Available online at www.CivileJournal.org

Civil Engineering Journal

(E-ISSN: 2476-3055; ISSN: 2676-6957)

Vol. 8, No. 02, February, 2022

Assessment and Evaluation of IWRM Implementation in Palawan, Philippines

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Received 30 September 2021; Revised 25 December 2021; Accepted 11 January 2022; Published 01 February 2022

Abstract

According to the United Nation's Sustainable Development Goal (SDG 6), the world needs to sustainably manage water resources through integrated water resource management (IWRM). The Philippines is committed to this goal by ensuring the implementation of IWRM at all levels. Concurrently, there is growing evidence that there is presently no consolidated data on the status of implementation at the sub-national level. With water shortages on the increase, it's more important than ever to find solutions to settle disputes and trade-offs so that water can be distributed effectively, sustainably, and equally. This paper aims to investigate the degree of implementation of IWRM that presents the actual state of affairs in terms of water management at the sub-national level. This study is focused on Palawan Province, with the following sites: Puerto Princesa City, El Nido, Roxas, and Taytay. A structured survey questionnaire was drawn up in accordance with the existing questionnaire developed for this purpose. The obtained data were computed using the steps developed for calculating the indicators of IWRM implementation degree. Puerto Princesa City, El Nido, Roxas, and Taytay have the following IWRM ratings: 39.93, 32.03, 37.99, and 36.32%, respectively, which means "medium-low" in which the IWRM components have largely been institutionalized, and deployment is well underway. In these regions, a subnational water management scheme exists, but its maximum capacity is mostly unrealized due to numerous constraints. The findings show that the numerous water laws are confusing and that water data for planning purposes is lacking. Even though there are many water agencies, they are not interconnected. This study is useful for successful IWRM implementation, which should encourage sustainable water resource management for environmental sustainability. Integrated methods for water resource management help to organize sustainable growth by assessing how water is handled in agriculture, urban applications, and the surrounding ecosystems.

Keywords: Integrated Water Resource Management; IWRM Implementation; SDG 6.5.1; Water Governance.

1. Introduction

Water resources play a significant role in providing all living organisms with an adequate food supply and a stable environment [1]. Worldwide, freshwater availability is only 2.5%, with two-thirds frozen in polar ice caps and glaciers [2]. Pressure on water and water resources is increasing as a result of rapid urbanization, and many of the world's major aquifers are depleting [3]. The loss of surface and groundwater is affecting the hydrological cycle and increasing the

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http://dx.doi.org/10.28991/CEJ-2022-08-02-08

effects of climate change [4]. In a developing world, climate change is seldom the only impetus for water adaptation to climate change to allow policymakers to allocate additional resources for the production of water infrastructure [5]. For a better view of the social-ecological processes that are intertwined [6], trends toward participatory management and agile governance are causing a major paradigm change in the management of water resources [7, 8]. There are concerns about water shortages that can still be adequate to fulfill rural, household, industrial, and environmental needs in countries [9]. Users, on the other hand, are reluctant to use the resources due to a shortage of economic means [10].

As argued by Al-Saidi, water sectors in many countries have responded to rising risks and emergencies by establishing new institutional mechanisms, decentralizing water supply planning, or building new facilities [11]. According to a detailed status report released by the United Nations, at the state, subnational, basin/aquifer, and local levels, IWRM is being applied. Subnational, basin, and municipal adoption, on the other hand, lags behind national implementation. These noticeable disparities around the board pose questions, as these lower levels are where the most hands-on management is needed. To be successful, IWRM requires both group and technical awareness, as well as localized implementation [12].

Water resource management is a continuous and long-term operation. It necessitates the involvement and collaboration of states, institutions, and organizations at the international, global, state, and local levels, as well as the private sector, charitable organizations, and committed individuals [13]. Water supplies are under-demand and future supply is unpredictable, making preparation and management choices more difficult [14]. The IWRM model is thought to be a good way to deal with uncertainty [15, 16]. IWRM modeling represents human-environment interactions and thus has many similarities to socio-ecological systems modeling and the more recent concept of socio-hydrology. "Social-ecological systems modeling" is frequently concerned with sustainability [17] or resilience [18], whereas "sociohydrology" is concerned with the interaction and co-evolution of coupled human-water systems [19]. Water management or policy decisions typically involve stakeholders from multiple sectors, which makes IWRM distinctive. IWRM relies on water balance and hydrological modeling tailored to a policy or planning context. This necessitates integrating hydrology with other environmental sciences. Effective practices throughout the model development and application lifecycle can improve IWRM modeling success, from framing key questions and defining objectives to using the model to meet its intended purposes [20]. While scholars have made significant progress in developing IWRM, conceptualizing modeling methodologies, and reporting case studies, there is still a dearth of documented knowledge about the modeling workflow and the role of contextual factors in determining this workflow and the practices to employ. Practice-oriented guidance may support explaining some of the nuances encountered by those involved in IWRM modeling on a micro-level. Relevant studies are apparent for the enhancement and improvement of water governance.

Pahl-Wostl et al. [21] implemented a multi-level water policy transdisciplinary diagnostic methodology that is paired with a participatory progress management method. Water management is not only a technological problem but also a social, economic, and political concern [14]. Thus, there is a need for stakeholder participation in management [16, 22], which has been transformed into legitimate public engagement provisions and water management disclosure [23]. As argued by Kumar et al. [24], the government/management system should be such that local management interventions are integrated with broader basin management behavior and that communities are encouraged to participate in governance and management. Ching and Mukherjee [25] carried out a meso-level study that showed how narratives supplement the IWRM model to meet the need for adaptability and decentralized decision-making in highly complex contexts; thus, account narratives and public decision rules are useful for water governance. The use of bibliometric research in the development of narrative analysis in the study of water resource management demonstrates that narratives have a significant influence on decision-making and behavior [26]. Water management decisions require transparent data on ecological, economic, and social aspects. Handling, integrating, and interpreting such data requires both administrative and technical skills. The decision-making process for freshwater ecosystems requires input from natural scientists, social scientists, engineers, and economists. Tools that facilitate cross-disciplinary communication are needed to support this collaboration.

The definition of IWRM has gained widespread acceptance as the preferred method of water management in both rich and poor countries [27]. IWRM is a mechanism that facilitates the organized production and management of water, land, and related services in order to optimize the resulting economic and social welfare in an egalitarian manner while protecting essential habitats [28]. IWRM promotes decentralizing water resources to the municipal level as a management activity by increasing citizen involvement in the decision-making process [29]. Economic efficiency, social justice, and environmental protection are the basic concepts and principles of IWRM, which are widely known and accepted [24, 30]. One of the most significant challenges in implementing IWRM is overcoming limitations related to the impact evaluation of suggested policies [31]. The IWRM is a strategy for increasing the sustainability and capacity of water resources to meet future demand [32]. Additionally, the IWRM is a dynamic mechanism that requires resource sharing between competing uses and users, implying political push. Rapid urbanization has strained water resources and weakened societal resilience in the face of water scarcity, leaving fewer options for addressing IWRM [33]. The IWRM can help alleviate global water scarcity by analyzing watershed distribution, establishing strategic guidelines by

involving local communities, and implementing effective ones in water-scarce regions [34]. For this management approach to work, all stakeholders must be involved, and innovative tools must be used. It seeks to build partnerships and avoid marginalizing water users and groups [35, 36].

Academics and water resource managers worldwide have adopted and tested the IWRM approach [37-40]. Hooper [41] emphasized that integrated management is a collaborative and coordinated effort, not a merger, requiring a holistic and sustainable vision. This idea is now widely used to solve water resource issues. The scientific community is well aware of the costs and damages associated with not applying IWRM.

In line with Target 6.5 Sustainable Develop Goals (SDG 6 on Clean Water and Sanitation), the aspirational goal for indicator 6.5.1 is to achieve a very high degree of compliance, or a global average score of 91 to 100, through IWRM implementation at all levels, including transboundary cooperation as required [42]. In the recent survey conducted by the United Nations in 2018, among the 172 countries that responded, Philippines has a rating of 51.5 which means "medium-high" capacity to incorporate elements of IWRM is largely sufficient, and most elements are applied as part of long-term projects [13].

The Philippine government has consistently enunciated the need and value of comprehensive development, utilization, conservation, and protection of water resources [43]. With the sub-national water resources policy, IWRM related and supportive sub-national policies and legislative issuances have also been formulated by local government units in the Philippines [43]. These policies and issuances are oftentimes related to the creation of offices for localization and operationalization of IWRM, enforcement of compliance with requirements of national laws and policies, revenue generation and resource mobilization, standards for service delivery provision, programs for promoting and supporting IWRM related elements, and commemoration of special events related to water and the environment. On the contrary, there is currently no consolidated data on the status of implementation and achievement of objectives of these sub-national policies; thus, there is no data on the degree of implementation in the sub-national level. Water management in Palawan seemed fragmented, given the rising pollution and over-exploitation of groundwater. This integration issue arose despite the public authorities' action programs, in particular, the regulatory establishment and implementation norms aimed at upgrading the sector's liquid and solid discharge sanitation [44]. Other management issues include the use of raw wastewater for irrigation, excessive use of fertilizers and pesticides, and lack of solid waste treatment, all of which harm the water table and the region's water systems [45]. All of the identified risks have irreversible effects on water quality, availability, and future renewal. Thus, integrated and coordinated water resource management is required to solve this region's water issue.

