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The Role of IWRM in Achieving Water Security: An Empirical Study in Khenchela Province (Algeria) Stations of Water Distribution and Treatment

دور الإدارة المتكاملة للمياه في تحقيق الأمن المائي

دراسة تجريبية في محطات توزيع ومعالجة المياه لولاية خنشلة (الجزائر).

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Abstract :

This study hypothesizes a causal relationship between the key elements of IWRM and water security.

The results show three positive significant relationships, between economic efficiency, social equality, environmental sustainability and water security.

Keywords : IWRM, Economic Efficiency, Social Equality, Environmental Sustainability, Water Security.

ملخص :

تهدف هذه الدراسة إلى تحديد العلاقة بين تطبيق منهج الإدارة المتكاملة لموارد المياه وتحقيق الأمن المائي.

أظهرت النتائج ثلاث علاقات موجبة ومعنوية بين الكفاءة الاقتصادية، المساواة الاجتماعية، الاستدامة البيئية والأمن المائي.

الكلمات المفتاحية: إدارة متكاملة لموارد المياه، كفاءة اقتصادية، مساواة اجتماعية، استدامة بيئية، أمن مائي.

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1. Introduction :

The basis of integrated water resources management (IWRM) was emerged at the beginning of the 20-th century in the process of establishing the frameworks for water resources management developed in some countries of Europe and other continents (Dukhovny & Sokolove, 2005,p: 6-15).

Following the international conference on water and the environment, organized by the water sector in Dublin, Ireland, 26-31 January 1992. The conference attracted 500 water experts from different countries and 80 international organizations. They came up with a working model for sustainable development, which considered as an approach of integrated water management (Snellen &Schrevel, 2004, p: 6-10). The keynote paper entitled "water and sustainable development" by Koudstaal, Rijsberman & Savanije prepared for this conference, contains almost all of the characteristics of IWRM as it is seen today.

Based on Dublin conference guiding principles, several studies have referred to the necessity of implementation of IWRM (Dukhovny &Sokolov, 2005; snellen&schrevel, 2004; Global Water Partnership, 2005; Humberto, 2011). The IWRM performance evaluation can divide into three aspects: social performance, economic performance and ecological environmental performance (Wenxin, 2016, p: 189).

2. Research Problem:

According to the Status Report on the Implementation of IWRM in the Arab Region, Algeria classified as a medium-low degree of IWRM implementation with Egypt, Libya, Yemen, Mauritania and Sudan. While, Tunisia and Morocco achieved a medium- high degree. At the same time, Arab countries like United Arab Emirates, Kuwait and Qatar achieved a high degree (UNESCWA, 2019, p: 3-80).Therefore; this study aims to identify empirically the score of IWRM implementation in Khenchela province from the view of a sample of employees in stations of water distribution and treatment and explore its relation with water security.

Based on the above discussion, the main question of this study can be formulated as follows:

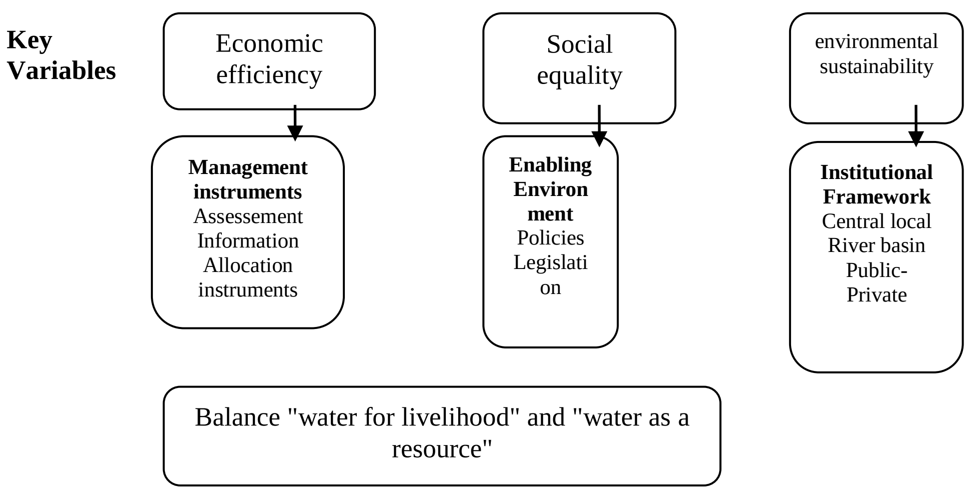
Is there a relationship between IWRM and water security at the stations of water distribution and treatment in Khenchela province?

