

Article

Water Resources Management in Mexico, Chile and Brazil: Comparative Analysis of Their Progress on SDG 6.5.1 and the Role of Governance

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Abstract: Integrated Water Resources Management (IWRM) is globally regarded as a suitable alternative to adapt to the effects of Climate Change. Chile, México, and Brazil are developing countries that are highly vulnerable to climate change and have different water management models, thus presenting the strengths and challenges for IWRM compliance. Our analysis aims to compare advances in terms of the achievement of SDG 6.5.1 in these countries, in relation to the degree of implementation of IWRM and their correlation to the OECD principles on Water Governance. We used IWRM Data Portal, UNEP-DHI, including 33 indicators, and we used the proposal of Bertule et al., (2018) to analyze the relationship among IWRM and governance. Our findings indicate that the Chilean model has low social involvement in water management due to a market-based water governance system with weak state regulation and lack of legal instruments to implement watershed management programs. In Mexico and Brazil, there is greater citizen involvement in watershed organizations, and ecosystems and aquifers have been incorporated to aid with water management. These three countries show a low performance of gender indicators, deficient financing, and information in terms of decision-making, and a lack of effective mechanisms for social participation, which are key aspects of governance.

Keywords: water security; watershed management; SDG6



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1. Introduction

Socioeconomic systems are increasing in complexity, making natural resource management and governance relevant to address conflicts between different sectors. Furthermore, social–ecological responses to Climate Change (CC) effects are multiple, interconnected, and emerge at different time scales [1], requiring holistic and adaptive approaches to management [2–4].

In terms of adaptation to CC, Chile, Mexico, and Brazil present seven of the nine characteristics of vulnerability to CC [5], being cataloged in the 87th, 26th, and 91st places in the ranking of the most important countries affected by climatic risks, respectively. Chile and Mexico are the two Latin American countries that are projected to present the highest water stress index by 2040, whereas Brazil presents a low index at the national level, but a different situation is presented in some regions, at the local level [6–9]. These conditions

imply an impact in the social, healthcare, and agricultural sectors, increasing inequalities, poverty, and water crises related to weak mitigation and adaptation policies [10–12], increasing the vulnerability of millions of inhabitants to extreme climatic events to an even greater extent.

To address this problem, IPCC communications [5,12,13], the Sustainable Development Goals (SDGs), and the Water-Food-Energy NEXUS approach [14], have appealed to countries to strengthen and/or implement Integrated Water Resources Management (IWRM), defined as “a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” [15]. In this sense, the emphasis should be placed on developing local capacities to achieve water, energy, and food security, which is promoted by the official recognition of access to water and sanitation as a human right by the United Nations (2010) and the commitments made at COP 21 in Paris (2015) and COP 25 in Madrid (2019), which have been ratified by Mexico, Chile, and Brazil.

In 2015, these three countries committed to fulfil the 2030 Agenda for Sustainable Development [16] which promotes the achievement of 17 SDGs. SDG 6: Clean Water and Sanitation aims to “ensure availability and sustainable management of water and sanitation for all” and contains the indicator 6.5.1: “degree of IWRM implementation”, which reflects the importance of water management and governance to achieve this SDG. Analyzing this indicator becomes relevant to achieve the rest of the SDG 6 targets, which directly impacts aquatic ecosystems’ health (SDG 6.6) and water efficiency (SDG 6.4), which in turn affects water quality (SDG 6.3), sanitation, hygiene (SDG 6.2), and equitable access to drinking water for all (SDG 6.1) [17].

In Chile, the National Council for the implementation of the 2030 Agenda was created in 2016; however, meeting SDG 6 is considered difficult to achieve because Chile has not yet been able to implement IWRM. In relation to water resources, this country has developed the National Policy (2015), the National Strategy (2012–2025), and the National Water Management Board (2020), regarding efficient and sustainable management, institutional improvement, social equality, and informed citizenship as priority aspects to face the increased water demand; however the proposed objectives have not yet been met, and they lack an integrated management approach.

In Mexico, the implementation of the 2030 Agenda included the development of the National Strategy, the formation of the Technical Committee Specialized in Sustainable Development Goals (SDGTC), and the Monitoring and Implementation Organisms (MIOs) of the 2030 Agenda in 32 federal entities, incorporating this agenda in sectorial, state, and municipal programs [18]. In relation to water resource management, Mexico have used previous instruments such as the Regional Water, National Water Reserves, Water Quality Monitoring, Comprehensive Development for Water, Sanitation Operators, Payment for Environmental Services, and the Indigenous Infrastructure programs, the results of which have contributed to the fulfillment of the SDG 6. The Vulnerability and Risk Diagnosis, and the local Adaptation program to Climate Change and Protected Natural Areas (PNA), are actions taken to comply with SDGs 6 and 13 [18], to improve governance, and to promote the integration of scientific knowledge for IWRM. Although there are coordination mechanisms, such as the Inter-Ministerial Climate Change Commission (CICC), the Technical Committee of the National Water Commission (CONAGUA) on water resources, and commissions in state and local governments, there are problems of disarticulation, lack of application, scarce financing, and contradictory policies without a long-term vision, thus hampering their implementation [19–21].

Brazil created the National Commission for SDGs of the Government Secretariat of the Presidency of the Republic, including Government representatives, civil society, and the private sector. The National Confederation of Municipalities has been crucial in guiding municipalities to incorporate the SDGs in multiannual investment plans, sectorial programs, and management processes, enabling them to adapt to local contexts [22,23]. Some existing

instruments, such as the National Policy for Basic Sanitation (Federal Law No. 11,445), the National Policy of Water Resources (Federal Act No. 9,453/1997), water security plans, security and sanitation plans, and the National Program of Rural Sanitation, are considered actions that contribute to the fulfilment of SDG 6. Since 2019, the Brazilian Water Observatory works with watershed committees to identify improvements in water management; however, there are implementation deficiencies, such as the lack of regulation of treated water, lack of social participation, transparency, and a current controversy over amendments to the legal framework regarding the private sector's active intervention in drinking water and sanitation services [22–24].

The problems related to the proper functioning of these three countries' plans and programs are closely linked to governance failures. This makes sense, since the current water crisis is a governance crisis [25]. Water scarcity is not only defined by geographical factors or natural availability, but it is also the consequence of a deficient water governance system [25]. Water resource management requires appropriate institutional and regulatory frameworks, coordination, and social participation to balance uses and practices that depend on a limited resource.

