Challenges and guidelines for integrated water management in river basins: an expert view

Desafios e diretrizes para a gestão integrada da água em bacias hidrográficas: visão dos especialistas

Monise Terra Cerezini [1]

Frederico Yuri Hanai [2]

[1] *PhD in Environmental Sciences, Post-Doctoral Fellow, Department of Environmental Sciences (DCAm), Federal University of São Carlos (UFSCar), São Carlos, SP, Brazil*
E-mail: rmo_terra@yahoo.com.br

[2] *PhD in Environmental Engineering Sciences, Professor, Department of Environmental Sciences (DCAm), Federal University of São Carlos (UFSCar), São Carlos, SP, Brazill*
E-mail: fredyuri@ufscar.br

doi:10.18472/SustDeb.v14n2.2023.49626

Received: 05/07/2023
Accepted: 17/08/2023

ARTICLE – VARIA

ABSTRACT

Integrated Water Resources Management (IWRM) is a widely accepted approach that requires technical, political, and institutional structuring for its effective implementation. An Expert Panel was created to identify Brazil's primary challenges and guidelines for water management. The participants' opinions indicated that most of the issues identified reached an agreement of 70% or higher. Among these challenges, education and participation were frequently cited by experts as central concerns. These themes were also recognised as crucial factors in addressing the challenges related to water resource management and ensuring the successful execution of the National Water Resources Policy.

Keywords: Integrated water resources management. Delphi. River basin. Water Governance.

RESUMO

A Gestão Integrada de Recursos Hídricos (Girh) é uma abordagem amplamente aceita que requer estruturação técnica, política e institucional para sua implementação efetiva. Com o objetivo de identificar os principais desafios e as diretrizes para a gestão das águas no Brasil, foi conduzido um Painel de Especialistas. A opinião dos participantes revelou que a maioria dos problemas identificados obteve uma concordância igual ou superior a 70%. Entre esses desafios, a educação e a participação foram amplamente citadas pelos especialistas como questões centrais. Esses temas também foram apontados como fundamentais nas ações e diretrizes para superar os desafios na gestão dos recursos hídricos e para a efetiva implementação da Política Nacional de Recursos Hídricos.

Palavras-chave: Gestão Integrada de Recursos Hídricos. Delphi. Bacia hidrográfica. Governança da Água.

1 INTRODUCTION

Water management from an integrated perspective has become a complex challenge due to various issues related to the use of this crucial and strategic natural resource. According to the Global Water Partnership (GWP), Integrated Water Resources Management (IWRM) is a process that aims to coordinate the development and management of water, soil, and related resources, seeking to maximise economic and social well-being fairly without compromising the sustainability of ecosystems (GWP, 2000). This definition emphasises the importance of planning and managing water with other environmental resources, ensuring its equitable and sustainable use.

The National Water Resources Policy (PNRH), Law No. 9.433/1997, introduced integrated water management in Brazil. This model represents a systemic approach to participatory integration guided by watershed-level planning, decision-making through plural and decentralised deliberations, and the establishment of legal and economic instruments that guide the rational use of water (SILVA, 2013).

In this context, Porto and Porto (2008) have suggested that, for this so-called integrated management to become feasible and achievable, a new stance is required to construct a management approach incorporating sustainable development's foundations. Thus, IWRM must consider the main principles of sustainable resource use in a multi-sectoral approach and the adoption of non-structural measures, with an emphasis on demand management (SILVA; PORTO, 2003).

Thus, water management should be based on a systemic, sustainable, and integrated approach considering the watershed as a territorial management unit involving surface and groundwater. Although the water resource legislation addresses the systemic aspect through the principle of integration, it still lacks a perspective that would integrate economic and social processes, making planning difficult and interfering with the proposition of efficient public policies (TUNDISI, 2008). To address these challenges, Tundisi and Tundisi (2016) emphasise the need for a new water governance approach that would integrate eco-hydrological processes and ecosystem services, involving the decentralisation of water management at the watershed level.

However, despite being widely accepted and disseminated, this concept demands significant technical, political, and institutional coordination and structuring for its practical implementation. To identify the main challenges and guidelines for the integrated management of water resources, the present study relied on the results of an Expert Panel, which would provide guidelines for developing and implementing actions, programs, and projects to address and overcome challenges, promoting IWRM.

