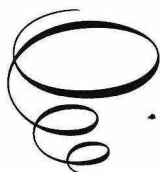


# Transforming Spatial Data into Public Policies for Social Justice and Environmental Sustainability

Edited by

Alexandra Aragão

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Transforming Spatial Data into Public Policies for Social Justice  
and Environmental Sustainability

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## CHAPTER THIRTEEN

### THE MEANING AND SOCIOLEGAL IMPORTANCE OF RIVER BASINS

JOSÉ IRIVALDO ALVES O. SILVA<sup>1</sup>  
ANA L. BURGOS<sup>2</sup>

#### Summary

This chapter is the result of a collaboration between Mexican and Brazilian members of the JUST-SIDE network to analyze the sociolegal character of the spatial unit known as the watershed. The objective is to place the watershed at the center of the debate on planning for sustainable development, considering the reduction of territorial injustices within its boundaries and using its sociolegal dimension. Following a brief review of the legal frameworks for watershed management in Mexico and Brazil, we argue that situations of territorial injustice could be reduced with a watershed

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approach if the sociolegal dimension, which shows clear weaknesses, is improved. Through case studies, we demonstrate the importance of considering this geographical unit as a conglomerate of territories that have a sociolegal dimension that should be oriented toward the reduction of territorial injustices occurring within their boundaries. Often, the most vulnerable populations in a basin are the hardest hit by development models that damage common resources such as water through activities such as mining (the Brazilian case) and hydroelectric dams (the Mexican case). Finally, we emphasize that the implementation of integrated watershed management with adequate sociolegal support is key to sustaining good governance schemes, including the coproduction of participatory mapping.

**Keywords:** territorial inequalities, water security, watershed management, legal analysis

#### 1. Introduction

The aim of this chapter is to bring the river basin (watershed) to the center of the discussion on planning and sustainable development as a way to mitigate the territorial or spatial injustices currently experienced in many parts of the world. We believe that decision-makers have neglected the basin as the foundation for a fair distribution of the common goods produced from it through environmental services provided to cities, especially water, which is metaphysically important in the traditions of many communities in Latin America.

Therefore, we present the cases of two very important countries in the regional and global context, Brazil and Mexico, that present peculiarities, contradictions and similarities, especially because they have diverse peoples and communities with strong ties to the history of Latin America as well as similar socioeconomic characteristics. Both have traditional communities, rural groups, indigenous peoples, river dwellers, and quilombos, among other vulnerable communities, and are increasingly affected by extractivist activities, whether conducted by the government or by private entities.

We understand that a condition of good governance is essential to reduce territorial inequalities. To this end, river basins allow us to recognize the territories that manifest themselves within their boundaries, which often go beyond the conventional political-administrative division, making them a complex unit. Moreover, in this territory, or in multiple territories, human activities and local decisions influence factors such as soil and vegetation that in turn regulate hydrological processes, which draws attention to the need for the integrated planning of the elements that make up the basin.

Thus, with regard to Brazil, we will present here the process of contamination of the Rio Doce basin in Minas Gerais, which forms the basin of the same name and which suffered the consequences of the collapse of the Vale tailings dam and other companies. This was the result of the actions of the development model without environmental urban planning that takes into account traditional peoples, nature and quality of life. With regard to Mexico, the case of the Infiernillo-Bajo Balsas reservoir basin is presented; this rural basin is characterized by high marginalization, where the strategic objectives of the nation-state to produce hydroelectric energy have violated and cancelled access to rights and the potential development of local territories. The next section explores the relationships among the water crisis, the watershed approach, and the territorial complexity expressed within the boundaries of a watershed. In Section 3, some elements are presented to delimit in general terms the legal-normative frameworks that could operate to reduce territorial inequality in watersheds in Latin American countries. Section 4 briefly presents the two case studies in Brazil and Mexico; the discussion and conclusions are presented in Sections 5 and 6.