An adequate and efficient governance process determines the context in which water management works [26]. Water resource management was initially carried out through a top-down approach by centralized governments, and was focused on increasing water supply, but not on managing water demand. The lack of understanding about the integration of human and hydrological systems as socio-ecological systems, the low research budget, and the deficient correlation between science, politics, and management has led to misconceptions about social-hydrological dynamics, indiscriminate uses, misappropriation, and institutions that do not adequately respond to these challenges [12,19].

One good water governance approach was developed by the OECD (2015), including the 12 Principles on Water Governance, which were grouped into three key dimensions: effectiveness, efficiency, and trust and engagement (Figure 1); however, these principles have been subject to debate as to how they can be integrated into SDG 6.5.1 [25,27,28].

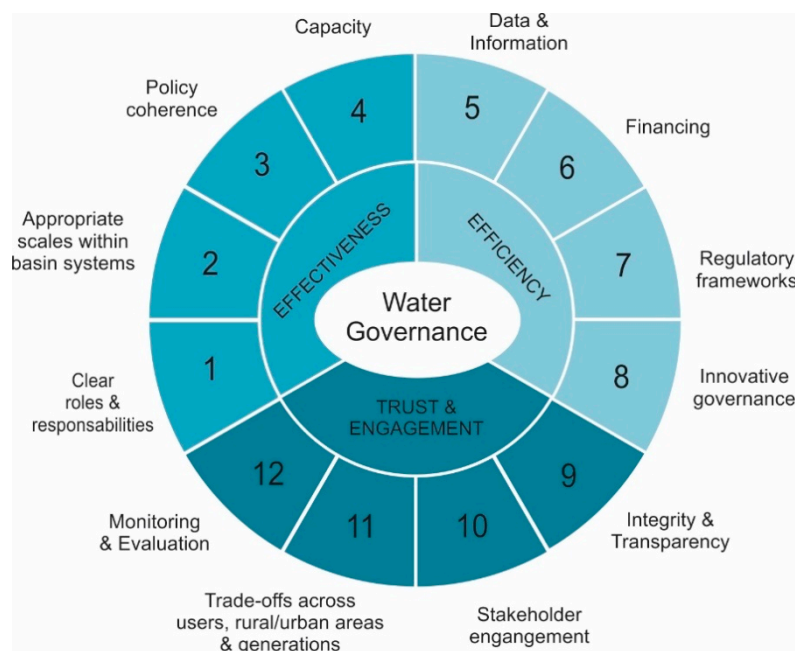


Figure 1. The 12 principles on water governance. Adapted from [25].

Since 1990, water governance reforms seek to create and strengthen IWRM on a global scale. In scenarios of water scarcity, IWRM facilitates agreements and decentralization for decision-making, creating synergistic associations and valuing local practices to ensure water supply and territorial environmental integrity [19,29,30]; however, in some coun-

tries, its implementation has been incipient [20,31,32]. Taking this into consideration, and recognizing the difficulties of implementing IWRM models, we performed a comparative analysis between Mexico, Brazil and Chile. These countries were selected due to their different water governance systems and IWRM implementation schemes, being representative of Latin America. In this sense, our study aims to: (1) comparatively analyze the progress between Chile, Mexico, and Brazil in terms of IWRM implementation, according to SDG 6.5.1, in order to identify main achievements, gaps, and/or aspects to improve; and (2) analyze the existing association between IWRM indicators and the OECD Principles on Water Governance, since we consider governance to be a key aspect for achieving IWRM implementation.

2. Chile, Mexico, and Brazil: Three Approaches for Water Management

In Mexico, Chile, and Brazil, water resource management has been historically different in terms of their institutional and regulatory frameworks, and the implementation of actions towards IWRM (detailed in Table 1).

Table 1. Institutional framework and attributions of each country [33–40].

Framework	Chile	México	Brazil
Water Governance models	Multiple actors at central level and few implementers at local level (requires coordination and articulation at the highest level)	Few central government actors and multiple local and regional authorities (requires Presidential intervention, coordination between institutions)	Multiple actors at the central level and at the local or regional level (challenge of coordination between institutions, between regions and between civil actors)
Territorial Unity IWRM	Political-administrative division	The watershed as a management unit	The watershed as a management unit
Community organization to participate in water management	Water User Organizations (WUOs) with limited participation: Water boards, River Vigilance Committees, Association of Canal Users, Water Communities and Drainage Works Communities	Basin councils, Basin Committees, micro-basins, COTAS Technical Groundwater Committees, Local organizations (peasants, indigenous), Inter-municipal associations	Basin councils (made up of federal, state and local authorities and civil society representatives)
Regulatory instruments and planning mechanisms	Law 19.300, DFL 1122 (Water Code), Regulatory instruments such as secondary quality and emission standards, Environmental Impact Assessment System (SEIA), Management and Decontamination Plans	Political Constitution of the United Mexican States, General Water Law LAN (1992), National Hydrological Plan (2003–2018). State Constitution, State Water Law and State Water Law Regulations (3 states and City of Mexico); Official Mexican Standards, Plans by basin, sub-basin and micro-basin. Water Resources Information Systems. Regulatory instruments with a basin approach	National Water Law (Law 9,433/97); Sanitation Law (11,485); National Water Resources Policy; National System for Water Resources Management (SINGREH), Brazilian Water Resources Plan São Paulo Water Resources Plan Guarani Aquifer Agreement, Plans by basin
Institutional framework, managers and actors	43 institutions involved in the audit and control of the Water Resource. There is fragmentation among institutions and lack of articulation mechanisms among actors	CONAGUA (governing agency) Integrated technical committee, Watershed Organizations, Watershed Councils Watershed Committees, Groundwater Committees (COTAS), Clean Beaches Committees, Municipalities (drinking water and sewerage) and Indigenous Committees)	National Water Resources Council, National Secretariat of Water Resources and Urban Environment, National Water Agency (ANA), Water resources councils of the states and the federal district, Basin Agency, Basin Committees, Watershed water agencies, Federal and state government bodies (related to water resources management)

Table 1. Cont.