2 MATERIALS AND METHODS

2.1 DATA COLLECTION

In this study, the Delphi technique was employed to identify the main challenges and necessary guidelines for integrated water management through consultations with an Expert Panel of various experts in the field.

The Policy Delphi approach (TURROF; LINSTONE, 2002) was adopted, whose objective is generating and exploring alternatives rather than attaining consensus. This method serves as an appropriate and coherent data collection tool in line with the research design and should be chosen according to the characteristics of a study, such as the need for an interdisciplinary approach and the prospects for structural changes in the sector, as is the case for IWRM (PAHL-WOSTL, 2007).

The Policy Delphi technique gathers opinions on a specific issue, facilitating policy formulation and decision-making processes (TUROFF; LINSTONE, 2002). The technique seeks to expose different stances and arguments through consultations with a group of experts, ensuring respondent anonymity, statistical representation of the results, and feedback on the responses (WRIGHT; GIOVINAZZO, 2000).

The application of the Policy Delphi method to the present study involved creating questionnaires with open and closed questions regarding water resource management, which were sent to experts in the field. Participants were selected considering stakeholders who directly or indirectly operate within the National Water Resources Management System (Singreh), covering all 27 federal units. The participants included state water resource management agency staff, members of the National Water Resources Council (CNRH) and State Water Resources Councils (Cerh), members of Basin Committees (CBH) and Water Agencies, experts from the National Water and Basic Sanitation Agency (ANA), as well as researchers and professors from universities, institutions, and research programs focused on the topic.

The estimate was to distribute questionnaires to approximately 500 individuals. Given that expert selection is a crucial step in implementing this technique, careful work was conducted to achieve balance in terms of participant representation, aiming to avoid biased results (WRIGHT; GIOVINAZZO, 2000). The research invitation letter, containing explanations about the Delphi technique, the study's objective, and the importance of participation, was sent to participants via e-mail. The study received ethics committee approval, and the contacted subjects gave written informed consent to participate in the study when completing the questionnaire.

2.2 DATA ANALYSIS

To validate the experts' responses in light of the group's opinion, the data obtained in the first-stage questionnaire were systematised and sent back to the research participants when responding to the second-round questionnaire. In this second phase, the participants were asked to indicate a level of agreement concerning the problems identified in the first stage using a Likert scale (levels: strongly agree; partially agree; strongly disagree; partially disagree; no opinion formed) and to suggest possible actions and guidelines to overcome and address the problems and obstacles presented.

At the end of the two rounds of information collection, the collected dataset was systematised and analysed. The quantitative questionnaire responses underwent simple descriptive statistical treatment to facilitate result evaluation. The Content Analysis methodology proposed by Bardin (1977) was employed to analyse open-ended responses, involving systematic steps of organisation, description, and analysis of message content. The content analysis comprised three stages: Pre-analysis, Material Exploration (coding), and Results Treatment and Interpretation.

In the Pre-analysis phase, a "floating" reading was conducted, which constitutes an initial engagement with the documents to be analysed to obtain a preliminary understanding of the material (BARDIN, 1977). In the case of the present research, the analysed material, or "corpus of analysis," consisted of the information obtained through the participants' responses. In the Material Exploration stage, the responses were coded into thematic categories, or codes, defined as sets of similar data that condense an idea. In the Results Treatment and Interpretation stage, the data were organised to propose inferences and interpretations of the results.

The Atlas.ti software, version 8.0, was used for data organisation, response coding, creation of research notes, and grouping and management of created elements. This software serves as a qualitative data analysis tool and facilitates data management and interpretation.

3 RESULTS AND DISCUSSION

The first stage of the research included 133 respondents. After compiling and analysing the obtained responses, a new questionnaire was created and sent to the same group of experts for the second and final time. The second stage of the research involved the participation of 98 experts, representing 74% of the total respondents from the previous stage. In the literature, an abstention rate of 20 to 30% in the second round is considered acceptable (WRIGHT; GIOVINAZZO, 2000).