This study aims to fill this knowledge gap by describing the steps required to implement IWRM successfully. This focus on specific steps and activities necessitates a thorough understanding of the IWRM process, including how integration will be implemented, how stakeholders will be effectively involved, and how decisions will be linked to the problem and system context. The operationalization of IWRM still faces significant challenges in terms of knowledge integration and implementation. These issues are inherent to the IWRM concept and its practical application. The main challenge is to develop guidance on how to implement IWRM or how to address the integration dimensions of IWRM for a given problem. In this regard, the present study aims to address this gap by investigating the degree of implementation of IWRM at the sub-national level; to evaluate the rating in each section that covers the key component of IWRM implementation, and to conclude the similarities and divergences, and the sustainability of the IWRM in the study areas. This study focuses in Palawan Province with the following study sites: Puerto Princesa City, El Nido, Roxas, and Taytay (see Figure 1).

Subsequently, a structured survey questionnaire is drawn up in accordance with the existing questionnaire developed for this purpose [46]. This paper focuses on the first part of target 6.5. In this assessment, the components of the GWP on criteria for IWRM adoption are implemented, primarily different aspects identified with (1) supporting environment, (2) organizations and engagement, (3) management instruments, and (4) financing [13]. These four categories are accumulated into indicator 6.5.1, which measures the extent to which IWRM is being implemented. The findings of the case study are not counter-intuitive and confirm an average evolution of the study area's water resources management system. Thus, potential opportunities for improvement were also identified. The paper does not discuss the necessary institutional and governance reforms for IWRM that have been advocated by many. Moreover, despite current governance constraints, much progress can be made by inferring and communicating how new arrangements and approaches might improve water resource management.

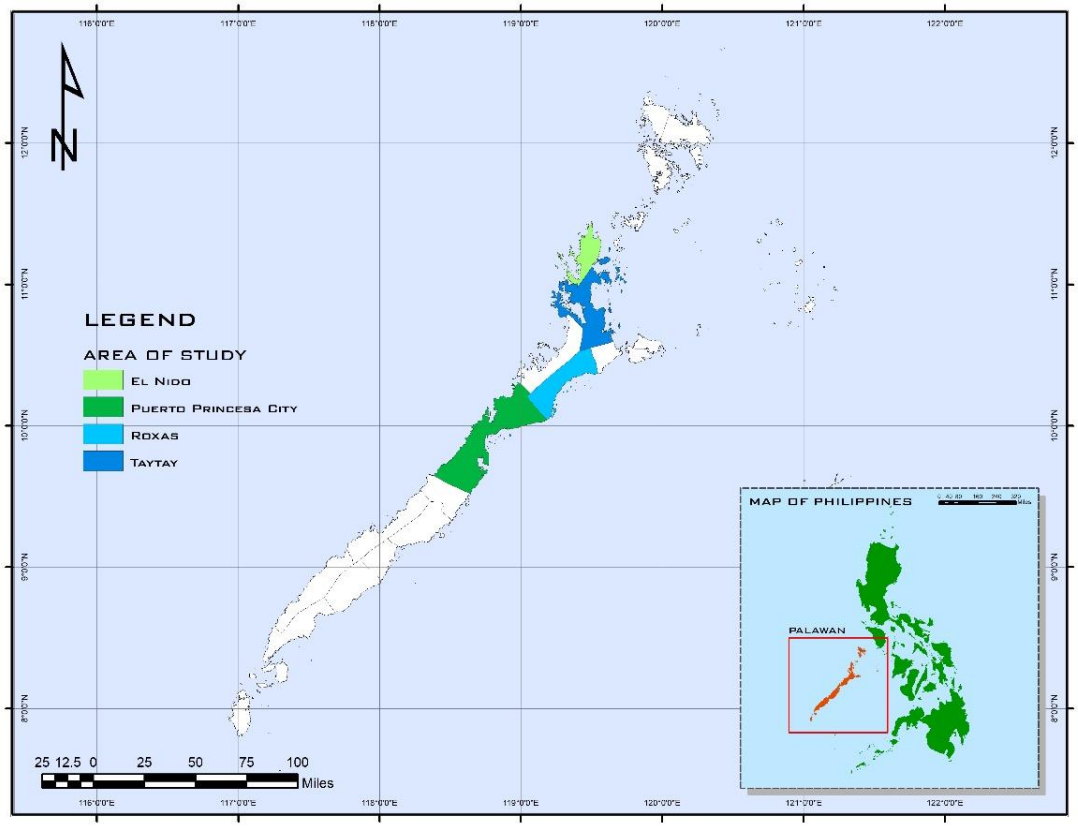

Figure 1. Map of the Philippines with the area of the study highlighted

2. Materials and Methods

2.1. Characteristics of the Research Site

The study considered the Local Government Units (LGU), water districts and other institutions in a certain locality for their strategic role in the implementation of IWRM at the sub-national level. The study sites are Puerto Princesa City, Palawan; El Nido, Palawan; Roxas, Palawan and Taytay, Palawan.

2.2. Selection Criteria

This study aims to enhance the IWRM degree of implementation to address water scarcity and to have efficient water resource management. The study sites are chosen in terms of water quality and accessibility.

2.2.1. Puerto Princesa City

The Irawan River, with an approximate width of 10 meters located within the territorial boundaries of four barangays, is the main source. The water classification is Class A [47], comprising the 80% water source of the city. The city's groundwater quality is low, with a pH greater than 7.2, which is the minimum for reasonable quality groundwater. Groundwater, which accounts for 20% of the city's water supply, contains elevated amounts of calcium and magnesium, which create crust deposits in boilers [48-49]. Water service utility is provided by the Puerto Princesa City Water District (PPCWD), Level III. According to the PPCWD data, only urban barangays are the areas they currently serve [45]. The rest of the component barangays of a highly urbanized city do not have access to quality water. These barangays continue to utilize Level I and II water sources [45]. In the bulk of the city's 66 barangays, the water district instituted a water rationing scheme to counter the scarcity. The city suffered unprecedented water shortage for decades, prompting for such study to be conducted to address the problems in water resource management implemented in the city.

2.2.2. El Nido, Palawan

In 2018, due to numerous complaints raised by tourists and government personnel, a senior official asked the Department of Health to test the drinking water supply of El Nido, suggesting it might be contaminated with harmful bacteria [50] 50. The DENR in Mimaropa (Mindoro, Marinduque, Romblon, and Palawan) region announced that fecal coliform levels had returned to normal seven months after the agency and local government launched a cleanup campaign against errant establishments encroaching on coastal easements [51]. Residents in El Nido have dug wells as

their main source of water. Only 3% of the population had their own faucet, with about 17% having shared faucet community water system [52]. The municipality has a poorly managed water system and has no sewerage system. Sewage is discharged directly to the bay without treatment; thus, it is deemed necessary to be considered as one of the areas of study for the IWRM degree of implementation.

2.2.3. Roxas, Palawan

A majority of the household water consumption in Poblacion, Roxas, Palawan are supplied by the Umalad watershed through the Roxas Water District (RWD) [53]. RWD delivers potable water from its pumping station in Barangay IV, Poblacion, which has a capacity of 1,500 cubic meters per day. Through an agreement from the Provincial Government of Palawan and the Municipal Government of Roxas, the Caibulo Water Project, which can supply up to 30,000 cubic meters per day, may soon be used [54]. The salinity of the water in Roxas is 5.4 parts per thousand, or 225 times more than the norm, according to the water measure [55]. This is concerning, according to health authorities, because so much salt in the water may have negative health consequences. Thus, long-term solutions for Roxas are necessary to safeguard the health of water users.

2.2.4. Taytay, Palawan

Based on the ECAN Resource Management Plan (2015-2020) of Taytay, Palawan, limited water supply is a major problem and is listed as a priority to be addressed [56]. Numerous plans such as pipe systems and artesian wells were created to improve the waterworks system and expand all existing water systems in the area to assure continuous supply. The municipality has abundant sources of surface water due to its lake and numerous branching rivers and waterfalls. It has 39 rivers and 15 waterfalls located in 9 barangays, as reported in its Comprehensive Land Use Plans (1999-2009). However, the groundwater resources are challenging to utilize because of the overlying rocks that have very low permeability, which restrict water flow [56]. Few areas with shallow wells were developed as sources of supply for the households. Both pumped, and gravity water facilities were constructed to supply Barangay Poblacion. The sources for the gravity type are Mamaquen Surface water, Malaipit Spring source, Melita Spring source, and Nagbenter Source [56]. Most of the water facilities are operating and functional only within a limited time that makes it difficult to supply water on peak days and dry seasons.

2.3. Overall Research Approach

The study design was developed based on the following factors: A standardized questionnaire may be used to collect information about awareness levels, and using a focused group discussion to conduct the questionnaire to the respondents is a simple and accurate method. The information required to complete the survey questionnaire is expected to be held by government officials, water district directors, and stakeholders. This study will adopt the steps developed for the computation of the indicators of IWRM's degree of implementation.