Framework	Chile	México	Brazil
Water Management	Centralized and not having a basin management structure. Water resources management is based on market criteria and Water Use Rights (WUR)	National Water Commission (CONAGUA) as lead agency, with powers for river basin management and specific functions to other agencies at the state and municipal levels	Decentralized, participatory and Integrated. Three levels of government autonomous
Vision of Water	The Water Code (1981) defines water resources as “national public good”, and defines WURs at the request of users, free of charge, in perpetuity and inherited; and without specifying the use	The Political Constitution and the Law on National Waters recognizes water as an asset Public, the right to access, dispose of, and clean up water for personal and domestic consumption (p). Temporary water concessions	Recognizes water as an asset Public with prioritization of use

Brazil has the first historical period of watershed regulation, where the State is responsible for water and sanitation supply. The establishment of the Water Code (1934) developed water resource management instruments, whereas the Federal Institution (1988) defined the National System of Water Resources (SINGREH) and the criteria for granting water use rights. The principles of IWRM and the National Policy of Water Resources (PNRH) were incorporated, including the prioritization of water for human consumption, the recognition of watersheds as administrative management units, and a decentralized political-administrative organization, where the three levels of government (Union, States, and Municipalities) were autonomous. In this sense, they can develop laws and implement them. In addition, water allocation is controlled by the national government and state, and municipal governments are responsible for institutional arrangements in water and sanitation.

Since the implementation of the PNRH (1997), water management modernization was based on giving greater importance to social participation in order to achieve legitimacy in policies, and to recognize multiple uses of water. Watershed councils (formed by the federal and state governments, local authorities, and the civil society) participated in water management, were responsible for the elaboration of watershed plans, the establishment of access rights, water use fees, and conflict mediation [20,34,41,42].

In Mexico, the application of IWRM began in 1998 with the National Water law (LAN), which was formally recognized as a national priority in 2004 [43,44]. In this sense, watersheds were considered to be the basis for environmental management actions, and institutional and local capabilities for integrated watershed management were improved. This law allowed the creation of watershed councils and commissions that incorporated different actors in the decision-making process, with the technical and economic support of the National Water Commission (CONAGUA). The latter is a decentralized coordinating body representing different sectors in the decision-making and assessment processes. Advances in the implementation of IWRM have been achieved, from a public policy perspective, through incentives, subsidies, and administrative regulations, which required coordination among different actors regarding water, land, and other natural resources; however, the link between land use, planning, and watershed programs has not been observed except in a few cases [43].

In Chile, the watershed as a management unit is not defined in the 1981 Water Code, which is the main legal body in terms of water allocation since water management obeys political-administrative territorial divisions (16 regions). Furthermore, management is not linked to land use planning and its effects on the water system [39], in spite of the fact that usually one watershed could be located within two or three border regions. The Water Code also allows the national government to grant perpetual use rights to private organizations and individuals, so water is treated as a private good, whose regulation is based on market criteria through Water Use Rights (WURs) and is tradable among users, including

water supply and sanitation services [45,46]. There are participatory mechanisms such as the Water Use Organizations (WUOs), which are private entities regulated by the Water Code, responsible for water collection, conduction, and allocation between their members; however, these are exclusively composed by WUR holders, inhibiting the inclusion of other actors affected by water management, thus increasing vulnerability [47,48]. A study carried out by the World Bank (2013) identified 43 institutions involved in water management in Chile, observing overlaps and duplicities in their functions, as well as deficient or non-existing coordination and implementation gaps [39,45]. Despite the development of the National Strategy of Integrated Watershed Management (2007), Chile has not advanced to the IWRM because this is not permitted by the current legal framework, nor is weak scientific information available for aquatic systems' structure and functioning. In addition, the allocation criteria do not respond to hydrological dynamics, access problems, and the weak quality of information about WURs that have been granted [11,27,33,34].

3. Methodology

In order to fulfill the first objective, which is to comparatively analyze the progress between Chile, Mexico, and Brazil in terms of IWRM implementation, we used the IWRM Data Portal, UNEP-DHI, for indicator 6.5.1. In addition, the implementation degree of the IWRM (0–100) of UNEP-DHI established in 2017 and 2018 was also taken from a reference questionnaire for each country. This was applied as a result of national coordination centers consulting key actors such as national and sub-national ministries, water management institutions, as well as other stakeholders such as civil society organizations, academia, and the private sector. The assessment of 172 countries, which was systematized and made available to the public by the UNEP-DHI Center on water and environment, has been used in the national reports of progress in the implementation of the 2030 Agenda [28,49,50].

The parameters include 33 indicators grouped into four dimensions:

- (I) Enabling environment: conditions that promote the implementation of the IWRM in terms of policies, legal instruments, and planning; 1.1a. A national water resource policy or similar; 1.1b. National laws on water resources; 1.1c. National IWRM plans or similar; 1.2a. Subnational water resources policies or similar; 1.2b. Basin/aquifer or similar management plans based on IWRM; 1.2c. Arrangements for transboundary water management in basins; 1.2d. Provincial/state water resource laws.
- (II) Institutionalization and participation: roles of institutions and other actors in implementing measures; 2.1a Capacity of national government authorities to lead the implementation of national IWRM plans or similar; 2.1b. Coordination among national government authorities representing different sectors on water resources, policy, planning, and management; 2.1c. Public participation in water resources, policy, planning, and management at a national level; 2.1d. Business participation in the development, management, and use of water resources at the national level; 2.1e. Gender-specific objectives for water resource management at the national level; 2.1f. Capacity building for IWRM at the national level; 2.2a. Basin/aquifer level organizations to lead the implementation of IWRM plans or similar; 2.2b. Public participation in water resources, policy, planning, and management at a local level; 2.2c. Gender-specific objectives at sub-national levels; 2.2d. Gender-specific objectives and plans at a cross-border level; 2.2e. An organizational framework for the management of transboundary waters of the most important river basins/aquifers; 2.2f. Provincial/state authorities responsible for IWRM.
- (III) Management instruments: allowing decision-makers to proceed with an informed choice between different management alternatives; 3.1a. National water availability monitoring, including surface and/or groundwater; 3.1b. Sustainable and efficient management of water use at the national level, including surface and/or groundwater, as appropriate to the country; 3.1c. National pollution control; 3.1d. Management of water-related ecosystems at the national level; 3.1e. Management tools to reduce impacts of water-related disasters at the national level; 3.2a. Watershed management

instruments; 3.2b. Aquifer management tools; 3.2c. Exchange of data and information within countries at all levels; 3.2d. A cross-border exchange of data and information between countries.

