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Authority of water resources in the Vinces River basin (Ecuador) (Original)

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Abstract: The Vinces River basin is highly suitable for agriculture. This factor has allowed for the intensive development of agricultural crops, which provide a significant amount of foreign currency for the country but also exert strong pressure on water resources for irrigation and have displaced significant native vegetation. In this context, it is necessary to implement governance to ensure the territorial management and development of the basin. This work aims to identify governance problems related to agricultural land use and water demand for crop irrigation in the Vinces River basin. This research involved an analysis of the current situation of general watershed management in Ecuador, and specifically of this important basin in the center of the country. This research included an analysis of conceptual governance frameworks and the collection of digital geoinformation for subsequent processing in Geographic Information Systems. This information was also used to tabulate official statistical information and conduct field verification of agricultural crop management. The main agricultural areas of the study basin, banana, cocoa and oil palm, exert great pressure on the basin's space and water due to irrigation activity during the long summer dry season, while the figures collected by the environmental authority on historical water concessions for irrigation in the basin do not reflect the true volume used by the agricultural sector.

Key words: basin; irrigation; agricultural crops; authority; g.i.s

1 Introduction

The Latin American and Caribbean region must rethink natural resource governance in order to transform the primary and extractive sectors into platforms for achieving structural change with social inclusion, including it as an epicenter on the public policy agenda for the coming decades. Water occupies a prominent place at the heart of these disputes. These disputes present cultural, historical, territorial, social, political, economic, and distributive connotations that are key to understanding and resolving them, and determine the need for interdisciplinary approaches.

At first glance, governance is a form of governing, that is, a process that fosters state-society interactions. As is well known, the state sphere is not its only field of application or significance. In general terms, the notion of governance designates the set of institutional procedures, power relations, and public or private, formal and informal management modes that regulate the actions of political organizations (Mazurek et al., 2009). Governance is defined as the process of interaction between strategic actors, with a more sociological and political focus on the interplay of institutions and organizations. According to Leca (1996), it is "the interaction of a plurality of governing actors, not all of whom are state or even public." The criteria for good governance are transparency, participation, and accountability. This opens up the possibility of conducting transactions in an environment where collective rules are developed, decided upon, legitimized,

implemented, and controlled by these actors. In Ecuador, there is evidence of self-sufficient public organizations, with little coordination of actions among themselves and no coordination with private and civil society actors. Municipalities, universities, unions, provincial councils, private companies, and ministerial departments act without seeking coordination with other actors, which generates inefficiency and duplication of efforts. Therefore, strengthening the intermediate level of government is key so that development policies and projects do not remain isolated initiatives and/or documents that are not implemented.

By Ministerial Agreement 66/2010, the National Secretariat of Water (2010) establishes that the integrated management of water resources will be exercised in a decentralized manner by hydrographic demarcations, basins or sub-basins, through the water resources management agencies by hydrographic basin and their respective authority, which will be established by the National Secretary of Water (SENAGUA) and their functions, powers and competencies will be established in the functional organic regulations of the entity.

The world's population exerts great pressure on soils to meet their food needs through their intensive use, together with poor management practices such as intensive tillage, monoculture, indiscriminate application of agrochemicals, among others (Vera et al., 2020). Soil use is the greatest source of wealth for any country in the world, being of importance to humanity for obtaining quality and quantity products that delimit the productivity and sustainability of production systems Mbaca and González (2021). The planet has been affected by natural disasters caused by environmental degradation and climate change, in addition to political and economic crises, dragging it into a global food crisis that especially affects underdeveloped or developing countries (Arap M. et al., 2020). Unlike what occurred during most of the history of agriculture, irrigated production now has an unusual and transcendental importance, generating no less than 40% of the food consumed by all peoples of the world, despite the fact that the irrigated area only represents a fifth of the total area (Gaybor, 2008).

2 Materials and methods

Study area

The Vinces River basin is located from the northeastern sector to the center of the Guayas River basin, extending for 4,268 km. It takes its name from the river that crosses it in a north-south direction, (Figure 1).