The data gathered during the survey were analyzed for all categories and the expected degree of implementation of IWRM was calculated in accordance with the step-by-step computation [57]. The general meanings of the implementation groups for the overall 6.5.1 indicator score, provided in Table 1, are based on the particular question's threshold definitions

Table 1. Implementation types, score thresholds, and interpretation for the IWRM in general [13]

	Score range	Overall IWRM score general interpretation
Very high	91 – 100	The vast majority of IWRM components are completely integrated, with goals regularly met and plans and projects evaluated and updated on a regular basis
High	71 – 90	Plan and policy goals for IWRM are largely fulfilled, with strong regional reach and stakeholder participation
Medium-high	51 – 70	Capacity to incorporate IWRM elements is largely sufficient, and elements are usually introduced as part of long-term projects.
Medium-low	31 – 50	IWRM components have largely been institutionalized, and deployment is well underway
Low	11 – 30	The implementation of elements of IWRM has started in general, but with modest adoption across the country and perhaps poor stakeholder interest
Very low	0 – 10	The production of elements of IWRM has been delayed or halted in most situations.

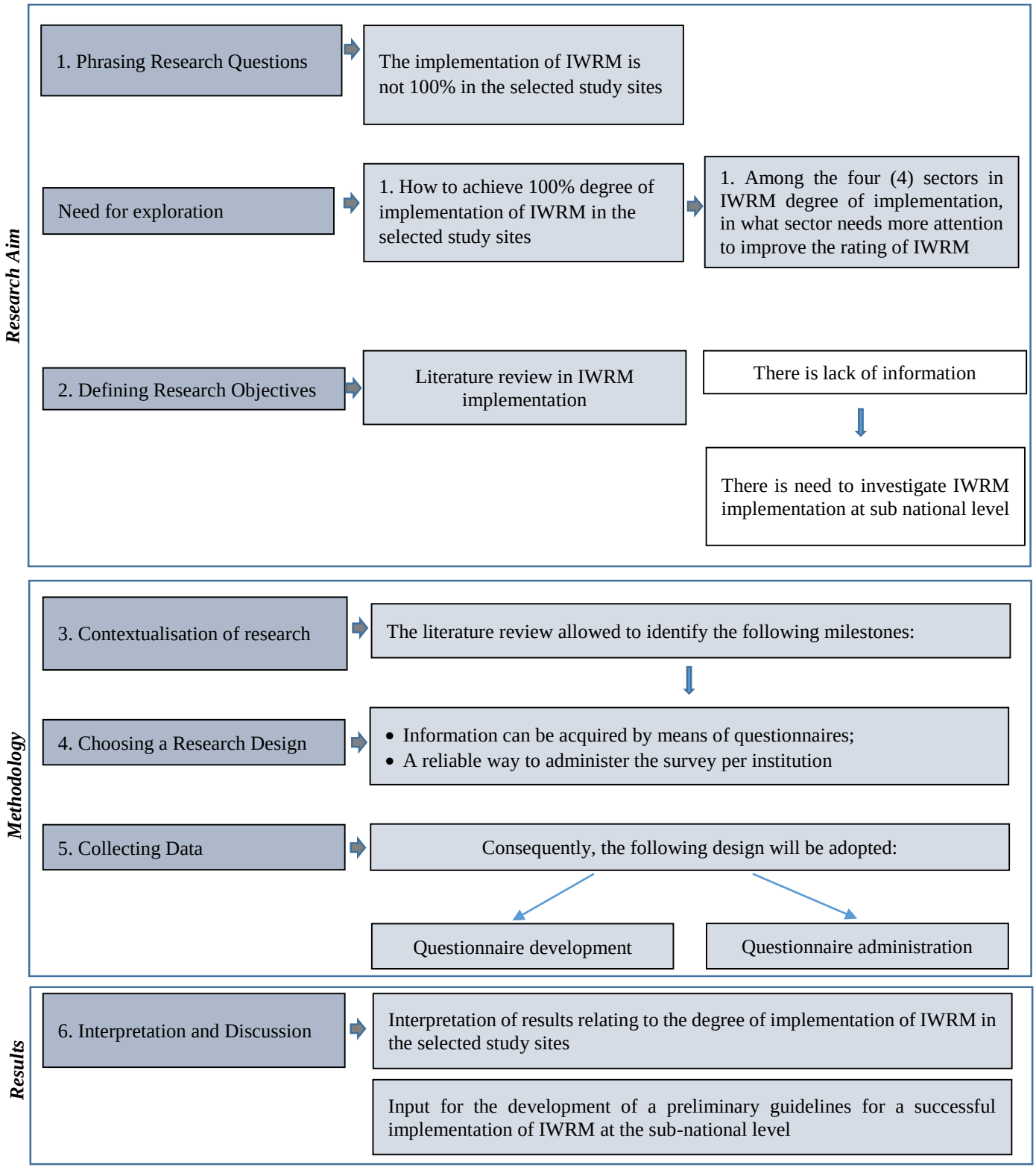

Figure 2. Methodology of the study

2.3.1. Survey Questionnaire (UNEP, 2018a)

The SDG indicator 6. 5.1 on IWRM implementation is based on a self-assessed questionnaire with questions organized into four main dimensions of IWRM:

- Enabling environment: The most common policy, legal, and strategic planning tools that support IWRM implementation.
- Institutions and participation: Aspects of institutional and stakeholder support for implementation.
- Management instruments: Tools and activities that help decision-makers and users choose between alternative

actions.

- Financing: Various budgeting and financing sources used for water resource development and management.

Each of these four sections has questions at the national, subnational, basin/aquifer, local, and cross-border levels, as well. This talks about the target 6.5 formulation of putting IWRM into use "at all levels." The questionnaire was divided into two parts. The first section was organized to gather data on age, gender, profession, and educational qualifications. Whilst, the second part contained 27 questions related to information about the IWRM degree of implementation.

Questions Q1 – Q6 want to verify the state of programs, rules, and proposals to help IWRM at the national and sub-national levels. Questions Q7 – Q15 aim to verify the status of institutions for IWRM implementation at the national and sub-national levels. Questions Q16 – Q23 wanted to verify the status of IWRM management tools at the national and sub-national levels. Questions Q24 – Q27 aim to verify the status of funding of production and maintenance of water resources at the national and sub-national levels. The interview is accounted for the respondents who are knowledgeable in the implementation of IWRM. The survey was conducted in different institutions in the study area. The study provides for non-structural measures such as a collaboration strategy and awareness campaigns. The intent is to raise the awareness of stakeholders and water resource managers on the addressed topics. Orientation lectures were also held in a focused group discussion at the beginning of the study.

3. Results

Face-to-face interviews were conducted during the survey. A brief orientation about IWRM was presented before the interview. The IWRM rating of all responses was then calculated. From the questionnaires administered to the respondents, the following results were gathered. The questionnaires were divided into four sections, each containing sub-questionnaires that cover a key component of IWRM.

3.1. Enabling Environment

This section discusses the enabling framework, which refers to the requirements that facilitate IWRM implementation. It provides the most popular IWRM legislation, legal, and planning methods. The rating of the study sites for this section is shown in Figure 3.

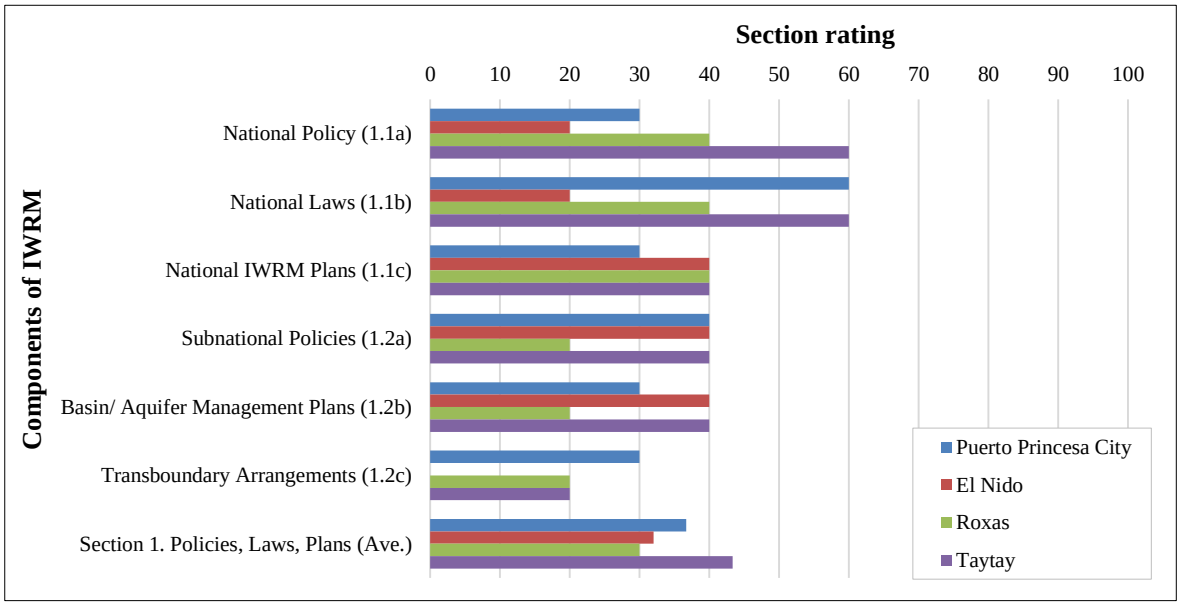

Figure 3. Rating of study sites for Enabling Environment Section

Puerto Princesa City obtained a sectional average of 36.67, which lies at "medium-low" level. Based on the general interpretation of score, it means that some aspects of IWRM have been institutionalized, and execution will follow. The degree of execution in the city of water resources policies and plans are equally "low", which signifies the existence and implementation of policies but are not based on IWRM. Meanwhile, the implementation of national formulated laws is far more effective with implementation at "medium-high", suggesting that such laws are applied by the majority of water-related authorities. Subnational policies are at "medium-low" range. Basin/aquifer management plans show a balanced but sluggish effort given by the authorities to formulate plans and commence utilizing and implementing them. Similarly, at "low" degree of implementation is the transboundary arrangement, suggesting that arrangements are in the preparatory stage.