- (IV) Financing: sources of economic resources to develop management processes; 4.1a. National budget for investment including water resource infrastructure; 4.1b. National budget for recurrent costs of IWRM elements; 4.2a. Subnational or watershed budgets for investment including water resource infrastructure; 4.2b. Revenues collected from specific levies on water users at the basin, aquifer, or subnational level; 4.2c. Funding for cross-border cooperation.

These are qualified individually by the different stakeholders and sectors, using a 0–100 scale, in increments of 10, thereby calculating the mean score of each of the four dimensions of the IWRM, and subsequently, calculating the final average. The categories are assigned based on scoring thresholds [50,51]. According to UN-Water, by 2030, the countries that are in the “high” (>71 to ≤ 90) and “very high” (>91 to ≤ 100) thresholds are in a condition to reach the global goal, though they must consolidate and reinforce their progress. Those countries in the “medium-high” (>51 to ≤ 70) threshold could potentially achieve the objectives, though they must make considerable efforts to achieve them. Countries in the “medium-low” (>31 to ≤ 50) and “low” (>11 to ≤ 30) threshold have a low probability of achieving the global objectives unless they significantly accelerate their progress. Finally, the countries in the “very low” (0 to ≤ 10) category, must reformulate their objectives according to the context [51].

To carry out the analysis, the data from each indicator were extracted per country, and comparative graphs were prepared, identifying the main performance advances in IWRM. This information identified the indicators in which there exist main gaps, weaknesses, and aspects to be strengthened between management models.

To achieve the second objective, the study by Bertule et al., (2018) analyzed the existing association between IWRM indicators and the OECD Principles on Water Governance. These authors establish a correspondence between both approaches, identifying questions in the UNEP-DHI survey to evaluate the progress of the performance of indicator 6.5.1. Likewise, they indicate that these questions are largely representative of the three OECD water governance dimensions. This is due to the fact that these provide a general view of the enabling environment, management instruments, participation, and financing that allow better water governance at different management levels. These associations can be observed in Table 2.

Table 2. Association between the OECD Principles of Water Governance and the indicators of the IWRM framework. Adapted from [28].

OECD Dimensions of Water Governance	OECD Principles on Water Governance	SDG Indicator 6.5.1
EFFECTIVENESS	P1. Clearly allocate and distinguish roles and responsibilities	1.1b; 2.1a; 2.1b
	P2. Manage water at the appropriate scale(s) within integrated basin governance systems	1.1a; 1.1c; 1.2c; 2.2a; 2.2e; 3.2c
	P3. Encourage policy coherence	2.1b; 3.1a; 3.1b; 3.1d; 3.1e
	P4. Adapt the level of capacity of responsible authorities	2.1a; 2.1f
EFFICIENCY	P5. Water-related data and information	2.1b; 3.1a; 3.2c; 3.2d
	P6. Financial resources	4.1a; 4.1b; 4.2a; 4.2b; 4.2c
	P7. Regulatory framework	1.1b; 2.1a
	P8. Innovative water governance	2.1c; 2.2b; 3.2c

Table 2. Cont.

OECD Dimensions of Water Governance	OECD Principles on Water Governance	SDG Indicator 6.5.1
TRUST and ENGAGEMENT	P9. Integrity and Transparency	2.1c; 2.1d; 2.2b
	P10. Stakeholder engagement.	2.1c; 2.1d; 2.1e; 2.2c
	P11. Manage trade-offs across water users	2.1c; 2.1e; 2.2b; 2.2c
	P12. Evaluation of water policy and governance	2.1f

Based on the above, a data matrix with a valuation of each indicator for SDG 6.5.1 was generated for each country. To integrate each principle in the OECD Governance framework, the values of the relevant SDG 6.5.1 indicators were averaged. Subsequently, the resulting values were averaged using the same scales to determine each corresponding governance dimension. Graphs were generated as a result of the correlation between both approaches and the performance evaluation scores of Mexico, Chile, and Brazil, observed below on Section 4.

4. Results and Discussion

4.1. Performance of SDG 6.5.1 over IWRM Progress

Mexico is evaluated to be at a medium-low level (49), because it still requires progress in terms of the mechanisms of local organization and participation in watershed committees to allow better coordination and management [20,41]; however, this country has policies and national laws concerning water resources that support the IWRM and includes cross-border agreements and local laws [43]. On the other hand, Brazil presents a higher score (51, medium-high) due to the greater capacity of the Brazilian government to lead the implementation of the IWRM at the federal, regional, and local levels, with greater capacities, coordination between institutions, watershed organizations, and other social sectors. Its management structure is decentralized and participative, although the model is not implemented in all watersheds, and it requires progress in local organization and social representativity [36,48,52]. Finally, Chile shows a low level of implementation (22.6) and a lack of legal frameworks that regard watersheds as a territorial unit for management. This restricts government capacities for the IWRM. The exclusivity of the Water Code as a national normative reference on water allocation does not allow water management at regional, subnational, or watershed levels. Furthermore, the lack of coordination and social participation (it is usually symbolic, with mainly informative or consultative non-binding mechanisms) limits integration in management.

According to I, enabling environment (Figure 2I), Chile is the only OECD country that does not perform IWRM. The lack of instruments and regional policies in Chile is evident in this regard, due to the local regions' dependence at the central national level. The characteristics required for IWRM implementation are not considered within the Chilean legislation, and normative instruments currently favor water management for isolated and non-integrated hydrological resources (groundwater legal instruments are different from rivers, glaciers and coastal water) [34,37,53].

In Mexico, the LAN grants responsibilities and coordinate functions among national authorities and local governments for IWRM. In addition, there are laws and regulatory and planning instruments at the regional scale that provide a greater capacity for action to local governments for transboundary watershed management [43,44]. It should be noted that, in Mexico, there are eight transboundary watersheds (three shared with the USA, four with Guatemala, and one with Belize and Guatemala). Among them, there are differences in the level of progress because, in the case of northern transboundary basins, the implementation of the IWRM approach is strongly influenced by the International Waters Treaty (1944), signed with the United States [10].