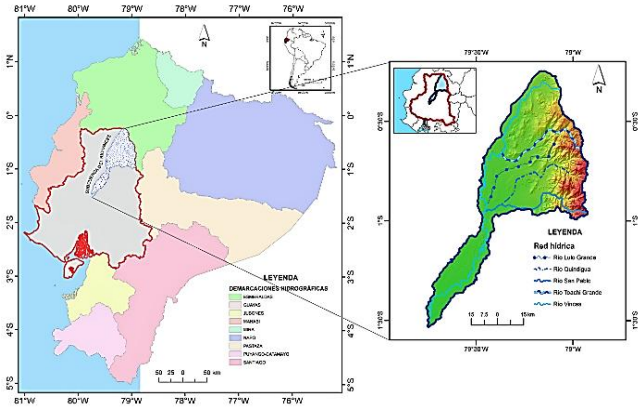

Figure 1. a) Guayas hydrographic demarcation and b) Vinces River basin

Administratively, the basin includes the provinces of Santo Domingo de los Tsáchilas, Cotopaxi, and Los Ríos. Its land use is predominantly agricultural, with the presence of tropical and subtropical export crops such as abaca, rice, bananas, coffee, cocoa, corn, and oil palm, among others.

The analysis of the problems of water resource governance in the basin will be addressed by analyzing the current regulations in Ecuador, then the conceptual framework of governance applied to the management of the Vinces River basin

will be defined. To explain the distance between the regulatory framework, discourse and practice from a critical perspective, the utopia of the discourse will be contrasted with what happens in reality in order to move forward on a superior proposal. To carry out the physical-natural characterization of the Vinces River basin, basic and thematic cartographic information at scales of 1:100,000, 1:50,000 and 1:25,000 provided by the Military Geographic Institute (IGM), the Ecuadorian Space Institute (IEE), the National Institute of Statistics and Census (INEC) and the Ministry of Agriculture and Livestock (MAGAP) was used. The current land use of the study area will be carried out based on the MAGAP project (2015), and all the aforementioned cartographic information will be worked on in the Geographic Information Systems (GIS) program ArcGIS Desktop 10.4.1. The estimation of the demand for water for irrigation by the main agricultural crops in the basin will be carried out based on the analysis of the concessions granted to the users of the basin by the Ministry of Water (SENAGUA) in recent decades. Data will also be taken from the Regional Hydraulic Plan of the Guayas Hydrographic Demarcation CISPDR (2016) corresponding to the water supply and demand for irrigation of agricultural crops in the basin under study. These data will be jointly analyzed with the surface area of the main agricultural crops in the Vinces River basin. Magap (2015) considered the irrigation requirements per ha/year especially in the summer season, which required extensive field verification.

3 Analysis and discussion of the results

The conflicts that have occurred in the management of water resources within a river basin around the world have allowed us to propose two approaches to the concept of governance (Figure 2).

ENFOQUE CONTRACTUALISTA

- Considera la Gobernanza como el resultado de un Contrato Social obtenido mediante un consenso entre los diferentes sectores de interés, que se ponen de acuerdo aceptando el mejor argumento lógico
- La Gobernanza constituye el ideal de estabilidad y equilibrio social.
- Usualmente no se internaliza el conflicto y más bien se trata de evitarlo o prevenirlo.
- No se considera un análisis desde la teoría del poder
- En relación al Agua este contrato tiene como objetivo la Gobernanza Efectiva del agua para lograr Seguridad Hídrica a largo plazo.

ENFOQUE CRÍTICO

- Considera la Gobernanza como la configuración institucional y normativa en la que se basa el gobierno, pero no como resultado del consenso y la concertación sino como efecto de las relaciones de poder y la lucha social es decir desde una teoría del poder.
- La Gobernanza se constituye en un discurso normalizador.
- El Estatuto de conflicto está internalizado
- La resistencia y el conflicto son considerados como espacios para redefinir las configuraciones de poder

Figure 2. Two approaches to governance

The analysis of the regulations for watershed management in Ecuador required the application of the Kelsen-Reyes (2013) scheme. This scheme is based on the hierarchy of legal norms as established by the 2018 Constitution followed by the different legal bodies applicable to the issue of watershed management in Ecuador (Figure 3).