In the first research stage questionnaire, participants were asked about the main challenges faced in water resource management within the watershed context. From the analysis of the responses to this question, it was possible to systematise codes representing categories of analysis associated with the participants' answers (Table 1). In the second research stage questionnaire, the participants were asked about the main action guidelines needed to overcome the challenges faced in integrated water resource management, as systematised in the first stage. Analysing the responses to this question made it possible to systematise the suggested action guidelines.

Table 1 | Codes and Number of occurrences in the participants' responses

Nº	*CODES*	*NUMBER OF OCCURRENCES*
1	Knowledge and Education	40
2	Participation	34
3	Managing Authority	32
4	Qualitative-Quantitative Balance	23
5	Management Instruments	21
6	Financial resources	18
7	Operational and Legal Coordination	15
8	Conflicts of Interest	14
9	Data and Information	12
10	Human Resources	11

Source: Prepared by the authors.

Regarding the Knowledge and Education code, 40 citations or excerpts were associated from the participants' responses to the question about the main challenges faced in water resource management in watersheds. From the citations associated with the Knowledge and Education code, the following issues were systematised (Table 2):

Table 2 | Codes and Number of occurrences in the participants' responses

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Lack of awareness and engagement of society regarding water issues	57%	31%	2%	8%	-
Lack of culture and education leading to community and user negligence	51%	33%	4%	10%	-
Lack of understanding and ignorance of legislation and management instruments	51%	36%	2%	9%	-
Lack of technical training for managers, basin committee members, and society	48%	37%	2%	10%	1%
Discrepancy between scientific knowledge and practical reality in water management	46%	37%	3%	12%	-

Question	Strongly Agree	Partially Agree	Strongly Disagree	Partially Disagre	No Opinion
Unfamiliarity with watershed issues and potential solutions	44%	35%	2%	17%	-

Source: Prepared by the authors.

Such issues were presented in the second stage of the research to the group of experts, who had the opportunity to indicate whether they agreed or disagreed with the challenges posed by the group. For the issues identified, there were more responses (above 80%) with options such as Strongly Agree or Partially Agree, with the most chosen response option for all questions being Strongly Agree. These results indicate that the experts agree with the issues raised within the theme, which significantly and directly impact water resource management.

The experts suggested the following guidelines to overcome the challenges identified for the Education and Knowledge theme:

- Implementing environmental education at all levels of formal and non-formal education continuously and in an integrated manner.
- Developing engaging educational materials about water resources.
- Incorporate education as an instrument of water resource policies.
- Creating formative processes directed towards managing authorities, committees, and stakeholders involved in the National Water Resources Management System (SINGREH).
- Establishing partnerships with universities, educational institutions, and research entities to promote educational activities and capacity-building.

Regarding the Participation code, 34 citations or excerpts from the participants' responses to the question about the main challenges faced in water resource management in watersheds were associated. The main related issues were then systematised based on the responses associated with the Participation code (Table 3).

Table 3 | Degree of agreement regarding issues associated with the Participation theme

Question	Strongly Agree	Partially Agree	Strongly Disagree	Partially Disagre	No Opinion
Lack of understanding and awareness about the importance of participatory management	58%	34%	1%	5%	-
Responsible entities still struggle with the participatory management model	46%	38%	4%	10%	-
Plurality of participation from various social segments is not encouraged	34%	39%	11%	14%	-
Unbalanced representation in committees and councils	32%	37%	10%	18%	1%
Limited involvement and participation of the government, users, and civil society in decision-making processes	31%	46%	5%	16%	-
Lack of legitimacy and alignment of representative participants with their group	29%	44%	8%	16%	1%

Source: Prepared by the authors.

For all the issues raised within this theme, there were a greater number of responses with options such as Strongly Agree or Partially Agree, ranging from 70% to 85%, indicating that the participants agreed with the identified issues. The data demonstrate that the participants concur with the issues raised within the Participation theme. Problems related to the lack of understanding about the importance of participatory management and the unpreparedness of responsible entities to handle this model were among those of most concern for the experts. This indicates that the participatory management model is still poorly understood by users, the population, and even the entities within the system, along with other pertinent aspects such as imbalance, lack of representation legitimacy, and limited involvement of stakeholders in decision-making processes.