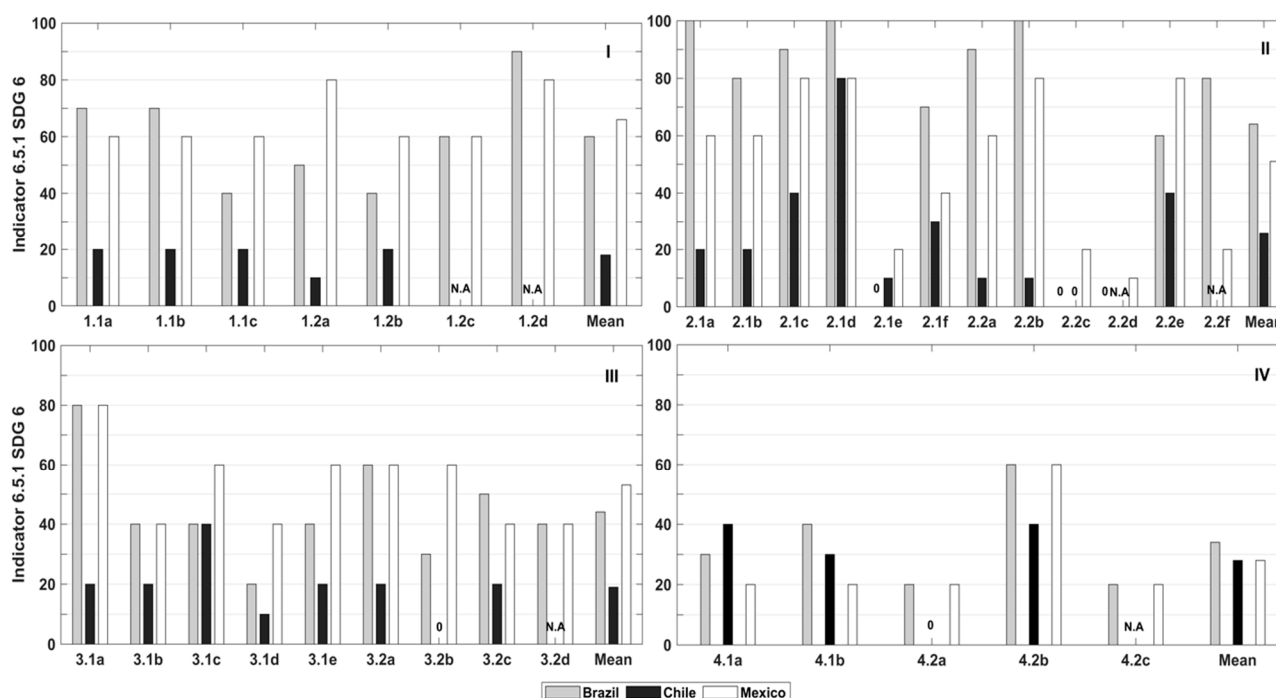


Figure 2. Advances in the performance of SDG 6.5.1 from Chile, Mexico, and Brazil (own elaboration of data from IWRM Data Portal, UNEP-DHI, 2018).

In Brazil, the PNRH and the watershed plans work similarly to Mexico, although there is less progress at the local scale. Water is considered a state property, and some uses of water are prioritized over others (for humans, the environment, etc.), and there is a system of WURs concessions and fees for the use of water resources [36,54]. In transboundary rivers, the Ministry of Foreign Affairs and the National Indigenous Foundation (FUNAI) participate in the case of indigenous territories, with the participation of communities' members [55]. The new scenario in Brazil, which has been officially valid since July 2020, could make the current situation less participatory for local governments, because the new law, 14.026/20 Legal framework for basic sanitation, aims to centralize regulation within a federal organism, National Water Agency (ANA).

II: institutions and participation (Figure 2II) show low development for specific gender objectives in IWRM at all levels in the three countries, reflecting the inattention to vulnerable groups (women, children, and the elderly). Mexico (as well as Brazil) shows greater progress in performance by having legal participative mechanisms and watershed organizations (26 watershed councils and 215 auxiliary bodies in Mexico: 36 sub-basin commissions and micro-basin committees, 88 groundwater technical committees, and 41 clean beach committees); however, these have not been implemented in all watersheds and show significant problems of coordination and representativeness [20,41].

Brazil presents advantages in terms of having a greater capacity for implementation of national plans and public coordination at the national and local levels through watershed committees. Since 2007, the entire country has been subject to the State Program of Water Resources, and it currently operates 9 interstate watersheds and 210 state committees. A total of 63% of the latter have watershed plans already prepared or in preparation, representing 74% of the municipalities and 77% of the total population [54]. Some management instruments such as the framework for classifying watercourses, water mass domains, and ecological flows, still require the harmonization of laws, as well as federal and state regulations to reduce management segmentation [36]. Recent environmental crimes, such as those that occurred in Mariana and Bruhmadino, Minas Gerais (2015 and 2019), and water pollution in Barcarena, Pará (2018), among hundreds of conflicts related to water,

suggest the need to strengthen water councils by increasing social sector involvement, representativeness, citizen surveillance, and monitoring [22].

In Chile, there is low progress in terms of national capacities for implementing IWRM, in terms of coordination between authorities, creation of public watershed institutions, and social participation (as it is exclusive to water rights holders). Regarding private water use organizations, these are constituted in a specific section of the watershed (river or aquifer section), but not in the entire watershed, with a few exceptions. Fragmentation and sectioning prevent an IWRM, management does not consider interactions between surface waters and groundwater, nor does it consider floods, droughts, and other accumulative effects in the upper, middle, and lower areas of the watershed. The absence of functional social participation instances prevents gathering governmental, private, and civil sectors for decision-making and implementation [47]. Some initiatives such as the Water Boards and Voluntary Agreements for Watershed Management, created for the coordination of local actors, present limitations such as lack of legal structure, financing, and representativeness. Furthermore, they are generated as a reactive strategy for conflict solving, or they are associated with cleaner production programs rather than planning for IWRM [37,39,45].

The three countries show some differences in the role of private companies' involvement in water management and use. In Chile, they act as WURs holders granted by the state through the General Waters Directorate (DGA), in perpetuity and free of charge, and they usually provide drinking water and sanitation services [34,47]. In Mexico, private companies have temporary concessions, generally for 30 years, which are granted by the state through CONAGUA [21,43]. In Brazil, water allocation permits (for temporary concessions and in some states with payment for the use of water since 1997) are issued in accordance with the recommendations of the hydrographic watershed plan. Here, watershed committees and councils allow dialogue with social representatives, which increases stakeholders' influence in decision-making processes, thus strengthening governance [56].