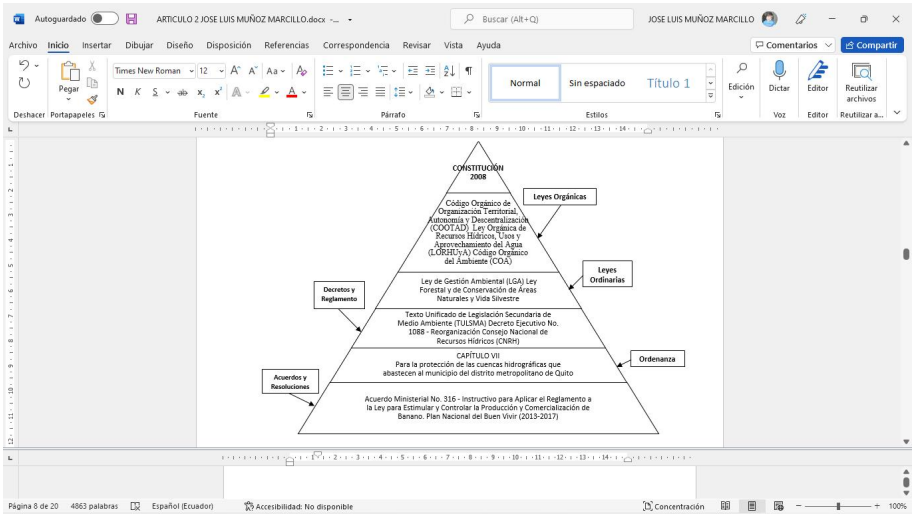

Figure 3. Kelsen's pyramid of the legal framework applicable in Ecuador

Among the legal regulations in force in Ecuador, the one that stands out for its relationship with the agricultural use of the Vinces River basin is Ministerial Agreement No. 316 of April 16, 2004, which includes the Codification of the Law to stimulate and control the production and marketing of bananas, plantains (Barraganete) and other related musaceae for export. In this regard, Chapter V in its general provisions in Article 25 states: "New banana plantations are prohibited. Its violation will give rise to the application of the sanction contemplated in the reform law to the law to stimulate and control the production and marketing of bananas, plantains (Barraganete) and other similar plantains destined for export. This agreement refers to the fact that banana plantations classified as organic, planted up to the date of issuance of this regulation, will be registered with the area planted to date and will not be subject to any sanction. GAD (Decentralized Autonomous Government) The jurisdiction of the municipal authorities of Valencia State is entirely within the Vince River basin, which is a highlight of GAD in other states of the basin. As a result of the reform of the laws declaring the protection and management of the Valencia State basin and small basins, it is declared a protected area or belt in the rural sector, and no construction of any type is allowed based on the following categories: Rivers 30 meters; Winter and summer flow estuaries 15 meters; Winter-only flow estuaries 10 meters; Medium flow estuary 9 meters; Low flow estuary 6 meters; Source stream (creek) 3 meters; Ravines 10 meters; Large sinkholes 50 meters in diameter around; Small sinkholes 25 meters in diameter around; Lagoons and lakes 10 meters from their banks. According to the Provincial Irrigation and Drainage Plan, GPLR (2016), the legal frameworks ratify the Secretariat of Water as the sole authority of the country's Water Resources, through its agencies EPA and ARCA, while the Ministry of Agriculture, Livestock, Aquaculture and Fisheries (MAGAP), through the Undersecretary of Irrigation and Drainage (SRD), is designated as responsible at the national level for the use of water resources in irrigation and drainage, oriented to the irrigation of plots at the national level, productive promotion and food sovereignty, in the same way the MAE assumes the responsibility of directing environmental regulations, and in the face of emergencies, the General Secretariat of Risks will assume the leadership. In the current scheme of political actors linked to the management of hydrographic basins from the point of view of the use of water resources in the Vinces River basin, institutions such as the MAE, MAGAP, the provincial GADs and the cantonal GADs have direct influence; however, with regard to the management of agricultural land use in the Vinces River basin (Figure 4a and 4b), there is currently no institution that is completely in charge of this aspect.