## 2. Water Crisis, River Basin and Territorial Complexity

### 2.1 Water Crisis

The accelerated deterioration of water resources is, along with changing weather patterns, one of the most dramatic threats to humanity. Water is a vital and irreplaceable resource for human life, ecosystems and wildlife. Water of acceptable quality is the basis for food security and all agricultural activities for food and fiber production as well as agro-industrial and transformation processes. Fresh and marine water bodies, including rivers, streams, waterfalls, springs, lakes, coasts and wetlands, are sacred spaces of symbolic value and recreational areas fundamental to people's spiritual and mental health. These simple statements hint at the size of today's problems, as water of acceptable quality has become a scarce and contested treasure, while the population is growing with large inequality gaps and high-environmental-impact activities are expanding rapidly.

The understanding of natural hydrological processes and the management of water resources are, along with agriculture, the starting point of civilization. Since the earliest civilizations, human groups have devoted themselves to understanding the timing of rainfall and drought and the hydroperiods of rivers and tides and to increasing their technological capacity to harness, store and distribute water. For more than 10,000 years, human groups have structured themselves around water sources and have extended

their capacity to manage this resource under different circumstances. The spatial and temporal distribution of water is an explanatory factor for the location of human settlements and their economic development as well as for the history, religion and symbolic life of human groups. Water and society are, without a doubt, an inseparable pair.

### 2.2 River Basin

Over the last hundred years, society has recognized that the ideal spatial unit for understanding and managing water resources is the river basin.<sup>3</sup> This is defined as a section of the Earth's surface where precipitation, moved by the force of gravity, flows downslope to a common point or outlet. A river basin is delimited by the highest elevations in the relief (the divide) and the set of smaller land units (subbasins and catchment areas) that are organized in a spatially hierarchical way to form a drainage network carved into the relief until the water reaches a single outlet or outfall. The river basin makes it possible to examine the hydrological processes that determine the availability of surface water in time and space and to make decisions based on an integrated and holistic interpretation of geographic space, water and society. The river basin approach is recognized as the best option to establish social spaces for managing water and related resources, such as forests and soil; to distribute water access fairly; to reduce water risk from floods, droughts and pollution; and to establish protection and remediation measures to preserve water resources for present and future life in specific geographic spaces.<sup>4</sup> As social spaces, basins necessarily have a legal-normative dimension.

Despite the alarming water crisis, river basins are still not considered entities of sociolegal importance in regulating access to water-related rights. They are not recognized as a powerful tool for interpreting territorial injustices and inequalities arising from the unequal appropriation and use of water by subjects located in the upper, middle and lower parts of a basin. In short, the potential of the basin as a sociolegal entity to settle, reduce and compensate for territorial injustices has not been clearly visualized.

<sup>3</sup> Ana L. Burgos, and Gerardo Bocco. 2015. *La cuenca hidrográfica como espacio geográfico* (In: "*Dimensiones Sociales en el Manejo de Cuencas*". Burgos, A., Bocco, G. and Sosa-Ramírez, J. (Coord.), pp 11-29. Edited by CIGA-UNAM; Morelia, 2015).

<sup>4</sup> Guangyu Wang, Shari Mang, Haisheng Cai, Shirong Liu, Zhiqiang Zhang, Liguang Wang, and John L. 2016. "Innes Integrated watershed management: evolution, development and emerging trends". *Journal of Forestry Research*, 27(5), 967-994.

## 2.3 Territorial Complexity

To situate the basin as a sociolegal entity for planning and sustainable development, it is necessary to define the notion of territory. First, we should clarify that a basin is not a *territorial unit* but a *spatial unit* delimited by a physical criterion, which is the relief of the Earth's surface. Thus, the limits of a basin are based on geological history and relief-forming factors, such as climate, lithology and time. In contrast, a territory is a portion of the geographical continuum that has been delimited by historical-social processes involved in the appropriation of space by specific subjects. The resulting territorial boundaries can be administrative (tangible), symbolic, or functional, i.e., determined by economic activities that are deployed in a space and control it. Each territory has an associated subject (individual, communities, ethnic groups, social groups, companies, or institutions) that exercises control and power over that space so that it is a lived, constructed and contested space. Administrative territories have explicit boundaries, subjects with jurisdiction, and competencies governed by legal and normative frameworks. Symbolic territories take their strength from the legitimacy exercised by subjects who are guided by usage, customs and customary agreements. Functional territories (e.g., mining territories) are constructed through material and energy flows, and their boundaries are diffuse and dynamic. The territories and the subjects that control them operate at different spatial scales. Thus, the same place in geographical space may correspond to multiple juxtaposed territories. A river basin is ultimately a conglomerate of territories that coexist in space-time<sup>5</sup>; from this conglomerate emanates the territorial complexity that characterizes river basins as sociolegal spaces.