The rest of this paper organized as follows: (1) Theoretical background, (2) Hypothesis development, (3) Methods, (4) Results and discussion, and finally (5) Conclusion and implications.

3- Theoretical Background:

According to the most authoritative ideologists and authors, IWRM is the process of coordinated development and management of water resources. This process based on the four Dublin guiding principles which are :(Moriarty & others, 2004, p: 5-12) (1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. (2)Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. (3)Women play a central part in the provision, management and safeguarding of water. (4) Water has an economic value in all its competing uses and should be recognized as an economic good. Therefore, the Global Water Partnership was established to foster IWRM, and defined it as "a process which promotes coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Setegn& Donoso, 2015, p: 73). The United States Agency for International Development has proposed another definition of IWRM as follows “IWRM is a participatory planning and implementation process, based on sound science, which brings stakeholders to determine how to meet society’s long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits” (Mei, 2006, p: 4). The two previous definitions consolidate two broad conceptual bases, namely, “integration” and “sustainability”. Integration is one of the interpretations of the holistic approach, which is suitable for water resource management, because of the high number of interrelationships between water resources, and land based activities. The concept “sustainability” refers to intra-generation fairness with the triangle – key elements “Ecology – Economy – Social equality” formulated during the United Nations Conference on Environment and Development in Rio de Janeiro 1992. The three key elements should initially have the same priority to conserve the basic needs of life, to enable all people to achieve economic prosperity, and to strive towards social equality (Kasbohm & Nguyen, 2009, p: 3). In the same context, Zaag &Savenije add that the three key policy principles are known as the three 'E' (1) equality, (2) ecological integrity, and (3) economic efficiency. From this point of view, improving Equitable and sustainable utilization of water is a pillar to achieve social environmental justice and economic benefit for present and future generations. However, IWRM is still an evolving concept and the three key concepts present a definition of IWRM. Figure 1 shows the components of IWRM.

Figure 1. The Three Pillars of IWRM, an Enabling Environment, an Institutional Framework and Management Instruments



Source: Hassing, J. & Ipsen, N., (2009), p: 4.

4. Hypothesis Development:

The Global Water Partnership (2000) defined water security as “ at any level from the household to the global, means that every person has access to enough safe water at affordable cost to lead a clean, healthy, and productive life, while ensuring that the natural environment is protected and enhanced”. Furthermore, the Global Water Partnership (2012) suggests that water security may be the larger goal and IWRM could be seen as a path to ultimately achieving water security. After, in 2014, the Global Water Partnership broadened its vision to achieve water security by focusing on IWRM as a means for increasing water security (Van Beek &Arriens, 2014, p: 18).Shah (2016) noted that over the past 25 years IWRM has emerged as an alternative approach for communities and societies seeking to increase their water security. Apparently, the objective of IWRM and water security is the same; it is the improvement of life quality for everyone (Shah, 2016, p: 14).