Figure 4. Actors with the capacity to act in the management of watersheds in Ecuador: a) Responsibilities of the various agencies at the national level in relation to irrigation and drainage. b) Irrigation and drainage competencies at the provincial level.

Source: PPRD, 2016

In Ecuador, at least 18 of the 22 Provincial Autonomous Governments (GAD) have provincial development plans at different levels, most of which have not been implemented. For their execution, it is necessary to strengthen the institutional capacities of the territories and decisively promote decentralization and state reform. In order for the Provincial Autonomous Government of Los Ríos, GPDLR, to apply efficient governance over agricultural land use in the Vinces River basin, it is necessary to strengthen this intermediate government. For this purpose, CONCOPE is the representative political organization responsible for promoting the development of the province through the formulation of public policies, territorial management, the construction of governability between actors and levels of government, the promotion of Economic Development and Sustainable Human Development. This objective image of CONCOPE is not met in practice, therefore the solution is to promote certain strategic processes that support the approval of a new Provincial Regime Law; progressively assume new roles and responsibilities through the decentralization process; institutional strengthening; and advancing the challenge of a new state structure based on a decentralized public management model.

The soil of the Vinces River basin is mainly suitable for agriculture, concentrating an area of 127,345.70 hectares of agricultural crops (Figure 5 and Table 1) where intensive monocultures requiring irrigation such as banana, cocoa and oil palm prevail. The crop of hard yellow corn, with the largest cultivated area, is winter-grown.

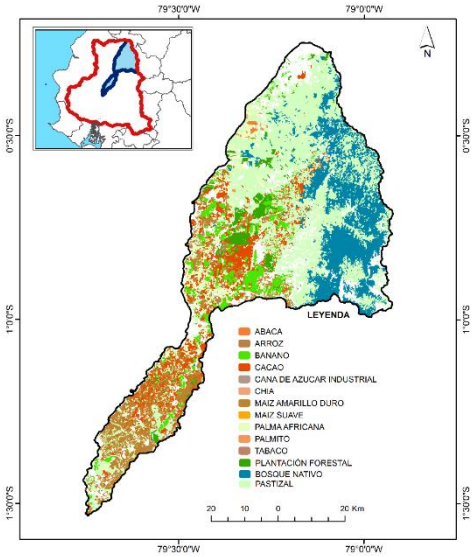

Figure 5. Agricultural use of the Vinces River basin (MAGAP, 2014)

Table 1. Area of agricultural crops in the Vinces River basin

CULTIVOS	Superficie (Has)	%
MAIZ SUAVE	0,18	0,00
CAÑA DE AZUCAR INDUSTRIAL	27,82	0,02
CHIA	58,13	0,05
ABACA	595,67	0,47
PALMITO	762,61	0,60
TABACO	1.368,51	1,07
ARROZ	3.444,17	2,70
PALMA AFRICANA	20.543,46	16,13
BANANO	23.932,09	18,79
CACAO	36.129,02	28,37
MAIZ AMARILLO DURO	40.484,04	31,79
TOTAL	127.345,70	100,00

Source: Own elaboration

4 Demand for water for irrigation

Banana cultivation over the long eight-month summer period requires an average of 26 liters of water per plant per day to maintain its productivity, considering that one hectare contains 1,500 plants, the volume of water that one hectare would require in one month would be 11,458,560 m. In the case of cocoa cultivation with a planting density of 1,000 plants per ha, its water consumption is 40% less water per hectare than that demanded by bananas and in the case of oil palm with a density of 170 plants per ha, and its water consumption is 50% less than the amount of water demanded per ha by banana cultivation.