Under these premises, it is necessary to investigate the scope of the river basin as a unit to conduct a legal-systemic analysis aimed at reducing territorial injustices related to water resources in a specific geographical space. We ask whether the notions of watershed and territory duly articulated with legal and normative notions related to the human right to water, to a healthy environment and to the self-determination of peoples can be integrated into a framework for analysis and management aimed at reducing territorial injustices. To what extent is the river basin as a unit of environmental management a good approach to the identification of relevant variables in judicial decisions and the formation of jurisprudence with an ecological bias? Of interest are cases of territorial injustices linked to access to water, the

<sup>5</sup> Ana L. Burgos, and Alejandro Velázquez. 2019. "A territory-oriented approach to operationalize sustainable management". *Global Journal of Human-Social Science* 19(1).

legal treatment of environmental damages and affectations due to water pollution, and the recognition of the responsibilities of different actors in pollution and lack of sanitation, among other problems.

## 3. The River Basin as a Sociolegal Entity for Management

### 3.1 The Legal-Administrative Area

The lack of access to an adequate amount and quality of water, as well as the existence of human life near contaminated bodies of water, has profoundly negative effects on human dignity. Restrictions on water quantity and quality condemn people and territories to stagnation, to the aggravation of territorial injustices and to social and environmental deterioration, definitively cancelling their future opportunities. For this reason, since 2010, access to sufficient quantity and quality of water has been recognized by the United Nations (UN) as a human right, and the obligation of states to actively address access to water as a public and social good has been installed in the legal and regulatory arena. It is accepted that this is a right that underlies and cuts across other rights, such as the right to a healthy environment, the right to health, and the right to the self-determination of peoples. Joy and collaborators<sup>6</sup> insist that the problem of water must necessarily be seen as a problem of justice. However, the exercise of the human right to water requires a profound understanding of the significance of water for the development of peoples,<sup>7</sup> which is beyond a simple governmental pronouncement. This framework of necessity and urgency positions the river basin as a juridical-administrative space necessary to ensure the exercise of fundamental rights, such as the rights to water and a healthy environment. The river basin must be considered a systemic entity that is appropriate to address human activities in different territorial contexts within the basin, where diverse subjects operate and must reconcile their attributions of the space.<sup>8</sup> The current condition of a given basin is the consequence of the forms of occupation of the space and the use of available water resources affected by strong disputes among social actors. Water access and disputes must be regulated to reduce the territorial inequalities that arise from the

<sup>6</sup> K. J. Joy, Seema Kulkarni, Dik Roth, and Margreet Zwarteveen. 2014. "Re-politicising water governance: exploring water re-allocations in terms of justice". *Local Environment*, 19(9): 954-973.

<sup>7</sup> Michael Tiboris. 2019. "Against Human Right to Water?". *Human Rights Quarterly*, 41(4): 916-938.

<sup>8</sup> Monica F. A. Porto, and Ruben La Paina Porto. 2008. "Gestão de bacias hidrográficas". *Estudos Avançados* 22 (63): 43-60.

differential access to water in sufficient quantity and quality. In this way, the river basin is considered an ideal laboratory for water resource management, for both supply and sanitation, and, in a more complete modality, for integrated environmental management. Urban, rural, environmental and water planning can intersect, which certainly makes the task of management with a common vision of the future for those who live in the basin more complex. This task includes the prevention of environmental damage and the reduction of water risk due to droughts, floods and pollution.