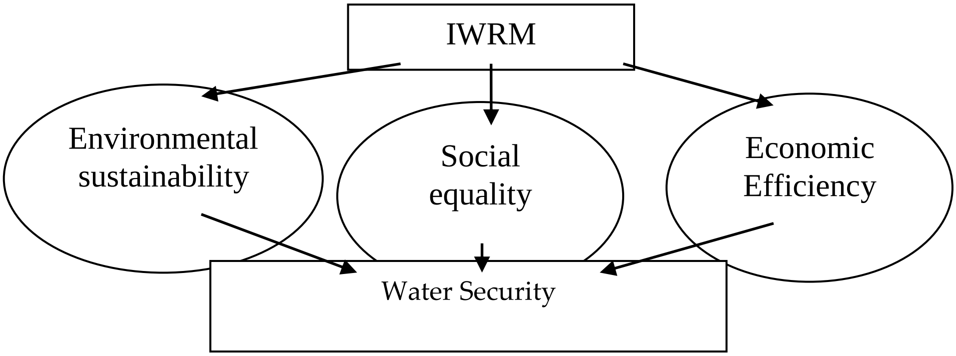
Grey & Sadoff (2007) defined water security as "The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production, coupled with an acceptable level of water-related risks to people, environments, and economies". While, Van Beek & Arriens (2014) indicate that the concept of water security is closely aligned to IWRM as all its principles, particularly the idea of integration, are embedded in the concept of water security. Van Beek & Arriens stated that Water security has three key dimensions – social equality, environmental sustainability, and economic efficiency –. Furthermore, they indicate that IWRM will help to improve water security depending on the amount and quality of effort and resources invested in. Thus, IWRM and water security are symbiotic and this leads to the continuous IWRM planning cycle**.**

According to the previous literature, it is clear that there is consensus on the relationship between IWRM and water security. Thus, the hypotheses of this study can be formulated as follows:

H_1: The Holistic Approach Of IWRM Concept Can Achieve Water Security.
H_{1a}: the first key of IWRM (Economic Efficiency) effect positively water security.
H_{1b}: the second key of IWRM (social equality) effect positively water security.
H_{1c}: the third key of IWRM (environmental sustainability) effect positively water security.

Figure 2 displays the research model based on the discussion above.

Figure 2. The research model



5. Methods:

5.1. Data Collection :

Data for this study collected using a personal survey at one point in time. For this reason, we used a Cross-Sectional survey, which is appropriate to the characteristics of this study (Owens, 2002). Questioners were distributed on a sample of 70 (n=70) employees working at stations of water distribution and treatment in Khenchela province (Algeria). The data collected represent a large population consists of administrators, technicians and engineers. The number of observations is suitable for statistical analysis by SPSS (Walker, 2008, p: 152).

Table 01 summarizes the number of items by key elements in the study questionnaire.

Table 1. Questionnaire items

N°	Key elements	No. of items
1	IWRM	9
	Economic efficiency	3
	Social equality	3
	environmental sustainability	3
2	Water Security	10
	Economic efficiency	3
	Social equality	3
	Environnemental sustainability	4

5.2. Respondent's Profile:

Table 2 contains the main features of the respondents, such as gender, Age, experience and Qualifications. The water stations have different categories of employees; most of them are male (71.4%).High proportion of employee's assigned technical tasks. The Age category 45-36 represent the high proportion (47.1%) of employees, While, (90%) of them have experience less than10 years.

Table2: Profile of the respondents (n=70)

Profile variables	category	Frequency	Percentage%
Gender	Male	50	71.4
	female	20	28.6
Age (years)	35-25	21	30
	45-36	33	47.1
	>45	16	22.9
Qualification	Administrators	30	42.9
	Technicians	36	51.4
	engineers	4	5.7
Experience	<5	19	42.9
	5-10	33	47.1
	>10	18	25.7

5.3. Validity and Reliability:

The questionnaire consists of 19 items; 5-point Likert-type response scale which ranges from strongly disagree (1) to strongly agree (5) has been used. To test validity and reliability of items, Cronbach's alpha coefficient has been selected. Alpha is one of the most widely used measures of reliability in the social and organizational sciences (Bonnet &WRIGHT, 2014, p: 1-6).Warrens, 2014 indicates that Alpha coefficient is an estimate of the reliability if the items of the test are essentially tau-equivalent. The items of a test can be split into two parts. For each part, the sum score of the items can be determined. If we apply Cronbach's alpha to the two sum scores, we obtain the Flanagan-Rulon split-half estimate of the reliability. In this study we split the items into two parts, the first one is IWRM and the second is water security. The coefficient of reliability falls between 0 and 1, with perfect reliability equaling 1, and no reliability equaling 0. For high-stakes settings reliability should be greater than 0.9, whereas for less important situations values of 0.8 or 0.7 may be acceptable (Haradhan, 2017; Ritter, 2010).