A recent second period in Brazil stands out for the updating of the legal framework to solve all sanitation problems in the country. The new law, 14.026/20 (legal framework for basic sanitation, 2020), promotes modifications such as: (i) the granting of powers to the National Water Agency (ANA) to state reference standards on the sanitation service (Law 9.984/2000 Creation of the National Water Agency ANA); (ii) to improve basic sanitation conditions (Law 11.445/07 National Policy for Basic Sanitation); and (iii) to achieve the adequate disposal of tailings (Law 12.305/07 National Solid Waste Policy) [57]; however, this new water law, which aims to privatize state water and sanitation companies, has caused a controversy in terms of putting a vital public resource in private hands, because it would have consequences that many countries currently regret by having privatized their water systems. This situation, which has been covered by the Latin American press, is not yet clear [58,59], and several leading institutions from civil society are concerned. Some consequences would be injustice, distribution problems, and commercial exploration, as well as the increased cost of drinking water and sanitation services. In addition, it could be possible that private companies, to obtain more economic profits, are only interested in providing services to municipalities that, due to their natural territorial conditions, do not have water availability problems, whereas what is required is to expand water and sanitation coverage in highly vulnerable areas [22].

The current law in Brazil marks a management type that brings it closer to Chile with respect to the possible privatization of drinking water and sanitation services through modifications to the legal framework [24,42]. In the case of Chile, some modifications were established through a mechanism called "Decree with Force of Law" (DFL No. 70, 1988, Law on Tariffs for Health Services) which indicates that private companies will be subject to fixed rates, establishing a maximum price for the provision of their services, which is calculated by the Superintendency of Sanitation Services (state agency in charge of regulation and supervision). In addition, a 7% of minimum profits has been established, which has incentivized companies to invest in this sector, allowing them even to obtain profits of around 20%. This has meant that, currently, in Brazil, sanitation service coverage

in urban areas has reached levels comparable to that of other OECD countries, reaching averages of 99.93% in drinking water coverage, 97.17% in sewage collection, and 99.88% in wastewater treatment [60]; however, a different reality occurs in rural localities, where it has been estimated that 47.2% of the population lacks a formal drinking water supply system [61]. Regarding sanitation, sewerage coverage in the rural world reaches only 25% [62]. In this regard, the creation of new strategies of state intervention are needed to increase this percentage and to address other problems, such as inequalities, in terms of access to drinking water and sanitation.

III: management instruments (Figure 2III) in Chile show a low performance in terms of ecosystem management, in managing disasters associated with extreme hydrometeorological events and water resources (similar to Brazil), managing aquifers, monitoring, information exchange, and efficient use of water. Legally, surface waters and groundwater are managed independently of each other, hampering the adoption of integrated water management [39]. Some advances correspond to pollution control at the national level, having tools and management instruments, such as some recent secondary quality standards for the protection of surface waters (currently, two lakes and three watersheds). There are also primary quality standard regulations, and the first decontamination plan for a lake, approved in 2020 (Exempt Resolution No. 437 of the Ministry of Environment), but not implemented at the watershed level [34,39]. The determination of minimum ecological flows is strongly influenced by a technocratic–scientific system (through the Decree No. 71 of the Ministry of Environment that modifies Decree No. 14 of 2012, which approves regulations for the determination of the ecological flow), that only considers physical and hydrological factors that do not include the effects of various human activities; therefore, if all basic hydrological requirements are met, the authority grants WURs, without considering social-ecological externalities. According to the Chilean Water Code, WURs must be registered; however, this is not compulsory. This becomes a problem in terms of having unclear data about the real demand for the resource [45].

Mexico has a medium-high performance regarding management instruments in watersheds and aquifers, disaster reduction, and pollution monitoring control; however, indicators referring to the efficient use of water, ecosystem management, and information exchange, are medium-low. It has the greatest performance (high) in terms of monitoring water availability, as it has a Water Information System, similarly to Brazil (Figure 2III); however, the information available is not entirely linked to decision-making [19]. Some recognized advances are the generation of ecosystem management studies and projects, as part of the watershed management approach. These include decrees on water reserves, sub-basin, and micro-basin management programs, and coastal watershed management (C6 Program on coastal basins and climate change).

Brazil has an Information System on water resources to support decision-making at all levels, and water course classifications to link water quality and quantity and prevent actions in some states; however, it has not been entirely implemented. Regarding ecological flows, these are established as a minimum flow once the demand has been supplied, but it has been regarded as an inadequate approach for ecosystem management [36]. In addition, the need to incorporate inland waters to the National and State Policy of Water Resources as an integral component of the coastal systems has been identified [22]; however, the new law in Brazil is generating insecurity, due to the lack of transparency. For example, this new law eliminated the right of each watershed to declare if they are under an emergency situation, transferring this function to the national government. This can be problematic in relation to environmental accidents such as in Minas Gerais (2019) and Vale Company, where a 1,000 km² watershed was totally destroyed.

Finally, IV: financing (Figure 2IV) in the three countries is lacking, as they present low progress in national and local budgets. The greatest advances in the three countries are observed in the revenues collected by some groups of actors at the regional level and infrastructure budgets. Mexico has a payment mechanism for environmental services [63] and “green” tax collection mechanisms, which, in some regional and local cases, are

used to obtain funds for the environmental sector, due to the scarce national budget for infrastructure and IWRM. In Brazil, watershed committees, in coordination with the basin Agency, obtain some financial resources from the collection of water bills destined for watershed management plans [54]. The National Plan for the Recovery of Native Vegetation included the recovery of watersheds. In 2017, an initiative of the Brazilian Institute of the Environment achieved the incorporation of a regulation to allocate fines to preservation services, improvement, and environmental quality. Here, aquifer recharge zones, as well as species and green areas destined to the protection of water resources, were included (Decree 9179/17 provides administrative infractions and sanctions on behalf of the environment and it establishes the federal administrative process for the investigation of these infringements, Law 9605/98 Environmental Crimes Act); however, this initiative was revoked by the current government, and the existing budget has been directed mostly to the generation of “gray infrastructure” for water and sanitation services [22]. In the case of Chile, annual budgets destined to the DGA are much lower compared with other state agencies [45]. For example, according to the 2020 budget law (Bulletin No. 12.953-05), the DGA received a budget of 20 billion Chilean pesos, which is equal to the 1.5% of the budget, and it was destined for the state department in charge of the construction of highways and bridges. This shows that the Chilean State considers water management to be a low priority.