Given the administrative and legal plurality of the river basin, good governance schemes are fundamental and must emerge from an integrative perspective of territorial conglomerates. We therefore argue that the basin and territory are fundamental categories for planning cities, rural areas and metropolitan regions with the purpose of establishing a water protection system to maintain various existing ecosystems. Lima<sup>9</sup> highlighted the systemic character of the basin and its potential to integrate environmental processes and human interference.<sup>10</sup> To this definition, we add the relevance of integrating the legal-administrative dimension inherent to the territorial complexity within a basin.

In addition, it is important to consider Carvalho's<sup>11</sup> proposal for integrated environmental planning, which must necessarily be intertwined with economic-ecological zoning (ZEE), which should itself be a standard of analysis for the legal-environmental demands that arise in basins. Thus, the river basin is the ideal laboratory for reconciling access and the exercise of rights.

### 3.2 Basin Legislation in Brazil and Mexico

In the case of Brazil, the law establishes the river basin as a legally relevant unit: "The river basin is the territorial unit for the implementation of the National Water Resources Policy and the performance of the National Water Resources Management System".<sup>12</sup> The Brazilian legislature has clearly established the basin as a territorial unit and as the recipient of the

<sup>9</sup> Aduato Gonçalves de Lima. 2005. "A bacia hidrográfica como recorte de estudos em geografia humana". *GEOGRAFIA (Londrina)*, 14(2):173-183.

<sup>10</sup> Enrique Leff. 2006. *Racionalidade ambiental: a reapropriação social da natureza*. Rio de Janeiro: Civilização Brasileira, 555pp.

<sup>11</sup> Rodrigo Guimarães de Carvalho. 2014. "As bacias hidrográficas enquanto unidades de planejamento e zoneamento ambiental no Brasil". *Caderno Prudentino de Geografia, Presidente Prudente* 36, Volume Especial: 26-43, 2014.

<sup>12</sup> Law 9.433, 1997.

water resources policy under the circumscription of the actors, such as public agents, who make up a management system. In practice, this definition increased the importance of the river basin and the opportunity for basin committees to represent stakeholders' interests in court.

Another practical impact is the need for these committees to establish the management of the resources within the basin's geographical boundaries, following the multiple uses of water, and the need for users to be represented in these committees. These are two advantages.

According to Leite et al.,<sup>13</sup> the responsibilities of the state to protect the environment as a macrogood, whether exclusive or common, are provided for in the Federal Constitution of Brazil (arts. 21, 23 and 24), which outlines a panorama of common protection of the environment, from legislation to execution. This is the context of water policy, which has the responsibility of establishing general guidelines and a National Water Resources Management System and of which the implementation is the shared responsibility of all entities.

However, for this to materialize, the basin committees must function effectively with a certain degree of organization. Another sore point is the financing derived from the concession of water within the basin, i.e., the collection of water abstracted by various users in small amounts. Therefore, in the National Water Resources Management System, the basin committees are at the base of the pyramid and the National Water Resources Council is at the top.

In Mexico in 2019, the main legislative instrument on river basins was the so-called National Waters Law (LAN), enacted in 1992 and last amended in 2022.<sup>14</sup> This law grants the executive power (EP) of the nation-state the maximum attribution to manage all waters of the national territory. The EP has delegated this power to the National Water Commission (CONAGUA), an agency with a massive budget. The verticality of the water management structure makes CONAGUA a rigid structure that operates and decides the fate of water for private interests and is highly distrusted and rejected by citizens across the country. Due to citizen pressure, in 2016, Articles 13 and 14 of the LAN were reformed to broaden public participation in basin organizations. However, these organizations remain merely