The result refers to the Composite Reliability and scores of all constructs (IWRM=0.729; water security= 0.721) which considered acceptable values. As for the validity, the result refers to (IWRM= 0.729; water security= 0.713) which also considered acceptable values (Haradhan, 2017, p: 58).

6. Results and Discussion :

Tables (3, 4, and 5) display the mean and standard deviation (S.D) of the first part of the questionnaire (IWRM).

Table 3 shows the mean and S.D values for “economic efficiency” items and its order depending on the approval degree. The mean of the item number 3 is the highest value (mean= 4.17; S.D= 0.58), so it came in the fifth order. The item number 2 comes forth (mean= 3.87; S.D= 0.70), the item number 1 comes third (mean= 3.84).

Table 3: Mean and S.D values for “economic efficiency”

N	items	Mean	S.D	order
1	The station is interested in improving the provided services and adopting periodic training programs for its employees.	3.84	0.91	5
2	The station seeks to reduce input costs	3.87	0.70	4
3	The station is interested in providing Services that meet client's needs.	4.17	0.58	3

Table 4 shows the mean and standard deviation values for “social equality” items and its order depending on the approval degree. The mean of the item number 5 is the highest value (mean= 3.51; S.D= 0.88), therefore, it came in the sixth order. Then, item number 6 came in seventh order because their (mean= 3.21; S.D= 0.79). While, the item number 4 with (mean=3.01; S.D= 1.04) came in the eighth order.

Table 4: Mean and S.D values for “Social Equality”

N	Items	Mean	S.D	Order
4	There is equality in the distribution of water between urban and rural areas	3.01	1.04	8
5	There is equal distribution of water between limited, medium and high-income clients	3.51	0.88	6
6	There is equal distribution of water between household, agricultural and industrial sectors.	3.21	0.79	7

Table 5 illustrates mean and standard deviation values for “environmental sustainability” items and its order. The mean of the item number 9 is the highest (mean= 4.27; S.D= 0.44), thus, it came in first order. The item number 7 came in second order with a (mean= 4.24; S.D= 0.60). While, item number 8 has the third order with (mean=4.17; S.D= 0.41). It can be concluded that environmental sustainability items are first-ranked, followed by social equality items then Economic efficiency items.

Table 5: Mean and S.D values for “environmental sustainability”

N	Items	Mean	S.D	Order
7	water distribution tubes are maintained And monitored periodically to reduce leakage	4.24	0.60	2
8	The station is committed to implement water project sand manage it in efficient manner to increase water sources	4.17	0.41	3
9	The station implement preventive measures to ensure that freshwater is not contaminated	4.27	0.44	1

Table 6 displays the mean and standard deviation values for "water security" items and its order depending on the degree of approval.

Table 6: Mean and S.D values for "water security"

N	Items	Mean	S.D	Order
1	The station seeks to reduce the cost of potable water	3.55	1.01	5
2	The station seeks to benefit from positive international experiences in IWRM through partnership agreement	2.62	0.96	9
3	Dams and reservoirs are built for water storage and collection and according to international standards.	3.90	0.51	2
4	potable fresh water is distributed to the entire population, both in urban and rural areas, on a regular basis.	2.92	1.04	8
5	the organization provides water for all neighborhoods in the state	3.30	1.08	7
6	There is complete discipline at water distribution times.	3.51	0.89	6
7	Water is treated with advanced biological techniques to improve water taste and drain from bacteria.	3.98	0.64	1
8	The organization applies modern technology in water treatment and purification and desalination.	3.81	0.76	4
9	The organization applies sewage recycling.	1.80	0.73	10