4.2. Contribution of SDG 6.5.1 Indicators on the IWRM Performance within the OECD Water Governance Framework

When relating the IWRM implementation indicators to the OECD principles on water governance (Figure 3), it can be observed that the greatest progress is found in Brazil (67 “High”), whereas Mexico does not perform as well (54.6 “Medium-High”). Brazil has the highest performance progress in the IWRM, which is related to national institutions, greater decentralization, and social participation mechanisms within the water governance model [34,36]. This can be observed in the contribution of SDG 6.5.1 indicators towards innovation, having a more solid regulatory framework, a greater capacity to support water governance, and more responsibilities relating to water governance. In addition, there are clear roles, integrity, and transparency, possibly derived from a more participative model, and greater autonomy in local governments and watershed organizations.

In the case of Mexico, efficiency presents the lowest averages, influenced by the scarce availability of financial resources granted to IWRM. They have a negative impact, despite having a medium-high performance average in terms of innovative governance, regulatory framework, monitoring, and data availability. In trust and engagement, only the integrity and transparency principles present greater progress, though the average is affected by the low monitoring and evaluation performance, compensation management, and commitment among stakeholders. Finally, in effectiveness, although there is policy coherence, clear responsibilities, and a multi-scale approach, there is a deficiency relating to the capacity for water governance that negatively affects the possibility of having more efficient water management, despite having the right environment for it. Even with a normative and institutional framework, some weak components of governance are the lack of information, political and social supervision mechanisms, and the limited commitment of the actors [19,20,43,64]. These limit the application and capacity for the practical implementation of IWRM.

The low performance in terms of IWRM implementation in Chile (24.7) shows an insufficient degree of effectiveness, due to incoherence between policies, the lack of clarity between functions and responsibilities, and the decreasing local capacity for water governance. This is also due to the poor availability of data and information, as well as an inefficient regulatory framework [34,39,45].

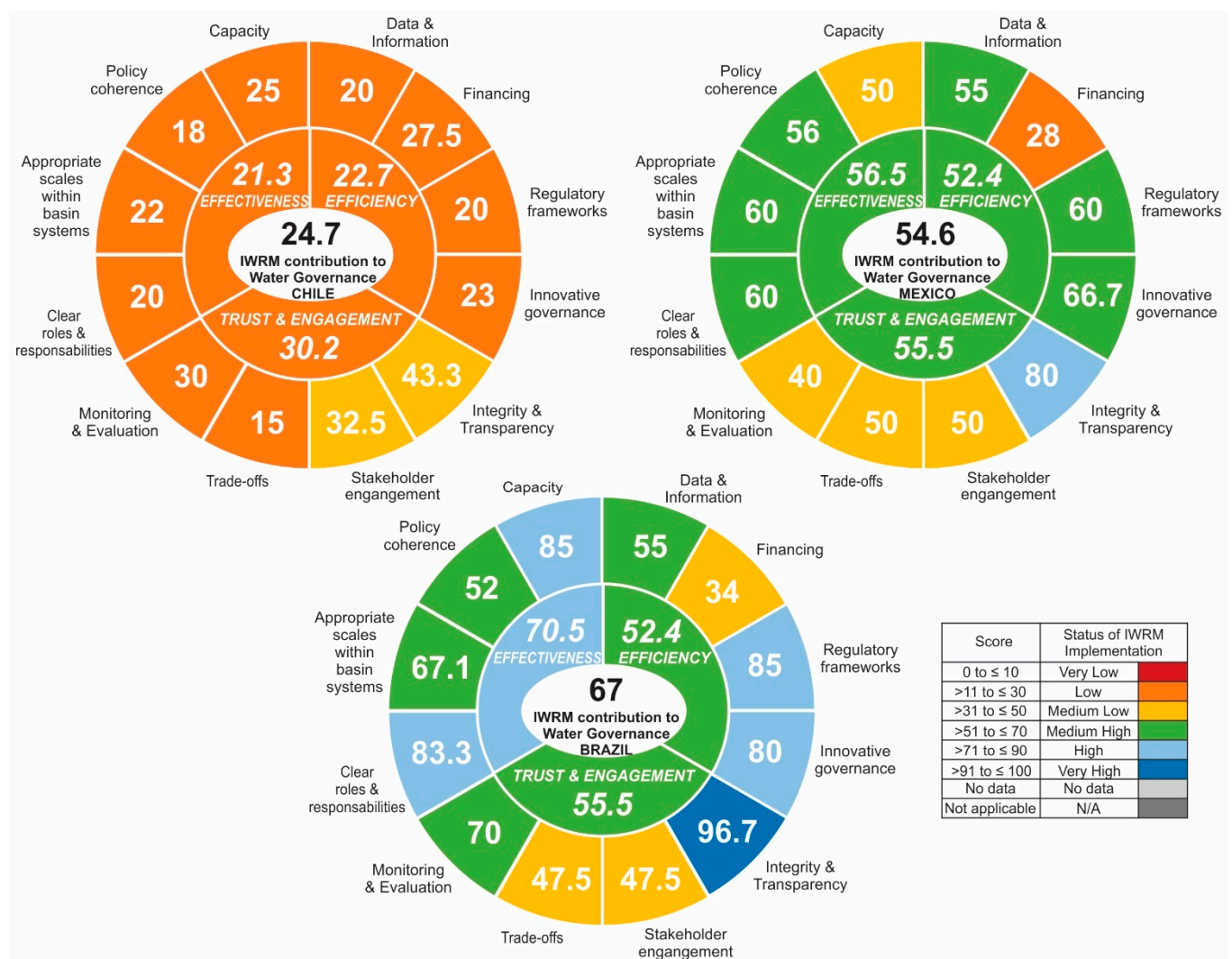


Figure 3. SDG 6.5.1 indicators for IWRM performance within the OECD water governance in Chile, Mexico, and Brazil.