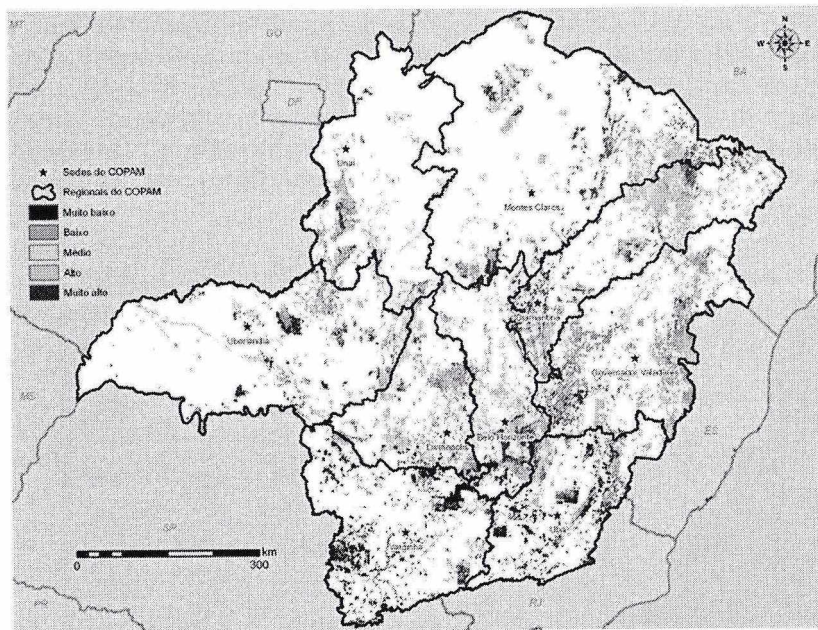
<sup>13</sup> José Rubens Morato Leite (Coord.). 2015. *Manual de Direito Ambiental*. São Paulo: Saraiva.

<sup>14</sup> Comisión Nacional del Agua. 1992. *Ley de Aguas Nacionales*. Distrito Federal: SEMARNAT  
CONAGUA. México, 1992; last reform 11/05/2022.





The lesson learned from this tragedy is the importance of planning to avoid catastrophic results. In this case, the lesson could be instructive for the state of Minas Gerais, which treats the development of mining as an important opportunity. Dozens of dams are scattered across the state territory; their safety conditions are not transparent, and they represent an imminent risk to humans and the environment. Considering that the entire state has approximately 754 dams, and the 2014 report of the competent agency indicated that only forty were safe, the outlook for the basins is not auspicious. Map 2 presents the risk due to mining areas scattered across the state. It is therefore possible to establish that there is no effective spatial planning and that new tragedies can certainly occur.

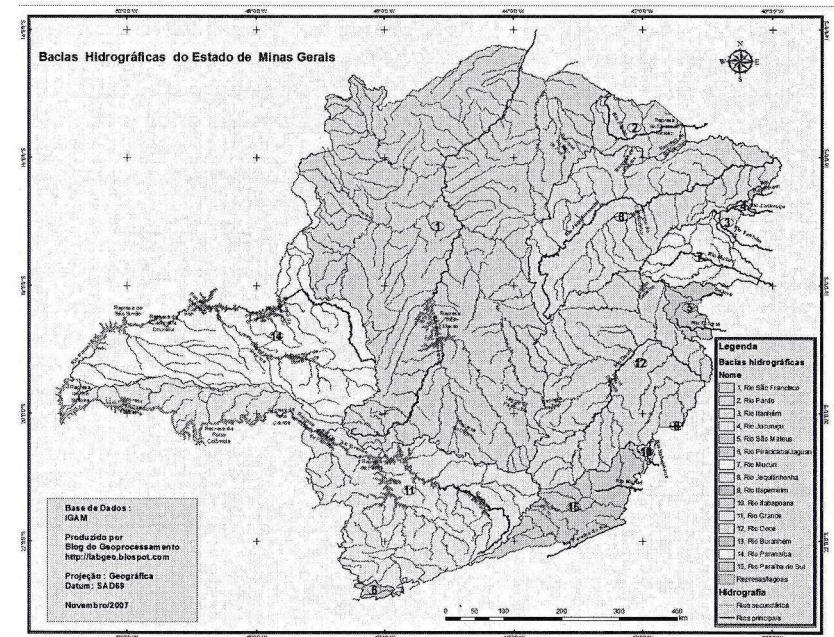


Map 2—Risk in dispersed mining areas throughout Minas Gerais state  
Source: Zoneamento Ecológico-Econômico de Minas Gerais<sup>16</sup>

The unimaginable extent of the risk to the region's population is evident when Map 3 is overlaid on the previous maps. Important basins such as the

<sup>16</sup> Nilton Curi. 2008. *Zoneamento Ecológico-Econômico de Minas Gerais: vulnerabilidade natural e qualidade ambiental associadas*. Lavras, UFLA.