Recording a 32-point score, Enabling Environment is implemented at "medium-low" degree in the municipality of El Nido. The implementation of this section is in progress, but the commitment of arrangements is not extensive. The policies and laws, which is at "low" degree range, show the presence of laws and policies that are water-related yet non-conformance to that of IWRM. National plans, however, positively implemented at "medium-low". Therefore, plans that are formulated nationally are approved by the government and is being implemented by a few authorities. Equally implemented are all the subnational or local elements; the management plans and subnational policies. At "medium-low" degree, indicating that subnational proposals are being developed based on IWRM, which has been approved by authorities and is now being used to direct work. Furthermore, it also indicates that management plans are approved in the majority of basins/aquifers and commencing to be used by authorities.

The average implementation level in Roxas is 30, which signifies that the municipality has begun limited implementation of IWRM policies, laws, and plans that conform to the IWRM at "low" level. However, even if it can be seen that the degree of implementation on national water resources policies, laws, and plans are "medium-low", it is reassuring to know that there are constant efforts from the national authorities to formulate, approve, and enforce laws, policies, and plans which are IWRM-conforming. Subnational policies, basin/aquifer management plans, and transboundary arrangements are likewise executed at a "low" rating. Although this level of implementation appears to be relatively low, this indicates the existence of such plans and laws at the subnational level yet not based on IWRM, and that basin/aquifer management plans are being prepared but not government approved.

Having an average scoring range of 43.33, the municipality of Taytay, Palawan, is implementing the enabling environment as its section with the highest level of implementation at "medium-low", this means that IWRM-related elements are government-approved and is starting to be used as a framework by the authorities. National laws and policies are implemented at "medium-high", indicating that approved laws and policies are applied and used, respectively, by the majority of appropriate authorities to coordinate management practices. Meanwhile, IWRM-relevant national plans have started to be recognized and implemented by the authorities at "medium-low", equally carried out with the subnational guidelines and basin/aquifer management plans which is pessimistically suggesting the equal efforts done by the authorities at other levels to gradually adapt and equate the national capacity. Transboundary arrangements also at "medium-high", suggesting that inter-municipal arrangements' provisions are partially implemented.

3.2. Institutions and Participations

This section discusses the various political, social, fiscal, and administrative institutions that aid in the implementation of IWRM. It contains some of the most common social institutions for IWRM. Institutional capability and efficiency, cross-sector alignment, stakeholder engagement, and gender equity are all part of it. The rating of the study sites for this section is shown in Figure 4.

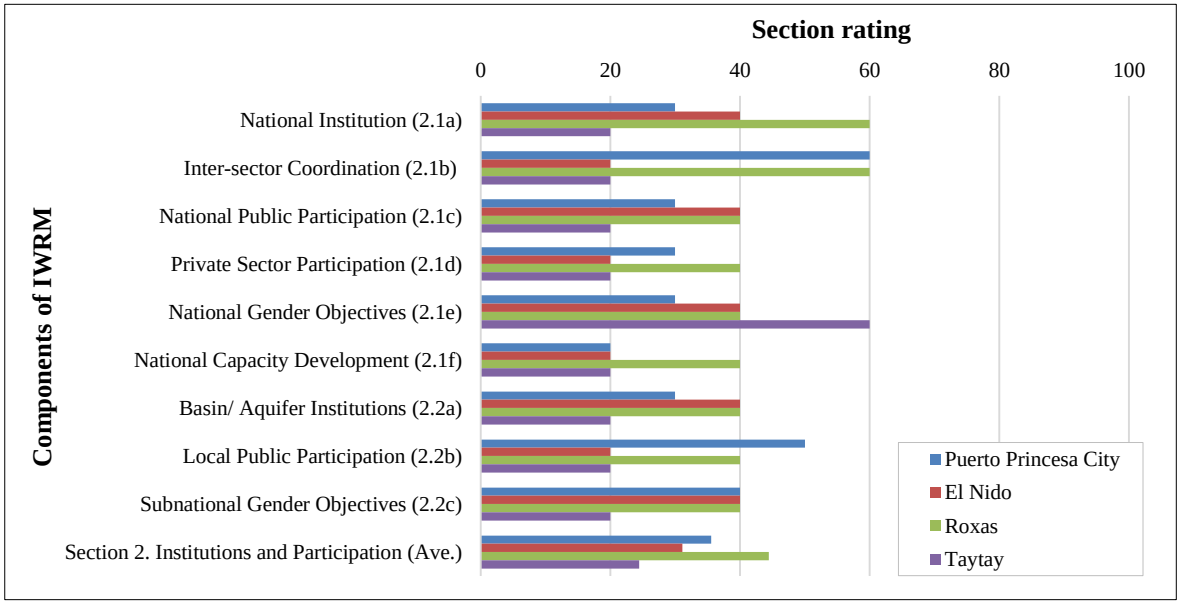

Figure 4. Rating of study sites for Institutions and Participations' Section

The score of Puerto Princesa in this section shows a scattered result, varying from capacity development to inter-sector coordination. The element which defines the capacity to lead the IWRM implementation at the national level and at the basin level, is applied at "low" degree. However, even when there is a constriction in the presence of national and local authorities, it is reassuring to see that there exists an effective capability of addressing possible conflicts of interest

between sectors and/or stakeholders with established coordination procedures in place. In the case of Puerto Princesa City, inter-sector coordination falls to "medium-high" range. It implies that there is effective communication between various sectors, to regularly engage in strategy, planning, and management processes. Local public participation is evident in the city. Local authorities are occasionally requesting information and opinions from the population, where information is made available to the stakeholders. Subsequently, local implementation of gender-specific objectives is also somewhat carried out forward. On the other hand, the national capacity development is reported as rather the "least" implemented element which connects to the short-term, ad-hoc, and occasional capacity development initiatives.

With a sectional average score of 31.11, El Nido implements the institutions and participations section at a "medium-low" degree. In terms of institutional capacity, the present water-relevant authorities and agencies only have the competence to effectively lead the formulation of IWRM plans and possess a clear mandate in pioneering the IWRM implementation, both in the national and basin/aquifer level. With a low level of institutional capacity, it is expected that inter-sectoral coordination is just at the communication level, where water infrastructure, strategy, planning, and management knowledge is shared among various sectors. Both the private sector and the local public participation are amongst those which are at "low" implementation level. It further implies the limited contribution of the business sector to the management, development, and effective use of water resources and the constrained and inadequate communication between the concerned authorities and the local community. Gender targets for water quality management are being applied similarly at the national and subnational levels, at "medium-low" implementation. This shows the recurring need to guarantee that water resources management and programs are incorporated in the gender objectives. Capacity development is reported to be similarly implemented less, implying that the municipality implements short-term activities that aim for development. Thus, in many municipalities, long-term progress and sustainability strategies for water resources management are critical calls for reform.

Roxas shows a sectional average of 44.44, which falls under the "medium-low" degree of implementation, a range where IWRM is rather institutionalized, and implementation is in progress. However, the two elements concerning the public authorities – national institutions capacity and cross-sectoral coordination - equally received a "medium-high" municipal implementation, implying that there are capable and effective authorities and there exist opportunities for various sectors to partake in implementing processes. Slightly behind is the presence of institutions that have a clear mandate on effectively leading the IWRM implementation. Nevertheless, all the remaining elements fall under the "medium-low" implementing degree, individually gathering a uniform score. For stakeholders' participation, implementation appears to be equally mitigated for both the national and local levels, signifying that the authorities occasionally request public participation – information, experiences, and opinions. Similarly, the implementation degree for gender-specific objectives is instigated at the national and subnational levels. Regular cooperation between the public and private sectors is emerging for the development of water resources, management, and efficient use. A "medium-low" degree of implementation for capacity development equates to a long-term capacity development plan, although hindered by the limited geographic and public coverage.

Showing a "low" average sectional score of 24.44, the municipality of Taytay records this as the lowest implemented section equivalent to a scoring range where IWRM has already begun, but limited interest and potentially low stakeholders' engagement. The result clearly shows an almost low uniform scoring range for all the elements with "low" rating. Notably, an integral advantage in the implementing level of gender-specific objectives at the national level compared to the subnational implies that there is a more strictly implemented framework regarding gender objectives nationally, however partially funded. All the elements that concern the public authorities - national institutions capacity, inter-sector coordination, and basin/aquifer institutions as aforementioned, received low scores. It clearly implies the constraints present in areas where it is hard for centralized institutions to have complete mandates over the extensive geographical coverage of their jurisdiction, which further implies the need for capacity development. Consequently, in having no proper authorities, there is also an almost non-existent stakeholders' participation, with very limited communications between the government and business community. Advancing these vital elements along with gender equality and empowerment could positively reform the aspects of effective IWRM elements' implementation.

3.3. Management Instruments

This section provides the mechanisms that allow decision-makers and consumers to make sound and informed decisions while choosing between various options, which covers conservation systems, water quality control and stresses, information sharing, and capacity building. The rating of the study sites for this section is shown in Figure 5.