Experts recommended the following guidelines to overcome challenges related to the Participation theme:

- Implementing communication, awareness, and social mobilisation programs to encourage participation.
- Providing training on participatory management and raising awareness about the importance of participation and the role of Committees.
- Establishing mechanisms to incentivise and provide financial support for the involvement of relevant stakeholders.
- Expanding the participation of underrepresented groups in decision-making processes, seeking balanced representation in Committees and Councils.
- Monitoring the effectiveness of stakeholder participation in Committees.

Regarding the Managing Authority code, 32 citations from the participants' responses to the question about the main challenges faced in water resource management in watersheds were associated. The following issues were systematised from the citations associated with the Managing Authority code (Table 4).

Table 4 | Degree of agreement regarding issues associated with the Managing Authority theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Institutional structures lacking stability, weakened and vulnerable to changes in government	63%	31%	2%	2%	-
Organisational arrangement with weak articulation and institutional integration	49%	42%	1%	5%	1%
Fragile implementation status of executive secretariats (basin agencies)	48%	29%	2%	11%	8%
Managing authorities highly influenced by political factors	43%	38%	1%	16%	
Lack of structure and managerial capacity in regional managing authorities	43%	45%	1%	8%	1%
Limited decision-making power and support for basin committee deliberations	41%	37%	5%	12%	3%

Source: Prepared by the authors.

For all the issues indicated, the options Strongly Agree or Partially Agree together accounted for more than 78% of the participants' choices. This demonstrates that the participants, on the whole, agreed with the challenges related to the Managing Authority theme and felt that the problems most concerning to experts are related to the lack of stability and institutional structure articulation and the

inefficient managerial capacity of the entities in the management system. These issues are affected by changes in government, low implementation of executive agencies, weak support for basin committee decisions, and political influences.

- To overcome the challenges identified for the Managing Authority theme, experts suggested the following guidelines:
- Enhancing the autonomy of Committees, strengthening and ensuring their decision-making power and support for decisions.
- Improving coordination among the institutions involved in water management.
- Developing support and strengthening programs for the National Water Resources Management System (Singreh).
- Reorganising managing authorities with a minimum national directive.
- Supporting the creation and strengthening of Water Agencies to alleviate the responsibilities of managing authorities.

Regarding the Qualitative-Quantitative Balance code, 23 citations or excerpts from the participants' responses to the question about the main challenges faced in water resource management in watersheds were associated. The following issues were systematised from the citations associated with the Qualitative-Quantitative Balance code (Table 5).

Table 5 | Degree of agreement regarding issues associated with the Qualitative-Quantitative Balance theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Irregular discharge of effluents in urban areas and pesticides in rural areas	78%	18%	-	2%	-
Irregular urban infrastructure compromising water quality	73%	21%	-	3%	1%
Inefficient management of basic sanitation by municipalities	73%	22%	1%	1%	1%
Challenges related to scarcity of supply and demand management	57%	37%	-	3%	1%
Traditional focus of water resource management based on flow and quality	55%	24%	4%	8%	7%
Conflicts regarding multiple water uses, priority utilisation, and equitable distribution	53%	39%	1%	5%	-

Source: Prepared by the authors.

For all the issues highlighted, the option most frequently chosen was Strongly Agree, representing more than 50% of the responses. These data demonstrate that the participants agree about the problems outlined in the Qualitative-Quantitative Balance theme. This theme received the highest levels of agreement in the responses compared to the other themes analysed by the participants, with most experts indicating their agreement with the presented issues. Among the challenges of greatest concern to experts, particularly important were the impact of urban infrastructure, irregular discharge of effluents and pesticides on water quality, and the inefficient management of basic sanitation in municipalities.

To address the challenges identified for the Qualitative-Quantitative Balance theme, experts pointed out the following guidelines:

- Implementing the National Basic Sanitation Policy in municipalities.
- Enhancing the National Hydrometeorological Network (RHN).
- Increasing the oversight of granted flow rates and urban effluents.
- Balancing the demand and supply of water in watersheds.
- Developing indicators for assessing water quality and quantity.

Twenty-one citations or excerpts from the participants' responses to the question about the main challenges faced in water resource management in watersheds were associated with the Management Instruments code, with the following issues being systematised (Table 6).