São Francisco basin, which extends into the northeastern region of the country, could suffer damage that would be difficult or impossible to repair.



Map 3—Minas Gerais watershed

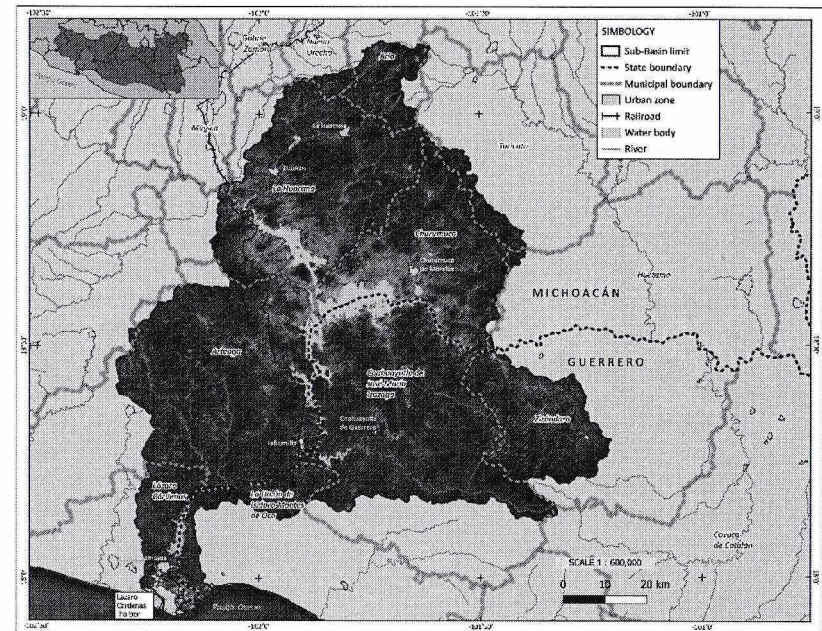
Source: <http://labgeo.blogspot.com/2007/11/mapa-das-bacias-hidrograficas-de-minas.html>.

## 4.2. The Case of Mexico

Mexico is a country with strong rural roots based on the rights of indigenous peoples and the Agrarian Reform stemming from the Mexican Revolution in the 1930s. However, the dominant development model in Mexico during the second half of the 20th century pushed the rural population into conditions of chronic poverty and marginalization. In their places of origin, the rural population has no public services or infrastructure to ensure access to the constitutional rights to education and health, nor does it have the means to develop a dignified way of life. In contrast, the state has remained absent or has intervened through corrupt and “clientelist” schemes to maintain its electoral base, with negative consequences for local populations. Since the end of the twentieth century, the abandonment of rural areas has

provoked massive migratory flows under precarious conditions to the United States and to cities where urban poverty belts are growing. This has led to the loss of identity, cultural traits and peasant ways of life. This is the context of the case of the Infiernillo Bajo Balsas (EI-BB) basin in western Mexico, where the lack of a river basin vision that integrates biophysical, social and institutional factors has led to serious consequences for the social fabric on a regional scale. The EI-BB basin encompasses the mouth of the large Balsas River basin, the second-largest basin in the country, toward the Pacific Ocean, where the Port of Lázaro Cárdenas is located (Map 4). The EI-BB basin contains the confluence of two large rivers (the Tepalcatepec and the Balsas Rivers), which collect the waters of several states in the country. Located at a low altitude, the area has a warm tropical climate, with low rainfall concentrated in four months, so that water is the main limiting resource—and a scarce one at that, particularly in the long dry season that lasts 7 to 8 months. In 2010, with a surface area of 8,024 km<sup>2</sup>, this basin had a population of only 220,000 inhabitants distributed in many small hamlets and rural villages scattered across a mountainous landscape. In 1964, the Mexican government decided to build the Adolfo López Mateos Dam on the final reach of the Balsas River, better known as “El Infiernillo” (little hell), a name that illustrates the thermal conditions of the place where the dam was installed in the center of the basin (Map 4).