The volume of water for irrigation of agricultural crops in the Vinces River basin corresponds to 573.06 hm3 according to CISPDR (2016) (Fig. 5). This volume was distributed according to the agricultural crops grown in the Vinces River basin (Fig. 6).

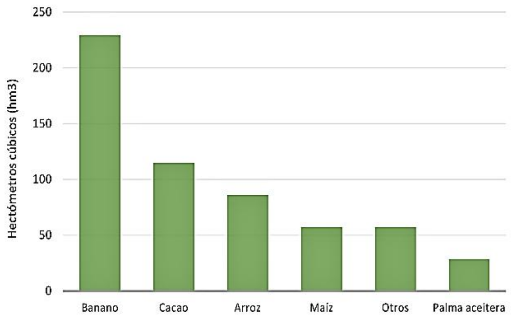

Figure 6. Distribution of 573.06 hm3 of water for crops

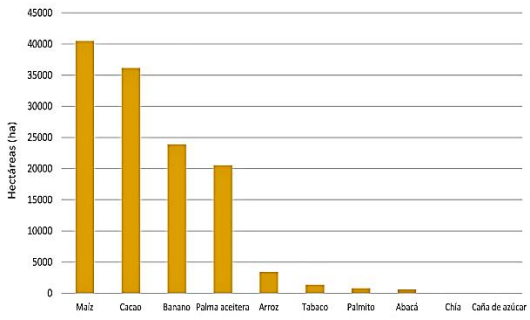

Figure 7. Distribution of irrigated agricultural crops in the Río Negro basin

The National Water Secretariat (SENAGUA) has granted water concessions for irrigation in the period between 1980 and 2018 for the Vinces River basin as indicated in Figure 7.

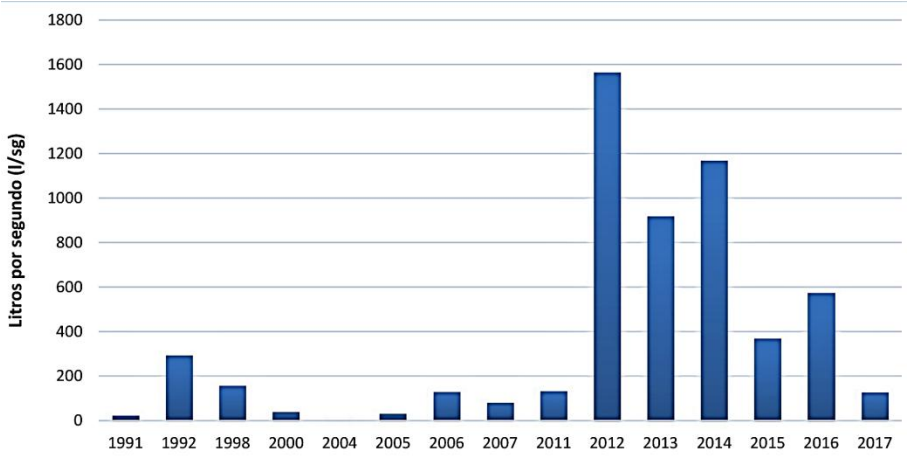

Figure. 8 Water concessions (l/sec) for irrigation of agricultural crops in the Vinces River basin, period 1980 - 2018

Figure 7 shows a significant year-on-year variation in water concessions granted by the National Water Secretariat. This is due to the fact that between 1991 and 2011 there was no greater control for agricultural users due to the difficulty this task represented for centralized control bodies, leading to the clandestine abuse of water resources for agricultural irrigation. Starting in 2008, after the National Water Secretariat (SENAGUA) was created by Executive Decree 1088, this situation changed thanks to the implementation of the Quevedo customer service office. The Vinces River in the central area of the basin, according to data from the Quevedo hydrological station, presents flow variations that are related to the winter and summer periods, as can be seen in Figure 8, where the average flow for the years 2000 - 2012 for the months of January - April corresponding to the winter months is 500 m3/sec, while for the dry season months between May and December it is 66 m3/sec.