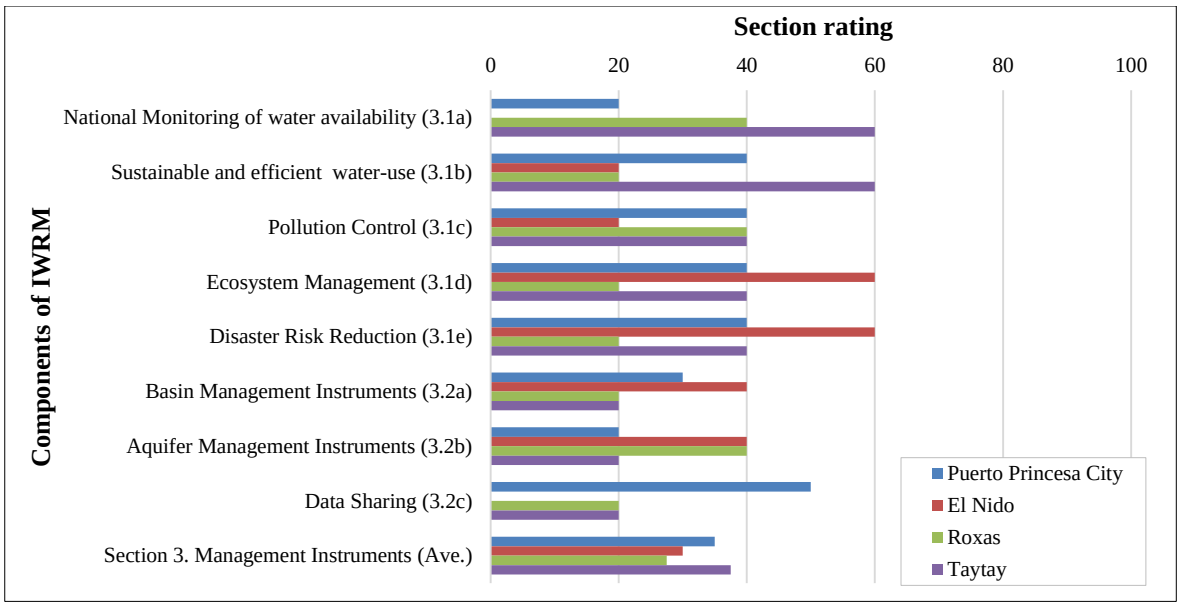

Figure 5. Rating of study sites for Management Instruments' Section

Puerto Princesa City's scoring distribution on this section shows a low sectional level of implementation. Correspondingly all the elements are reported to be at "low" or "medium-low" in implementation. At 35 points, this is at the "medium-low" stratum of general interpretation. The need for an established and regular monitoring of water availability is critical in finding alternatives and securing sustainable and efficient water use. These two elements are somewhat correlated in their purpose of mitigating future water scarcity problems. Therefore, considered a concern that these two related aspects are implemented poorly. The water availability monitoring systems in the city were established for a limited number of temporary projects only. Some sustainability control tools are implemented over a longer period of time but with limited scope for all water users and across the world. Elements that are seen to prepare, protect, and preserve the ecosystem are equally rated, however, at "medium-low" level. Generally, it implies that some management instruments were introduced over a longer period of time but with restricted sector scope, at-risk areas, and ecosystem category. With this, the ability to implement these management instruments is already present, however, the pressure focuses now on how to enlarge the radius of the impact of the implementation that will serve as boosters in achieving higher implementation levels. The city, as reported, is rather dependent on the basin-type water resources rather than the limitedly-producing aquifer resources, which consist of a low portion of the water source. Although there are still some constraints that impede the access to data and information, it is positive to see that longer-term data and knowledge exchange agreements occur between major data providers and users, and is on the verge of transitioning to provide data with a sufficient level of coverage across industries and across the country.

Management instruments section's implementation for El Nido could be considered as the least effectively enforced and realized, besides being the lowest scoring average amongst all four sections at 30 points "medium-low". Primarily, the absence of the critical element in national monitoring of water availability shows the main and basic need for the implementation to flourish. The absence consequently affects mainly the sustainable and efficient water use, in a sense that the management instruments are used infrequently and only for short-term programs. Ecosystem management, as it is deemed to overlap with pollution control, amazingly advanced the former by a huge gap, implying that management instruments include management plans and other tools. With long-term implementation and with adequate coverage of at-risk areas, disaster risk reduction is also seen as a focal element. Basin management instruments are equally implemented with the aquifer management instruments, signifying that implementation of these instruments is on a more long-term basis, with a sufficient regional and stakeholder reach. Data collection and access across relevant stakeholders are critical to sustainable and equal use of water resources. However, this element is reported to be non-existent.

Roxas has an IWRM average score and result distribution of "low" level of implementation at 27.50. At existing rates of execution, this average is seen as slow-moving, and the global goal is impossible to be reached. Although a huge portion of the municipality has access to managed potable water, there is still a low percentage that is reliant on other sources of water such as dug wells where aquifers are provided. This explains the implementation score of aquifer management instrument categorized as medium-low, which means that instruments are long-term implemented but have limited stakeholder coverage. In contrast, basin management, which is expected to be implemented more efficiently, received a low implementing score. These two elements that concern the implementation at the lowest level must be well-integrated to boost the implementing levels at the subnational. Monitoring national water supply and ensuring safe and effective water usage is essential for achieving Goal 6 (Target 6.4); these two received different scores, categorized as poorly implemented. Encouragingly, having the water monitoring carried out in a longer-term implementation is

constructive, and this could directly influence the progress in the instigation of efficient water usage. Pollution control, although limitedly, is progressively implemented on a more long-term basis compared to ecosystem management instruments which are likely to overlap, giving the same areas of concern on environment preservation. Disaster risk reduction and resilience are implemented only through short-term and ad-hoc programs. Data sharing is rather more difficult as it is challenging to collect data regarding water concerns, where availability is limited and hardly accessible.

The elemental scoring distribution of Taytay is varied, with a sectional average of 37.50, implying a "medium-low" degree of implementation, signifying that the IWRM execution has started but with limited coverage. The two highest-scoring questions, water availability monitoring and efficient water use, both received "medium-high" implementation range, are required to provide vital information to ensure that the water resources are sustainable. Meanwhile, the three elements that concern the environmental protection and preservation, pollution control, ecosystem management instrument, and disaster risk reduction are uniformly seen to be implemented with "medium-low" range score. This implies that programs that supports the improvement of water quality, protecting and restoring water-related ecosystems, and reducing deaths and economic losses relative to water disasters are continuously implemented yet limited in terms of geography, stakeholders' involvement, sectors, and ecosystem category. Capacity therefore, is present, but the challenge is on how to scale up the coverage from being limited to achieving adequate to excellent coverage. The status of IWRM management instruments at other levels is the lowest in this section. This could signify that implementation at local levels is slow to progress, and the need to focus the implementation target at other levels is high. Basin/aquifer management instruments, along with the data and information sharing, shows "low" degree of implementation. It is, therefore a necessity to urgently ensure management security in both the surface and groundwater.

3.4. Financing

This section examines the financial tools available for the production and maintenance of water resources from different sources. The rating of the study sites for this section are shown in Figure 6.

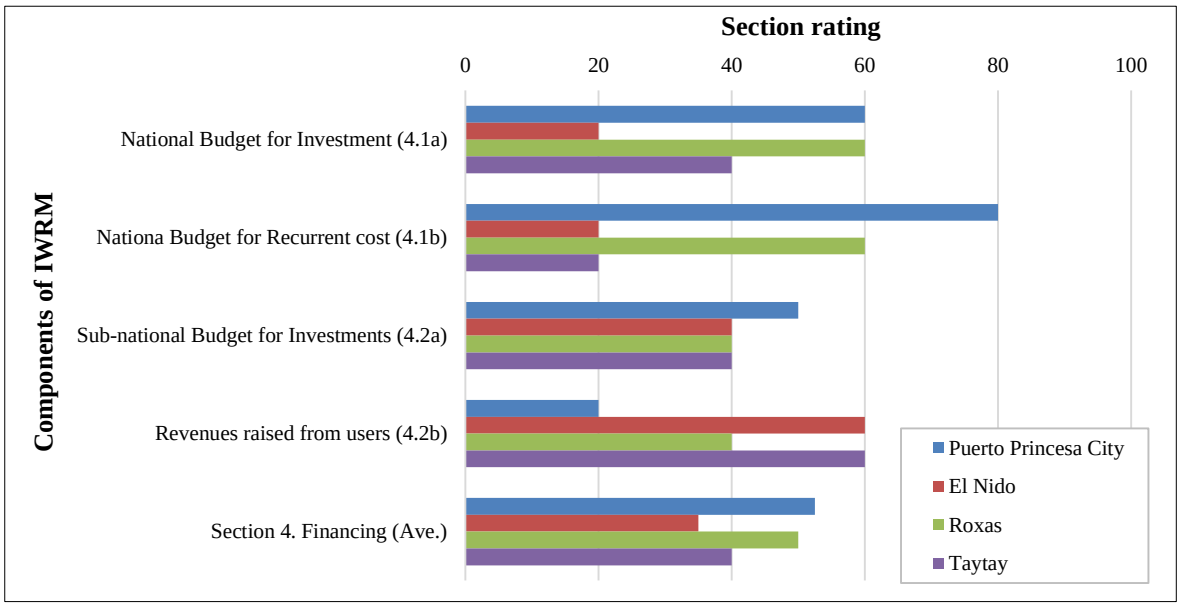

Figure 6. Rating of study sites for Financing Section

This section records the highest degree of implementation for Puerto Princesa City. At 52. 5 points, it is the only section to surpass the "medium-high" stratum of implementation. From the indicative score, the city has a chance to achieve the global goal, but efforts must be concentrated and continued before 2030. The national budget for recurrent cost obtains the highest score amongst all elements, implying that all elements are allocated, and implementations are regularly carried out. Meanwhile, the national budget for investments is efficient by providing sufficient budget allocations for all planned programs or projects. An appropriate budget has been set aside for proposed investments, but funds have not been disbursed or made available locally. Implemented at "low" level, the city aims to raise local revenue. Although revenues were regularly collected from users, these funds are not used for water supply conservation.