As the dam is of national interest for the exclusive generation of electricity, the Federal Electricity Commission (CFE) and the National Water Commission (CONAGUA) decreed a ban on the use of surface water from the year of its creation. This implies the impossibility of obtaining concessions for the legal use of water; impediments to the appropriation and use of water for domestic, agricultural and productive purposes; and the disqualification of public programs to implement irrigation systems and support for producers without any additional measures to compensate a population subjected to a dry tropical climate and without alternative sources of water. The dam has been in operation for more than 50 years and currently provides 36.8% of the country’s hydroelectric energy, ranking second in the country.



Map 4—Location of the El Infiernillo-Bajo Balsas (EI-BB) basin in western Mexico and the position of the Adolfo Lopez Mateos Dam in the center of the basin. Source: Own elaboration

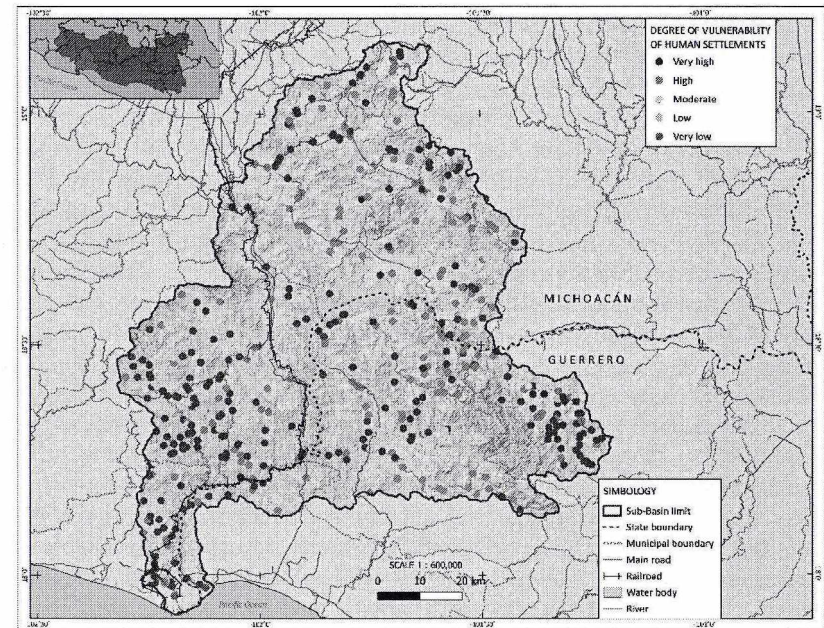
For more than five decades, the “El Infiernillo” dam has operated as an isolated entity with no consideration of the biophysical and social components of the basin where it is situated. Despite the fact that the complete basin is an electricity-producing space, local settlements are poorly served in terms of infrastructure and energy distribution. Local populations suffer recurrent physical damage to water pumps and minor machinery, such as fodder mills and household appliances. The installation of major agro-industrial processing machinery, such as refrigeration chambers or grain cleaners, is extremely difficult due to the poor quality of wiring and the power supply. Additionally, there are no preferential electricity tariffs for the inhabitants of the basin. In the 50 years since the dam’s creation, neither the federal and state governments nor the CFE or CONAGUA have established strategies for the promotion of territorial development under the prevailing ban. Since the 1990s, the population of the basin has shown high

rates of undocumented migration to the United States and the increasing and alarming operation of organized crime groups (drug trafficking).<sup>17</sup>

The exploration of the level of geographic and social vulnerability of the basin's settlements to extreme hydrometeorological events (mainly droughts) showed alarming results (Map 5). Of the settlements, 66% had indicator values greater than 0.6 in a range between 0 and 1 (where 1 is very high vulnerability and 0 is very low), while only 20 settlements (2.8%) had values <0.4. The results indicate that the EI-BB basin exhibits strong social exclusion and territorial backwardness, which are evident in the institutional, geographic (isolation, lack of connectivity) and social dimensions. The outlook worsens when the climate change scenario is considered. The most backward areas within the basin show high to very high levels of climate hazard due to statistically significant trends of the increased occurrence of extreme temperature and precipitation events.