Table 6 | Degree of agreement regarding issues associated with the Management Instruments theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Disregard of Water Resources Plans by other governmental policies	71%	21%	1%	4%	1%
Lack of land use and occupation management tools for water conservation	58%	26%	5%	9%	-
Absence, outdatedness, and non-implementation of Basin Plans in committees	50%	38%	2%	6%	2%
Non-implementation of water resource policy management instruments	48%	36%	1%	13%	-
Challenges in approving and applying Water Usage Charges	40%	37%	6%	7%	8%
Formalisation of water resource usage permits with responsible authorities	30%	44%	9%	10%	5%

Source: Prepared by the authors.

Taken together, the response options Strongly Agree and Partially Agree accounted for more than 74% of the responses to all problems presented. This outcome demonstrates that, in general, the participants agreed about the problems raised within this theme, with the lack of implementation of water resource management instruments and the absence, outdatedness, and lack of coordination of basin plans with other sectoral policies being among the challenges of greatest concern to experts, notably regarding the sector's agenda.

Experts have formulated the following guidelines as a means to overcome the challenges identified in the Management Instruments theme:

- Implementing Water Resources Plans, using them as a guide for the application of other instruments and involving the society in their development.
- Expediting the permit processes and intensifying their oversight.
- Introducing water usage charges and efficiently allocating the resulting resources.
- Expanding studies and implementing water body classification.

- Implementing consolidated and accessible information systems for all stakeholders.

Eighteen citations or excerpts from the participants' responses to the question about the main challenges faced in water resource management were associated with the Financial Resources code, with the Financial Resources code, with the following issues being systematised (Table 7).

Table 7 | Degree of agreement regarding issues associated with the Financial Resources theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Scarcity of financial resources for management and planning actions in watersheds	50%	30%	4%	11%	3%
Financial precariousness of the System	47%	27%	6%	10%	8%
Inefficient oversight of the application of financial resources in the System	45%	28%	6%	9%	10%
Inability to seek new funding sources for Basin Plan actions	38%	32%	4%	13%	11%
Lack of investments in monitoring and research in water resource management	31%	56%	1%	9%	1%
Lack of financial support for the maintenance of watershed committees	30%	46%	11%	5%	6%

Source: Prepared by the authors.

Regarding the problems raised, there were more responses with the options Strongly Agree or Partially Agree, which together accounted for over 70% of the responses for each problem. This result demonstrates that the participants generally agreed with the problems raised within the Financial Resources theme, but this was one of the themes that showed the highest divergence in terms of agreement with the problems presented. For most of the aspects presented as challenges in this theme, less than half of the experts fully agreed that oversight of financial resource application is inefficient, that there is a lack of investment in monitoring and research in the field, and that there is a lack of financial support for the maintenance of Committees and Basin Plan actions.

To overcome the challenges identified in the Financial Resources theme, experts suggested the following guidelines:

- Strengthening programs and actions for financial support in water management.
- Increasing financial investment in hiring and professional qualification.
- Structuring and regulating the Water Resources Fund to enhance resource allocation in the system.
- Establishing partnerships with the third sector and private sector to expand the budget.
- Expanding monitoring and oversight of resources applied to water management.

Fifteen citations or excerpts from the participants' responses to the question about the main challenges faced in water resource management were associated with the Operational and Legal Articulation code, with the following problems being systematised (Table 8).

Table 8 | Degree of agreement regarding issues associated with the Operational and Legal Articulation theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Disconnection between land use and water management	80%	14%	1%	2%	1%
Lack of coordination between the Water Resources Policy and other sectoral policies	79%	18%	-	1%	-
Fragmented actions and efforts in water resource management	66%	27%	1%	4%	-
Operational and legal disarticulation at the municipal, state, and federal levels	64%	29%	2%	3%	-
Lack of integration between surface water and groundwater management	61%	28%	7%	1%	1%
Lack of alignment between basin priorities and watershed committee actions	35%	40%	5%	8%	10%

Source: Prepared by the authors.

The option "Agree Completely" was the response most frequently chosen regarding the top five problems identified. Overall, the participants agreed with the issues raised within the theme of Operational and Legal Coordination, and the challenges that most align with the experts' opinions are related to the lack of integration between the management of surface water, groundwater, and land use. This is one of the themes that showed the highest agreement in the participants' responses. The lack of coordination between water policy and other sectoral policies and fragmented actions in water resource management are notable obstacles to overcome.