This section is implemented at "medium-low" having a 35-point score for El Nido. Centralization and location priorities play an important role in the scoring differences in the municipality. It can be seen that an increasing trend is created from the national to the subnational level. Both national budgets for investments and recurrent costs are implemented at "low" level. This shows that national budgets are allocated primarily for planned investments and for just a handful of the components, as well as early deployment. Even if the subnational budget for investments is only

implemented at "medium-low", it is encouraging to note that it is sufficiently allocated for planned investments. User-raised revenues can be seen as the highest implemented element in this section, which is to be taken positively, as it will be a stepping stone to start establishing financial stability, which can cover some important IWRM activities. This could be interpreted that El Nido utilizes a limited amount of collected revenues in implementing some IWRM activities.

This section unexpectedly leads all other main aspects of IWRM in Roxas. At exactly 50 points, financing aspects is at the verge of progressing from "medium-low", which means that financial elements are institutionalized and implemented. The pattern those sub-national elements lag their national counterparts clearly shows that there is a lack of focus on local levels which can possibly be caused by centralization. Nationally, for all proposed activities or schemes, there is enough money allocated and funds disbursed by scoring a "medium-high". However, a "medium-low" subnational budget for investments implies an adequate budget set aside for proposed investments, but inadequate funds disbursed or available. As the implementation of IWRM is slowly yet progressively moving, recurrent costs are now necessary. The majority of the components have been allocated, and deployment has begun. Furthermore, having an institution that could provide water provision services, there is but limited revenues raised from users. As encouraging as it is, there is still the continuous need to enhance financing for sustainable, equitable, and efficient water management.

Similar to other aspects, financial aspects of the municipality of Taytay show a somehow different score distribution, with a sectional average of 40 points under "medium-low" range. The municipality shows an equivalent scoring for the two elements concerning the investment budgets. A sufficient budget has been set for proposed investments, but insufficient funds have been disbursed or made available. It's discouraging that only a handful of the components have recurring costs allocated and that execution is still in its early stages, which needs to be immediately addressed to achieve all the other aspects, as financial is considered a major tool to do so. On a positive note, a score in raised revenues implies effective revenue-raising and allocating strategies and plans covering some IWRM element implementation activities. Seemingly, the lack of implementing capacity from the national level is covered in the sub-national level.

As shown in Table 2, Puerto Princesa City, El Nido, Roxas, and Taytay have the following IWRM ratings; 39.93, 32.03, 37.99, and 36.32%, respectively, which all means "medium-low" rating wherein IWRM components have largely been institutionalized, and deployment is well started. While there is subnational water control in these regions, its maximum capacity is often not understood due to various constraints. Since spatial dimensions are not only closely related but also interdependent, implementing IWRM at all levels is a critical part of SDG target 6.5. Activity or inaction at one stage, in particular, may have a direct effect on the quantity and consistency of water. The problem in this strategy is to ensure that IWRM implementation at the transboundary and subnational/local levels does not fall behind the national level to the point where it impedes progress 13. The majority of responses have equivalent standards of enforcement for programs, rules, and plans; organizations and participation; and management instruments. Financing for water quality control and monitoring must be expanded, mainly by better cost-recovery.

Table 2. IWRM Rating of the selected study sites

	Puerto Princesa City	El Nido	Roxas	Taytay
Sector 1. Enabling Environment	36.67	32.00	30.00	43.33
Sector 2. Institutions and Participation	35.55	31.11	44.44	24.44
Sector 3. Management Instrument	35.00	30.00	27.50	37.50
Sector 4. Financing	52.50	35.00	50.00	40.00
IWRM Rating	**39.93**	**32.03**	**37.99**	**36.32**

Although it's the SDG benchmark, past surveys show that the research sites are unlikely to meet the global goal at the existing rates of implementation. A report argued that implementing IWRM would be one of the most comprehensive steps countries can take towards achieving SDG 6. A holistic IWRM approach would provide institutional structures and multi stakeholder processes to balance water resource development and use for people, economic growth, and ecosystem services. With diverse natural resources, social and economic development, each region would need to find a path to integration. A long-term political commitment to change would be essential [58]. The report referred to GWP's framework for helping countries decide on actions based on their socioeconomic development [59]. There was also evidence linking a country's Human Development Index (HDI) to IWRM progress. This suggested IWRM was mostly associated with wealthy nations, but the report found this was not always the case. According to Shah 59, countries with strong national institutional capacity and coordination, and high stakeholder participation at the national and local levels could implement IWRM with or without high HDI.

4. Discussion

The four study locations report comparable implementation levels for policies, laws, and plans; institutions and participation; and management instruments. The averages for these three dimensions are comparable (32-35), though they vary considerably between sites. The study sites report a low to moderate level of financing implementation.

Financing for water resource management and monitoring must be increased, most notably through improved cost recovery. Result shows the IWRM rating in the selected study sites are quite low. It demonstrates the individual rating of study sites for each section that covers the key component of IWRM. Implementation is happening, but to such an extent that ratings vary from 0 to 100. Each site can be identified to make progress. Different approaches to implementing integrated water resource management are needed as there is no "one-size-fits-all". While site-specific, these approaches will resonate with many other sites. Important improvements may be achieved by concentrating on some of the survey's lower-scoring regions, such as basin/aquifer management, financial structures, and capability growth. These indicate clear directions on what sections must be prioritized and what steps to take.

Effective implementation of integrated water management includes a wide variety of factors, including establishing a framework for controlling the quality of water, to be engaged to create regulations that address the private sector's equal and sustainable use of water resources [13]. Multiple elements of IWRM may be applied by a number of actors in a variety of ways and at varying speeds. Implementing these components if IWRM should consider the local political, economic, and social realities in each nation. In short, IWRM implementation should not be seen solely as the work of the ministry of water, although it will have a coordination role function to be played. Although there is no such thing as ideal water governance metrics, an indicator addressing various components of the IWRM offers a valuable input framework to promote the implementation of key aspects of good water management.

5. Policy Implications

As argued by Rola et al. [60], water governance in the Philippines has the following constraints: confusion in legal documents for water, inadequate water data for planning, interconnected water agencies; and insufficient human and financial resources. The effectiveness of the local levels in their mandates is also impelling. Local governance is functioning; however, decisions and actions are still bound by the powers at the national level, which results in conflicts between national and local governments.

The majority of the responses from the survey reported that water conflicts are present in their localities. Although several conflicts cited issues over failure to comply with corporate laws, at the organizational or LGU level, conflict resolution is based on the customary procedure. Further, the results from the study sites are predominant in the different parts of Palawan. In this context, accelerating the IWRM implementation in these sites is needed to contribute to a higher national IWRM rating. In this respect, actions and steps must be taken to advance the management of water resources. The list below should be determined and prioritized to contribute a significant outcome to IWRM rating.

5.1. Enabling Environment of Laws, Policies and Plans

- Advancing the introduction of water strategies plans and regulations.
- Establishing strategies for watershed management.
- Harmonizing rules on transboundary water.

5.2. Institutions and Stakeholder

- Ensure that the national and subnational have the capacity to perform their functions.
- Strengthen transparency for water-use efficiency by local authorities.
- Create procedures at central and local government levels to handle IWRM projects.
- Improve water agencies' recruiting procedures to ensure trained workers; build workers such that they are well trained with the expertise needed to enhance IWRM implementation.
- Strengthen private sector and stakeholder involvement in water resources development and planning.

5.3. Management Instruments

- Establish appropriate frameworks for the implementation of hierarchical coordination management tools and human and financial resources.
- Improve the cooperation and collaboration between management-to-business experts in order to implement new technologies that improve water quality.
- Protect ecosystems, watersheds, and water reservoirs.
- Create arrangements for data sharing.

5.4. Financing

- Establish viable processes of funding and budget allocation for the implementation of IWRM.
- Influence to build IWRM infrastructure projects by local governments and development councils.

- Allow water trading at various levels to further improve cost recovery.
- Encourage public-private partnerships in water resources management.

6. Conclusion

The right to water is a fundamental human right. Nonetheless, many people, particularly the poor, have limited access to it, despite the fact that available annual resources far outnumber total withdrawals. Inadequate water governance at multiple levels contributes to the creation of "artificial scarcity." The findings indicated that the numerous legal documents governing water are confusing and that water data for planning purposes is insufficient. While there are numerous water agencies, they are not vertically or horizontally connected. These various institutions lack the necessary human and financial resources, as well as a local presence, to carry out their mandates effectively. The findings of this study confirm previous findings that governance is highly dependent on economic and social conditions and that no single approach to governance works in all situations. Economical solutions that fit all are also inadequate. While hierarchical governance appears to be the norm in the Philippines, polycentric governance may be appropriate.