Regarding water governance, Brazil has important advantages in terms of institutionalism, greater governmental abilities for the implementation of plans, and coordination and public participation for planning and management at the local and national levels. An example is the greater autonomy of the states, their responsibilities, and the performance of watershed institutions to lead the compliance of plans and programs [34]. The main weaknesses in Chile and Mexico are the lack of effective mechanisms for social participation and government's ability to implement them. In turn, these are negatively influenced by the low budget for IWRM and the great dependence on national funds [64]. Sectorization and a lack of specific budgets for local governments hamper the implementation of policies and programs to concrete actions that are destined for watershed management and capacity building.

In Mexico, there is greater development in terms of recognition and integration of ecosystem management at the local level, and subnational and local water policies and organizations at the watershed level. This is promoted to support the implementation of IWRM through mechanisms of public participation in local planning and management. In Chile, although the consideration of ecosystems in the natural resources management is low, there are some advances in maintaining the conditions to ensure the sustainability of aquatic ecosystems. From the Water Code reform in 2005, the obligation of maintaining a minimum ecological flow in surface waters was established for the first time [39]; however,

it has been criticized because it only applies to rights granted after 2005, when most of them had already been conceded before that date [45].

Even with differences in the level of implementation of the IWRM as a result of its different management models, a common factor that affects water governance in the three countries is the lack of financial resources to implement policies and programs. In Chile, the focus of participation is private, in terms of the investment for infrastructure, water purification, and distribution. This has generated consequences regarding water security, as it is subject to water supply through market mechanisms with low state regulation. This restricts access to some social sectors in times of scarcity, thus increasing their vulnerability [46]. The Chilean water resource management model, based on free market mechanisms which allow the reallocation of property rights over water, has presented negative social and environmental externalities and weakened state institutions in charge of regulation and control [37,39,45,46]; therefore, citizen confidence has been lost.

Currently, in the three countries, important citizen initiatives have been observed. Some of them have been incorporated into the Interamerican Surveillance Network for the Defense and Right to Water (VIDA Network), which are indicated as follows: the Water for All in Mexico, the World Alternative Water Forum in Brazil, the Coordinator of Movements for the Defense of Water and Life, and the Movement for Water and Territories (MAT) and Movement for the Defense of Water the Earth and the Environment (MODATIMA) in Chile. Based on forums, assemblies, and citizen councils, these organizations are calling for changes in regulations and institutions regarding water management. These are related to the recognition of the right to water and sanitation, and the ending of the privatization of drinking water and sanitation services. New mechanisms are required to guarantee greater social participation in decision-making, empowering citizen monitoring, transparency, representativity of vulnerable and indigenous groups, and autonomy for watershed management in local territories [24,65].

5. Conclusions

Although the IWRM approach has been internationally promoted, its implementation in Latin America is still incipient. In the three analyzed countries, it is observed that there are obstacles that should be considered to ensure articulation, social participation, representativeness of all sectors, and adequate budgets for implementing actions. The development of local capacities and the generation of cooperation mechanisms to overcome water management barriers should also be considered. Additionally, IWRM requires a more collaborative mode of governance, with a multi-level coordination among actors.

Brazil presents the greatest progress in relation to a decentralized governance model, which provides greater coordination among different sectors and water organizations at the national level. The need to strengthen the development of watershed organizations and participation mechanisms, as well as budgets for implementing water plans and programs, is evident. In the Mexican model, the advances in implementation of the IWRM have been carried out using incentives and subsidies for the coordination of different sectors, thus contributing to the OECD principles on water governance in terms of capacity building; however, some implementation weaknesses are presented in relation to operational capacities, monitoring, evaluation, and commitment of institutional actors. In Chile, the lack of an adequate legal framework and institutional coordination have hindered the establishment of IWRM. The low level of development in terms of data exchange, despite the existence of monitoring mechanisms and transparency, reduces the availability of adequate information for decision-making. Without a doubt, these are key elements for strengthening water governance.

Financing for the implementation of the IWRM policies is a common problem. In Brazil and Mexico, although the legislation is aimed at coordination, the budget is sectorized, weakening the implementation of watershed plans, as well as their adoption by decision-makers. In addition, there are power inequalities regarding central government control through financing, which becomes a means to influence decision-making in councils and

watershed committees, with consequent problems of representativeness and accountability. We think that is important to incorporate new indicators in the financing component that make visible the degree of autonomy and the application of economic resources, the degree of correspondence regarding the generation of taxes where water is extracted and used, and how these economic contributions are reinvested to strengthen the IWRM in the same territory where they were obtained. In the Chilean model, financing is mostly destined for infrastructure development, maintaining a solely hydrological viewpoint towards water. Despite the proposals for the generation of watershed mechanisms, these are not accompanied by changes that ensure representativeness and social participation of all sectors, thus, in our opinion, it is not yet possible to advance to IWRM.

The three countries show a lack of consideration of gender objectives in the IWRM at all levels, affecting vulnerable groups. This represents a strategic line, which needs to be strengthened in order to reduce inequality gaps with regard to the human right to water and sanitation. Regulations, programs, and institutions that do not respond to the social–ecological characteristics of the territory cause various conflicts, such as the appropriation of water and indiscriminate uses. All these aspects increase vulnerability by not considering the long-term strategies of comprehensive watershed management in the face of Climate Change.

The status of the new law in Brazil requires attention over the coming years, in order to observe its effects. This is particularly important to ensure water security, since disproportionate urbanization and social inequality have caused conflicts among sectors due to problems of accessibility to water resources. In the case of Chile, the recent participatory process to rewrite its Constitution, and in Mexico, the proposal of the Citizen Water Law, will represent important changes in water management models in the future to advance in IWRM implementation.

The SDG 6.5.1 performance indicators proposed by UNEP-DHI are guiding decisions at the national level. Indicators at the local level are particularly important in those countries in which there is no watershed management, such as in the case of Chile. For a more specific analysis, and considering the variability within countries, we state that an important opportunity is the development of complementary indicators. Such indicators will allow for the recognition of the nuances presented at local scales, such as the multicultural nature of the watershed, variations in the role of subnational actors in water policy and governance, and cooperation mechanisms to decrease conflicts and harmonize actions among the political–administrative units that integrate watersheds, considering that these are key aspects for IWRM implementation.

The low scores regarding the available information for the IWRM in the three countries indicate the lack of data for decision-making; therefore, we regard this analysis as a reference that serves as the basis to recognize strengths and weaknesses for management. This is a tool with which to learn from the successful and unsuccessful experiences that guide public instruments for implementation processes and capacity building, which are relevant to ensure people's well-being and to reduce vulnerability.

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