To address the challenges identified within the theme of Operational and Legal Coordination, the experts suggested adopting the following guidelines:

- Developing a holistic vision of water management for all stakeholders involved;
- Shifting the culture from water abundance to recognising water as a finite resource;
- Promoting a dialogue between Water Resources Plans and Municipal Plans;
- Enhancing integration of water resources policy with other sectoral policies, especially land use policy;
- Strengthening integration and coordination among different institutions and levels of water resource management.

For the code "Conflicts of Interest," 14 citations or excerpts from the participants' responses were associated with the question about the main challenges faced in water resource management in watersheds. From the citations associated with the "Conflicts of Interest" code, the following problems were systematised (Table 9).

Table 9 | Degree of agreement regarding issues associated with the Conflicts of Interest theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Overlap of economic, political, and individual interests over collective interests	73%	20%	2%	3%	-
Predominance of corporate and sectoral issues in water resources management	56%	28%	1%	10%	3%

Question	Strongly Agree	Partially Agree	Strongly Disagree	Partially Disagre	No Opinion
Centralisation and political intervention by public authorities	52%	35%	3%	7%	1%
Conflicting relationships between managing entities within the political sphere	50%	33%	5%	6%	4%
Strong polarisation of decisions within government bodies	50%	35%	3%	8%	2%
Excessive vanity among stakeholders participating in committees	34%	33%	11%	15%	5%

Source: Prepared by the authors.

The "Completely Agree" option was the most frequently chosen response to all the problems presented. In general, this result shows that the participants agreed with the issues raised within the theme of Conflicts of Interest, and among the challenges indicated by the experts are the lack of prioritisation of collective interests, the predominance of sectoral issues, and political interference in water resource management.

To address the challenges identified regarding the Conflicts of Interest theme, the experts indicated the following guidelines:

- Developing political and technical instruments for conflict management.
- Implementing monitoring systems to address vulnerabilities.
- Establishing standards to reduce political and economic influence in deliberations.
- Minimising public authority interference in the management of Basin Committees for Water Resources (CBHs).
- Prioritising appointments based on technical rather than political criteria.

Regarding the Data and Information code, 12 citations or excerpts from the participants' responses were associated with the question about the main problems faced in water resource management in hydrographic basins. Based on this association, the following problems were systematised (Table 10).

Table 10 | Degree of agreement regarding problems associated with the Data and Information theme

Question	Strongly Agree	Partially Agree	Strongly Disagree	Partially Disagre	No Opinion
Disjointed databases and isolated information across various institutions and bodies	54%	37%	1%	5%	1%
Weak implementation of the National Water Resources Information System instrument	49%	39%	2%	6%	2%
Lack of transparency in sharing and dissemination of data and information	40%	34%	4%	15%	5%
Outdated and insufficient technical data for planning and management actions	39%	41%	4%	10%	4%
Excessively technical language in information presentation	28%	40%	7%	20%	3%
Manipulation of data and information	16%	30%	12%	19%	21%

Source: Prepared by the authors.

This result shows that the participants generally agreed with the issues raised within the Data and Information theme. However, it is important to note that, within this theme, the response to the problem related to data and information manipulation showed the greatest disagreement among the experts, with 46% agreeing, 31% disagreeing, and 21% having no formed opinion. This problem exhibited the lowest level of agreement among all the problems presented across all themes, which showed response agreement levels ranging from 67% to 97%.

This is an important point to analyse by indicating that experts disagree with this assertion. Other highlighted problems, according to the experts' opinion about this theme, included the insufficiency and outdated nature of technical data, the disconnection of databases, and the weak implementation of the Information System, all of which hinder planning and management actions for water resources.

The experts suggested the following guidelines in order to overcome the challenges identified for the Data and Information theme:

- Investing in research and technology to enhance data and information generation, collection, analysis, and sharing.
- Strengthening, integrating, and standardising the National Water Resources Information System (SNIRH).
- Establishing coordination among Singreh (National Water Resources Management System) entities for data and information sharing and exchange.
- Disseminating information about management instruments to the entire society.
- Improving mechanisms for the access to data by society and for information in a transparent, up-to-date, and accessible language.