A number of countries have incorporated IWRM concepts into their water management plans. However, there has been much too little progress on the ground in terms of operationalizing the definition and putting the practices into effect. The implementation of IWRM in the selected study sites falls under a medium-low rating. These areas adopted most elements of IWRM, and implementation is proceeding, but the arrangements and stakeholder engagement are relatively low. At the subnational, basin, and local levels, there is a need to concentrate on advancing elements of IWRM implementation. In some cases, it is essential to resolve the disparities in capability and approaches. Implementation needs to significantly accelerate in these areas to contribute to a higher national IWRM rating. Municipal and regional targets are encouraged to be established based on the municipality and region's context. Following that, the challenge for these areas is to design, acquire funding, and execute activities that can sustain the intervention areas and drive them toward goals.

7. Declarations

7.1. Author Contributions

Conceptualization, J.C.C. and E.B.T.; methodology, J.C.C. and E.B.T.; data curation, J.C.C.; writing—original draft preparation, J.C.C.; writing—review and editing, E.B.T.; visualization, J.C.C.; supervision, E.B.T. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available in article.

7.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Acknowledgements

The authors wish to thank the Department of Science and Technology – Engineering Research and Development for Technology (DOST-ERDT) for providing funding and research grants to the corresponding author. The University of San Carlos-Research Ethics Committee is also recognized for the review and approval of the survey questionnaire. The research assistants are acknowledged for providing support in the deployment of surveys and data gathering.

7.5. Conflicts of Interest

The authors declare no conflict of interest.

8. References

[1] Kötter T. (2019) Urban Development. In: Kühnhardt L., Mayer T. (eds) The Bonn Handbook of Globality. Springer. doi:10.1007/978-3-319-90377-4_61.

[2] Santamouris, M. (2020). Recent progress on urban overheating and heat island research. Integrated assessment of the energy, environmental, vulnerability and health impact. Synergies with the global climate change. Energy and Buildings, 207. doi:10.1016/j.enbuild.2019.109482.

[3] Kafy, A., Abdullah-Al-Faisal, Raikwar, V., Rakib, A. Al, Kona, M. A., & Ferdousi, J. (2021). Geospatial approach for developing an integrated water resource management plan in Rajshahi, Bangladesh. Environmental Challenges, 4, 100139. doi:10.1016/j.envc.2021.100139.

[4] Shakhawat Hossain, M., Arshad, M., Qian, L., Kächele, H., Khan, I., Din Il Islam, M., & Golam Mahboob, M. (2020). Climate change impacts on farmland value in Bangladesh. Ecological Indicators, 112, 106181. doi:10.1016/j.ecolind.2020.106181.

[5] Azhoni, A., Holman, I., & Jude, S. (2017). Adapting water management to climate change: Institutional involvement, inter-institutional networks and barriers in India. Global Environmental Change, 44, 144–157. doi:10.1016/j.gloenvcha.2017.04.005.

[6] Reynolds JF., Mark D., Smith S., Lambin EF., Li BLT., Mortimore M., Batterbury SPJ., Downing TE., Dowlatabadi H., Fernández RJ., Herrick JE., Huber Sannwald E., Jiang H., Leemans R., Lynam T., Maestre FT., Ayarza M., & Walker B. (2007). Global Desertification: Building a Science for Dryland Development. Science, 316, 290–297.

[7] Pahl-Wostl, C. (2007). The implications of complexity for integrated resources management. Environmental Modelling and Software, 22(5), 561–569. doi:10.1016/j.envsoft.2005.12.024.

[8] Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-)management from a governance perspective and defining a research agenda. Ecology and Society, 14(1), 26. doi:10.5751/ES-02827-140126.

[9] Nshimbi, C. C. (2019). SDGs and decentralizing water management for transformation: Normative policy coherence for water security in SADC river basin organizations. Physics and Chemistry of the Earth, 111, 1–12. doi:10.1016/j.pce.2019.02.010.

[10] United Nations Development Programme. (2006). Human Development Report - Beyond scarcity: Power, poverty and the global water crisis. vol. 28. Available online: http://hdr.undp.org/en/media/HDR06-complete.pdf (accessed on August 2021).

[11] Al-Saidi, M. (2017). Conflicts and security in integrated water resources management. Environmental Science and Policy, 73, 38–44. doi:10.1016/j.envsci.2017.03.015.

[12] Biggs, E. M., Duncan, J. M. A., Atkinson, P. M., & Dash, J. (2013). Plenty of water, not enough strategy. How inadequate accessibility, poor governance and a volatile government can tip the balance against ensuring water security: The case of Nepal. Environmental Science and Policy, 33, 388–394. doi:10.1016/j.envsci.2013.07.004.

[13] UNEP. (2018). Progress on Integrated Water Resources Management - Degree of IWRM Implementation. Water Science and Technology, 62, 1–69.

[14] Momblanch, A., Pedro-Monzonís, M., Solera, A., & Andreu, J. (2018). Water Accounting for Integrated Water Resources Management. Advances in Chemical Pollution, Environmental Management and Protection, 3, 63–96. doi:10.1016/bs.apmp.2018.08.001.

[15] Gupta, J., Pahl-Wostl, C., & Zondervan, R. (2013). "Glocal" water governance: A multi-level challenge in the anthropocene. Current Opinion in Environmental Sustainability, 5(6), 573–580. doi:10.1016/j.cosust.2013.09.003.

[16] Loucks, D. P., & van Beek, E. (2017). Water resource systems planning and management: An introduction to methods, models, and applications. In Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications. Springer. doi:10.1007/978-3-319-44234-1.

[17] Petit, O., & Baron, C. (2009). Integrated Water Resources Management: From general principles to its implementation by the state. The case of Burkina Faso. Natural Resources Forum, 33(1), 49–59. doi:10.1111/j.1477-8947.2009.01208.x.

[18] Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. Global Environmental Change, 16(3), 253–267. doi:10.1016/j.gloenvcha.2006.04.002.

[19] Sivapalan, M., Savenije, H. H. G., & Blöschl, G. (2012). Socio-hydrology: A new science of people and water. Hydrological Processes, 26(8), 1270–1276. doi:10.1002/hyp.8426.

[20] Badham, J., Elsawah, S., Guillaume, J. H. A., Hamilton, S. H., Hunt, R. J., Jakeman, A. J., … Bammer, G. (2019). Effective modeling for Integrated Water Resource Management: A guide to contextual practices by phases and steps and future opportunities. Environmental Modelling & Software, 116, 40–56. doi:10.1016/j.envsoft.2019.02.013.

[21] Pahl-Wostl, C., Knieper, C., Lukat, E., Meergans, F., Schoderer, M., Schütze, N., Schweigatz, D., Dombrowsky, I., Lenschow, A., Stein, U., Thiel, A., Tröltzsch, J., & Vidaurre, R. (2020). Enhancing the capacity of water governance to deal with complex management challenges: A framework of analysis. Environmental Science and Policy, 107, 23–35. doi:10.1016/j.envsci.2020.02.011.

[22] Barbosa, M. C., Mushtaq, S., & Alam, K. (2017). Integrated water resources management: Are river basin committees in Brazil enabling effective stakeholder interaction? Environmental Science and Policy, 76, 1–11. doi:10.1016/j.envsci.2017.06.002.

[23] Jacobson, M., Meyer, F., Oia, I., Reddy, P., & Tropp, H. (2013). User's guide on assessing water governance. United Nations Development Programme: Stockholm, Sweden.

[24] Kumar, M. D., Batchelor, C., & James, A. J. (2019). Operationalizing IWRM concepts at the basin level: From theory to practice. From Catchment Management to Managing River Basins, 1, 299–329. doi:10.1016/b978-0-12-814851-8.00011-2.

[25] Ching, L., & Mukherjee, M. (2015). Managing the socio-ecology of very large rivers: Collective choice rules in IWRM narratives. Global Environmental Change, 34, 172–184. doi:10.1016/j.gloenvcha.2015.06.012.

[26] Leong, C. (2021). Narratives and water: A bibliometric review. Global Environmental Change, 68, 102267. doi:10.1016/j.gloenvcha.2021.102267.

[27] Anderson, A., Karar, E., & Farolfi, S. (2009). Synthesis: IWRM lessons for implementation. Water SA, 34(6), 665–670. doi:10.4314/wsa.v34i6.183667.

[28] Agarwal, A., delos Angeles, M. S., Bhatia, R., Chéret, I., Davila-Poblete, S., Falkenmark, M., ... & Wright, A. (2000). Integrated water resources management. Global Water Partnership/Swedish International Development Agency, Stockholm, Sweden.

[29] Savenije, H. H., & Van der Zaag, P. (2008). Integrated water resources management: Concepts and issues. Physics and Chemistry of the Earth, Parts A/B/C, 33(5), 290-297. doi:10.1016/j.pce.2008.02.003.

[30] Zaag, P. V. Der, & Savenije, H. H. G. (2012). Principles of Integrated Water Resources Management. Great Lakes, 165–165, 165–165. doi:10.1201/b13146-9.