Figure 9. Average flows (m3/sec.) period 2000-2012 at Quevedo station

Source: Prepared by the authors based on (INAMHI, 2019)

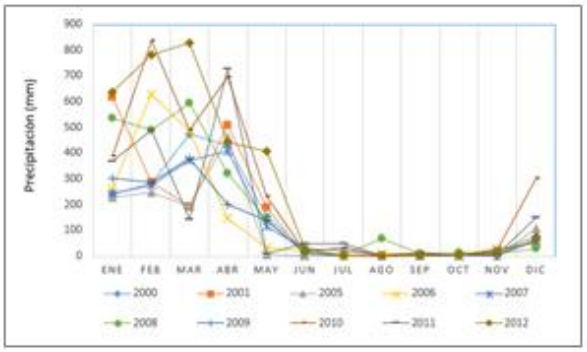

Figure 10. Average precipitation (mm) years 2007-2016 in Quevedo River

Source: Prepared by the authors based on (INAMHI, 2019)

The precipitation pattern in the Vinces River basin is distributed according to the climatic seasons: winter, lasting four months, and summer, lasting eight months. Figure 10 shows that the average winter precipitation for the period 2007–2016 was 422 mm, while the summer precipitation was 75 mm.

Considerations for water resource governance in the Vinces River basin

In order to reduce the gap between the existing regulatory framework in the discourse of the management of the Vinces River basin and practice from a critical perspective, it has been deemed necessary to develop a superior proposal, which is presented below.

① SENAGUA should carry out a holistic management among state institutions to develop a bill that addresses issues such as water management models, institutional framework for irrigation and drinking water, pollution, moorlands and wetlands, attention to territories of extreme drought or flooding, interlinking them with real mechanisms of collective participation.

② Development of a National Water Policy led by SENAGUA, supported by the participatory construction of local water plans, allowing for better coordination between entities such as MAGAP, MAE, MIDUVI, SNGR, the Decentralized Autonomous Governments (GADs), AME, CONGOPE, CONAGOPARE, and water boards, irrigation boards, towns, nationalities, and other organizations.

③ It was observed that there is no comprehensiveness or integrity in the management of watersheds, so it is recommended that true integration be made effective through Integrated Water Resources Management (IWRM) accompanied by coordination of actions through the Governance of watersheds that favor processes and spaces for participation Solanes&Andrei (2005) of the basin actors at both horizontal and vertical levels.

④ Establish watershed councils, with autonomy and clear roles for decentralized public institutions and GADs, with the participation of social and water user organizations and technical support. These councils will be responsible for developing local water plans, monitoring their implementation, and evaluating their compliance.

5 Conclusion

As part of the broader analysis plan being developed, only one controversial aspect of governance was given as an example, which will cover a wide range of relationships to be considered when seeking balanced governance to ensure respect for governance of shared resources. These relationships are included in the context of territorial development, interpreted as a dynamic and complex process, where three types of spheres of action can be identified, with different logics constituting specific fields. From their different forms of interaction, different forms of governance arise that are applicable to specific development situations (Bustos, 2014).

The study of water resource governance in the Vinces River basin demonstrated a high demand for agricultural irrigation for large monocultures whose highest productivity coincides with the country's eight-month summer. Therefore, pressure on surface watercourses is significant, leading to a critical deficit scenario in the near future. Deficiencies in the current management of Ecuador's watersheds were also evident, making it necessary to implement integrated governance models to achieve sustainable watershed management.

Currently, the legal frameworks in force in Ecuador ratify the National Secretariat of Water as the sole authority for the country's Water Resources, while the Provincial Decentralized Autonomous Governments (GADP) are socially entrusted with the powers to plan, build, operate, maintain and rehabilitate irrigation and drainage systems at the provincial level, without having any authority over land use management in basins, as is the case of the Vinces River basin.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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