Regarding the Human Resources code, 11 citations or excerpts from the participants' responses were associated with the question about the main problems faced in water resource management in hydrographic basins. Based on these associations, the following problems were systematised (Table 11).

Table 11 | Level of agreement regarding problems associated with the Human Resources theme

Question	*Strongly Agree*	*Partially Agree*	*Strongly Disagree*	*Partially Disagre*	*No Opinion*
Reduced staff size in management organizations	58%	32%	2%	4%	2%
Limited technical workforce to implement Water Resources Policy instruments	57%	34%	1%	5%	1%
Lack of qualified personnel in management and oversight agencies	47%	35%	5%	8%	3%
Lack of technical support for the maintenance of watershed committees	42%	39%	2%	10%	5%
Shortage of professionals with specific technical expertise in water resources	37%	39%	11%	9%	2%
Inexperienced team in developing projects tailored to the needs of each basin	32%	45%	6%	9%	6%

Source: Prepared by the authors.

These data show that the participants generally agreed with the problems identified for the Human Resources theme. The challenges validated by the experts are related to the limited technical workforce and the lack of qualified personnel for roles within management entities and agencies to implement water resources policy.

To overcome the challenges identified for the Human Resources theme, the experts suggested the following guidelines:

- Hiring experienced and specialised professionals with a minimum qualification requirement for roles in the field of water resources.
- Developing appreciation policies, including job descriptions and salary plans, for professionals engaged in water resources management.
- Expanding and structuring a permanent and qualified technical team to operate within management organisations.
- Appointing leadership and managerial positions based on profile and technical capability.
- Conducting public recruitment processes to fill positions in the field.

Faced with the problems and challenges identified in the research, the theme of education and capacity-building consistently emerged in all proposals and guidelines presented by the participants. Undeniably, issues related to water resources management are intrinsically linked to educational challenges. This clearly shows that educational initiatives and processes play a crucial role in pursuing IWRM, serving as a foundation for other equally essential elements in constructing this comprehensive approach.

According to the National Environmental Education Policy (Pnea), established by Law No. 9.795/99, environmental education permits the public to build values, knowledge, and skills focused on environmental conservation. Its fundamental objectives are the development of an integrated understanding of the environment, the stimulation of critical awareness of environmental and social issues, and the encouragement of participation in preserving an environmental balance as an exercise of citizenship (BRAZIL, 1999).

In this context, as highlighted by Sauvé (2005), environmental education plays a decisive role in changing community behaviour and, on a broader scale, contributes to developing more responsible societies. For Berlinck *et al*. (2003), environmental education plays a fundamental role in raising society's awareness about environmental issues in watersheds, aiding local citizenship exercise and problem-solving. By addressing conflicts related to community water use, environmental education can encourage the adoption of new behaviours and social practices, empowering individuals to be agents of change in their own reality (BERLINCK *et al*., 2003).

Approaching environmental education focusing on water resources encourages each individual to consider his responsibility for water preservation, ranging from protecting river sources to understanding that conscious use is crucial for properly managing this vital resource (D'ELIA *et al*., 2020). Thus, it is clear that the development of water resource management from an integrated perspective needs to be supported by educational and pedagogical processes for community formation and the empowerment of managers at the state and municipal levels. This should be done in an articulated and continuous manner, across all levels and modes of formal and non-formal educational processes, alongside the expansion and assurance of access to informative and educational content about water management (BERLINCK *et al*., 2003; SILVA; PORTO, 2003; TUNDISI, 2008).

The theme of participation was also extensively discussed in terms of IWRM obstacles. The participatory perspective represents one of the guiding principles of the National Water Resources Policy (PNRH), guaranteeing rights related to water use and preservation (BIANCHINI; ROCHA, 2020; BRAZIL, 1997).

For an effective participation in water management, the quality of representation of each group or segment regarding demands and responsibilities must be ensured, legitimising its interests in guaranteeing the representation of diverse needs and interests in deliberative spaces (BARBOSA *et al*.,

2016). In this sense, the participation of qualified and representative actors is essential for Committees to function as spaces for discussing interests and legitimately negotiating conflicts, ensuring the democratic and shared construction of water resource policies (JACOBI; BARBI, 2007).