[31] Apostolaki, S., Koundouri, P., & Pittis, N. (2019). Using a systemic approach to address the requirement for Integrated Water Resource Management within the Water Framework Directive. Science of the Total Environment, 679, 70–79. doi:10.1016/j.scitotenv.2019.05.077.

[32] Ojha, C. S. P., Surampalli, R. Y., & Bárdossy, A. (2017). Sustainable Water Resources Management. American Society of Civil Engineers. doi:10.1061/9780784414767

[33] Rahman, M. S., Mohiuddin, H., Kafy, A. Al, Sheel, P. K., & Di, L. (2019). Classification of cities in Bangladesh based on remote sensing derived spatial characteristics. Journal of Urban Management, 8(2), 206–224. doi:10.1016/j.jum.2018.12.001.

[34] Katusiime, J., & Schütt, B. (2020). Integrated water resources management approaches to improve water resources governance. Water (Switzerland), 12(12), 1–22. doi:10.3390/w12123424.

[35] Akhmadiyeva, Z., & Abdullaev, I. (2019). Water management paradigm shifts in the Caspian Sea region: Review and outlook. Journal of Hydrology, 568, 997–1006. doi:10.1016/j.jhydrol.2018.11.009.

[36] Collins, R., Johnson, D., Crilly, D., Rickard, A., Neal, L., Morse, A., Walker, M., Lear, R., Deasy, C., Paling, N., Anderton, S., Ryder, C., Bide, P., & Holt, A. (2020). Collaborative water management across England – An overview of the Catchment Based Approach. Environmental Science and Policy, 112, 117–125. doi:10.1016/j.envsci.2020.06.001.

[37] Ahmad, A. Y., & Al-Ghouti, M. A. (2020). Approaches to achieve sustainable use and management of groundwater resources in Qatar: A review. Groundwater for Sustainable Development, 11, 100367. doi:10.1016/j.gsd.2020.100367.

[38] Brown, A. R., Webber, J., Zonneveld, S., Carless, D., Jackson, B., Artioli, Y., Miller, P. I., Holmyard, J., Baker-Austin, C., Kershaw, S., Bateman, I. J., & Tyler, C. R. (2020). Stakeholder perspectives on the importance of water quality and other constraints for sustainable mariculture. Environmental Science and Policy, 114, 506–518. doi:10.1016/j.envsci.2020.09.018.

[39] Chang, I. S., Zhao, M., Chen, Y., Guo, X., Zhu, Y., Wu, J., & Yuan, T. (2020). Evaluation on the integrated water resources management in China's major cities -- Based on City Blueprint® Approach. Journal of Cleaner Production, 262, 121410. doi:10.1016/j.jclepro.2020.121410.

[40] He, C., Harden, C. P., & Liu, Y. (2020). Comparison of water resources management between China and the United States. Geography and Sustainability, 1(2), 98–108. doi:10.1016/j.geosus.2020.04.002.

[41] Hooper, B. (2015). Integrated River Basin Governance: Learning from International Experience. Water Intelligence Online, 4(0), 9781780402970–9781780402970. doi:10.2166/9781780402970.

[42] SDSN Secretariat. (2014). Framing Sustainable Development Goals, Targets, and Indicators. Sustainable Development Solutions Network. Available online: https://resources.unsdsn.org/framing-sustainable-development-goals-targets-and-indicators. (accessed on May 2021).

[43] United Nations: UN Water. (2019). Indicator 6.5.1 "Degree of integrated water resources management implementation (0-100)". Available online: https://www.sdg6monitoring.org/indicator-651/ (accessed on May 2021).

[44] Cayabo Jr., G. D. B., O., D. M., Bacosa, J. A. M.-O., & P, H. (2021). Bacteriological assessment of the recreational water of Bacuit Bay, El Nido, Palawan, Philippines. Palawan Scientist, Western Philippines University, 13(1), 44–58.

[45] Hermanito Consad II. (2015). Supply & Quality of Drinking Water & Prevalence of Waterborne Diseases in Selected Barangays of Puerto Princesa , Palawan , Philippines, International Conference of Higher Education Research Forum, Manila, Philippines.

[46] United Nations Environment Programme (UNEP). Country Questionnaire for Indicator 6.5.1: ENG_6_5_1_Questionnaire. Available online: https://www.gwp.org/globalassets/global/gwp-sas_images/gwp-sas-in-action/sdg/country-questionnaire-for-indicator-6.5.1.pdf (accessed on November 2021).

[47] Gonzales, B. J. (2004). Puerto Princesa Bay and Honda Bay, Palawan: An Ecological Profile. Fisheries Resource Management Project.

[48] Puerto Princesa City Government. (2019). Water Resources. Available online: http://puertoprincesa.ph/?q=about-our-city/water-resources. (accessed on September 2021).

[49] Habeeb, N. J., & Weli, S. T. (2021). Combination of GIS with Different Technologies for Water Quality: An Overview. HighTech and Innovation Journal, 2(3), 262–272. doi:10.28991/hij-2021-02-03-10.

[50] Fabro, K. A. (2018). DENR wants tests done on El Nido drinking water. Available online: https://www.pressreader.com/philippines/palawan-news/20180603/281694025463543 (accessed on September 2021).

[51] Anda, R. (2018). El Nido waters clean, tests show. Available online: https://newsinfo.inquirer.net/1053453/el-nido-waters-clean-tests-show (accessed on September 2021).

[52] Pacific Consultants International. (2006). Report: Environmentally Critical Areas Network (ECAN) Zones Management Plan for El Nido Municipality, Palawan, Philippines.

[53] Frank Joe Mojica, & Flornita Nangit Ferrer. (2018). The Profile of Umalad Watershed in Roxas, Palawan. Journal of Agricultural Science and Technology A, 8(4), 195–202. doi:10.17265/2161-6256/2018.04.002.

[54] Roxas Palawan: Philippines (2018). World Heritage Encyclopedia. Available online: http://www.worldheritage.org/articles/eng/Roxas,_Palawan (accessed on September 2021).

[55] Chinee Palatino, ABS-CBN News, (2016). Palawan town residents complain of rusty, salty water supply. Available online: https://news.abs-cbn.com/nation/regions/05/27/16/palawan-town-residents-complain-of-rusty-salty-water-supply (accessed on September 2021).

[56] Environmental Resource Planning. (2015). Municipality of Taytay ECAN Resource Management Plan 2015-2020, Municipality of Taytay in the province of Palawan, Philippines. Available online: https://pcsd.gov.ph/wp-content/uploads/2020/12/2-Municipality-of-Taytay-ECAN-Resource-Management-Plan-2015-2020.pdf (accessed on May 2021).

[57] United Nations Environment Programme (UNEP). (2018). ENG_Step_by_step_methodology_6_5_1. Available online: https://unwater.org/app/uploads/2017/05/1_Step-by-step-methodology-6-5-1_Revision-2017-01-17_Final-1.pdf (accessed on September 2021).

[58] Ait-Kadi, M. (2016). Water for Development and Development for Water: Realizing the Sustainable Development Goals (SDGs) Vision. Aquatic Procedia, 6, 106–110. doi:10.1016/j.aqpro.2016.06.013.

[59] Shah, T. (2016). Increasing water security: the key to implementing the Sustainable Development Goals. Global Water Partnership (GWP) TEC Background Papers No. 22, 1-56.

[60] Rola, A. C., Pulhin, J. M., Tabios, G. Q., Lizada, J. C., & Dayo, M. H. F. (2015). Challenges of water governance in the Philippines. Philippine Journal of Science, 144(2), 197–208.

Appendix I: Sample Portion of the Questionnaire Showing the Rating Based on the Degree of IWRM Implementation

Information about the IWRM Degree of implementation:

The questionnaire contains four sections, each covering a key component of IWRM:

1. **Enabling Environment:** Creating the conditions that help to support the implementation of IWRM, which includes the most typical policy, legal and strategic planning tools for IWRM.
2. **Institutions and Participation:** The range and roles of political, social, economic and administrative institutions and other stakeholder groups that help to support the implementation of IWRM.
3. **Management Instruments:** The tools and activities that enable decision-makers and users to make rational and informed choices between alternative actions.
4. **Financing:** Budgeting and financing made available and used for water resources development and management from various sources.

Each section has two sub-sections covering the "National" and "Other" levels. Various levels are covered to address the target 6.5 wording "… at all levels." "Other" levels include sub-national, basin, local and transboundary. Questions relate to these levels depending on their relevance to the particular aspect of IWRM.

A.1. Enabling Environment

This section covers the enabling environment, which is about creating the conditions that help to support the implementation of IWRM. It includes the most typical policy, legal and planning tools for IWRM. Please check (✓) and rate based on the degree of implementation of IWRM on the given statements using the following scales:

0 – Very low 20 – Low 40 – Medium Low 60 – Medium-high 80 – High 100 – Very high

1.1 ***What is the status of policies, laws and plans to support Integrated Water Resources Management (IWRM) at the national level?***						
	Very low (0)	Low (20)	Medium-low (40)	Medium-high (60)	High (80)	Very high (100)
a. National water resources policy, or similar						
b. National water resources law(s)						
c. National integrated water resources management (IWRM) plans, or similar						
1.2 ***What is the status of policies, laws and plans to support IWRM at sub-national levels?***						
a. Sub-national water resources policies or similar						
b. Basin/aquifer management plans or similar, based on IWRM						
c. Arrangements for transboundary water management in most important basins / aquifers						