The case study shows the long-term consequences of the lack of planning and foresight from a river basin and territorial justice approach. The lesson learned is the relevance and urgency of considering the importance and sociolegal meaning of the basin to achieve territorial justice.

<sup>17</sup> Salvador Maldonado-Aranda. 2013. "Stories of drug trafficking in rural Mexico: territories, drugs and cartels in Michoacán". *European Review of Latin American and Caribbean Studies/Revista Europea de Estudios Latinoamericanos y del Caribe*, 94:43-66.



Map 5—Degree of vulnerability of settlements to extreme hydrometeorological events in the El Infiernillo–Bajo Balsas (EI–BB) basin (Mexico).

Source: Own elaboration

## 5. Discussion: Is the River Basin a Suitable Sociolegal Entity for the Reduction of Territorial Injustices?

Considering the river basin as a sociolegal entity for conducting environmental management and sustainable development processes is perfectly feasible if public actors and stakeholders are at least minimally prepared for the challenges. However, investments in human resources and technologies, especially monitoring and georeferencing, are needed. In cases where there is strong intervention by private entities, as in the case of mining, sound environmental management and territorial justice will be possible only if the state exercises effective regulation without overlooking mistakes that could cost lives and destroy the environment. The investigations of the Mariana tragedy in Brazil have clearly shown that there was a succession of omissions that went beyond the scrutiny of public officials. Where was the government?

The river basin is definitely a “sociolegal entity” if the “socio” is understood as also involving the environmental dimension. This definition implies that robust basin management will be realized only if the instruments proposed for its implementation are properly applied. In the Brazilian case, the instrument is the river basin master plan, which must be formulated based on a solid scenario-based forecast, especially in territories such as Minas Gerais that have many risk factors, e.g., the presence of tailings dams. Brazilian law establishes a series of instruments that support planning activities carried out in the whole basin, such as the basin plan, subsidies for water use, harvesting, the classification (framing) of water bodies, and ecological zoning. Finally, these instruments validate the basin as a sociolegal entity, allowing legal claims to be resolved through the verification of compliance in all stages by the public and private actors involved.

In the case of Mexico, there is still far to go for the recognition of the river basin as a relevant geographical unit to safeguard fair access to sufficient quantity and quality of water. This is one of the imminent threats to local and regional development in the country. Much further away is the possibility of the river basin being considered a sociolegal entity capable of addressing territorial inequalities and injustices within its boundaries. In Mexico, the legal and regulatory instruments in place are completely inadequate to take such a step. Moreover, public policy lacks the vision and will to position water and water security as strategic resources; thus, the high levels of social and territorial inequality to which a large proportion of the Mexican people are subject are expected to increase.

The cases presented point to important challenges. From academia, the geolaw approach needs to be strengthened as a field of knowledge capable of integrating geographical and legal frameworks to implement a more powerful watershed approach capable of helping reduce present and future territorial injustices.

## 6. Conclusions

In Brazil and Mexico, the river basin, conceptualized as a conglomerate of territories, is still far from becoming a *de facto* sociolegal entity in law. In both cases, ongoing development models are not consistent with care for the environment and human life in general, particularly for those living in vulnerable communities and belonging to groups that have not had effective public water management policies.

Moreover, management that approaches the basin as a sociolegal entity is fundamental to considering the basin as a living entity where several ecological and human activities are carried out, which is fundamental for the

maintenance of the water cycle. The protection of water resources rests on integrated management models, including rivers, groundwater, forests, air, and soils—in short, all the elements essential for life, with the maintenance of the urban mode adopted by the majority of the planet’s inhabitants.

In the imminent process of climate change, considering the river basin as a sociolegal entity will bring more consistency to disaster prevention policies, as more reliable scenarios can be constructed, bringing together traditional and scientific and technological knowledge as well as greater political will.

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