Bordenave (1994) highlights that participation contributes to people's critical awareness of their reality, enabling them to assert their rights. However, it is important to understand that participation is more than just a tool for problem-solving; it is a process inherent to the social nature of human beings, an expression and assertion of oneself in relation to the others (BORDENAVE, 1994).

Effective participation occurs when local demands are heard and the needs of different groups are represented, resulting in concrete transformations. Thus, participation should be how demands, obstacles, and challenges can be overcome towards the envisioned IWRM, as only through the involvement and coordination of users, public and private entities, and civil society in decision-making processes will it be possible to ensure the legitimacy and balance of interest representation in shared and participatory water management.

The experts proposed several guidelines aiming to face the challenges identified in the pursuit of IWRM, addressing institutional strengthening, effective implementation of management instruments, financial support for the system, operational coordination, policy integration, technical team training, resolution of conflicts of interest, access to information, as well as monitoring water quality and quantity.

The literature agrees with the guidelines suggested by experts. According to Senra and Nascimento (2017), integrated management demands certain essential conditions, which include, among others, legal regulations to establish the roles and obligations of each entity involved in the process, as well as a clear delineation of management instruments and institutional functions, and active inclusion of stakeholders. Ribeiro and Hora (2019) indicate that it is essential for the entities involved to understand the new management model proposed by PNRH, as well as the instruments it encompasses.

It is imperative to reconsider the current management model and to establish more effective interactions among water resource management agencies (TRINDADE *et al*., 2022). Additionally, a reassessment of the water resource management system as a whole is needed, with a special focus on the technical capabilities of the entities comprising Singreh, aiming at a more efficient and transparent execution of their technical competencies (TRINDADE; SCHEIBE, 2019). In an articulated organisation like Singreh, such guidelines are essential to strengthen system entities and raise societal awareness about the socio-environmental issues surrounding water resource management (ANA, 2022; BRAZIL, 2022).

The National Water Resources Plan (PNRH) is the guiding document for PNRH implementation and Singreh's operation (BRAZIL, 2022). Its participatory development involved various stakeholders and society in order to obtain an inclusive approach to address challenges such as Singreh functioning, development of management instruments, management of water resource quality and quantity, technical and scientific training and development, as well as integration with other sector policies (BRAZIL, 2022). The PNRH 2022-2040 Action Plan consists of programs to respond to these challenges. Thus, its rigorous and strategic adoption emerges as an indispensable path for overcoming the obstacles highlighted by experts in this research, effectively guiding water resource management.

4 CONCLUSION

The main objective of this research was to systematically compile, based on expert opinions in the field, the key challenges and the guidelines to achieve integrated water resource management. The majority (93%) of the identified problems obtained a concordance level above 70%. The problems that achieved the highest level of agreement were: Disconnection between land use and water management; Lack of coordination between Water Resources Policy and other sector policies; and Irregular discharge

of effluents in urban areas and pesticides in rural areas, with 80%, 79%, and 78% of participants fully agreeing, respectively.

Education and participation were the themes most frequently mentioned by experts as the primary challenges faced in water resource management. These findings reveal that within the context of IWRM, education and participation emerge as crucial themes to drive progress in water management across the country, underscoring the importance of education as a foundation for promoting positive changes in other areas and topics related to water resource management.

The guidelines proposed in the present study aim to overcome key challenges and strengthen the water governance model in the country, following principles of integrated, decentralised, and participatory management. They encapsulate the fundamental aspects that must be prioritised in the water agenda according to the experts' perspective and should be valued and prioritised by governments and managers in planning and water resource management.

The interrelation of these themes is essential to effectively implement the National Water Resources Policy and achieve Integrated Water Resource Management. The strategic adoption of the National Water Resources Plan as a guiding document emerges as a fundamental approach to overcome the challenges identified by experts in this research, providing an effective guideline to enable the desired integration of water resource management in Brazil

ACKNOWLEDGMENTS

The authors extend their gratitude to the research participants for their contributions and shared knowledge and to the reviewers for their critiques and suggestions. This study received support from the Coordination for the Improvement of Higher Education Personnel (Capes), Financial Code 001.

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