatory watershed management requires further innovation concerning the type of participation expected of the communities in these processes. This involves epistemological challenges to recognize local knowledge and political challenges in cases where the community requires support to accept roles and responsibilities in watershed management.

The findings obtained from this research enable illustrating that it is possible to integrate local knowledge systems in the management of water supply forest watersheds. The monitoring experience carried out in Batuco and the collective creation of a forest watershed management guide confirmed that the integration must come from scientific, technical, and political perspectives, which starts a methodological dialog towards local environmental knowledge, as well as strong field work that guarantees the stakeholders' motivation and commitment. Therefore, the integration of multi-disciplinary and cultural approaches into the design of a forest watershed management guide confirms the feasibility for different stakeholders to incorporate local monitoring aspects in watershed management, as a territory management tool for the common duty of water preservation.

Consequently, this involves the incorporation of local monitoring aspects in watershed management, including qualitative aspects, regarding governance and local practices towards usage and conservation of water, and biological aspects, identified from direct and permanent observations. This was evident from the analysis of case 1, which confirmed the ability and availability of local stakeholders to contribute to the monitoring and inform the characteristics and physical changes of water.

The integration of the social component in watershed management is a challenge for local and national governments, as well as private companies, in the regions where these two case studies were conducted. The reinforcement of water governance through local participation is pertinent in order to build more resilient landscapes. However, its achievement will require the empowerment of the communities to stand at a similar level as public and private institutions.

This suggests the confirmation of the main hypothesis of this research, as the participation of stakeholders and local knowledge in watershed management requires strategies that guarantee its

proper integration. Likewise, the cases studied are empirical references concerning the possibilities of water governance in the territory, surpassing the current informative and consulting approaches.

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