The mean of the water security construct is ranged from 3,98 to 1,80 the item number 7 comes first order as the much approved one. From the degree of approval of each item mentioned in table 6, it can be conclude that the station took in consideration environmental sustainability at first order then economic efficiency. Hence, there is lack of attention to the social equality aspect of water distribution.
To confirm the previous results, the correlation coefficient *r* for the study variables is calculated. An absolute value for *r* ranged from 0.1 to 0.3 is classified as small; while, a value between 0.3 and 0.5 is classified as medium and of 0.5 or more is classified as large (Samuels, 2014, p: 1-5;Sedgwick, 2012).

Table7 shows Pearson's correlation coefficient *r* for the study variables. The correlation coefficient between economic efficiency and water security is medium and positive (*r*=0.322), p-value (sig=0.00) which is lower than the level of significance 0.05.Therefore, the null hypothesis will be rejected and the alternative hypothesis will be accepted. Thus, there is a statistically significant relationship between economic efficiency and water security.

The correlation coefficient between social Equality and water security is small and positive (*r*=0.165), p-value (sig=0.00) which is lower than the level of significance 0.05.Therefore, the null hypothesis will be rejected and the alternative hypothesis will be accepted. Thus, there is a statistically significant relationship between social Equality and water security.

The correlation coefficient between Environmental sustainability and water security is large and positive (*r*=0.165), p-value (sig=0.00) which is lower than the level of significance 0.05.Therefore, the null hypothesis will be rejected and the alternative hypothesis will be accepted. Thus, there is a statistically significant relationship between Environmental sustainability and water security.

Table7: Correlation coefficient between IWRM constructs and water security

IWRM constructs	Water Security	
	r	Sig
Economic efficiency	0.322	0.00
Social equality	0.165	0.00
Environmental sustainability	0.625	0.00

To confirm the above results a pooled test is used as "Analysis of Variance" (ANOVA), which is applicable when the aim is to infer differences in group values when there is one dependent variable and more than two groups, such as one independent variable with three or more levels, or when there are two or more independent variables (Sawyer, 2009). Therefore, the ANOVA test is suitable for this study, one-way ANOVA were specifically used to determine whether there are any statistically significant differences between the means of two or more independent groups (Clayton, 2017, p: 2).

Table 8 displays the results of ANOVA test for this study. Larger F value implies that means of the groups are greatly different from each other compared to the variation of the individual observations in each groups. Therefore, the null hypothesis is rejected, since; the group means are not the same, and supports that at least one group mean differs from other group means (Hae, 2014, p: 2).

Table 8 shows that the calculated F of IWRM (0.995) and water security (1.063) are larger than the tabulated F (0.278, 0.311),which leads to reject the null hypothesisH_0, and accept the alternative hypothesis (Holistic Approach of IWRM Concept Can Achieve Water Security).The calculated F of economic efficiency (0.489) is larger than the tabulated F(0.066) which leads to reject the null hypothesisH_{0a}, and accepts the alternative hypothesis H_{1a} (The first key of IWRM "Economic Efficiency" can achieve water security). The calculated F of social equality (0.482) is larger than the tabulated F (0.143), so, the null hypothesis H_{0b} is rejected and the alternative hypothesis H_{1b} is accepted (The second key of IWRM "social equality" can achieve water security). The calculated F of Environmental sustainability (0.506) is larger than the tabulated F (0.452) which leads to reject the null hypothesisH_{0c}, and accepts the alternative hypothesis H_{1c} (The third key of IWRM "Environmental sustainability" can achieve water security).

Table 8: ANOVA table

Source of Variance	Sum of squares (ss)	Eta-squared (η2)	degrees of freedom (df)	Mean squares (MS)	t-test	F Calculated	F Tabulated (Sig)	Decision
Between groups								
(IWRM)	4.00	0.229	4	2.00	1.746	0.995	0.278	rejection of the null hypothesis
Water security		0.229	5	4.50	1.783	1.063	0.311	rejection of the null hypothesis
Within groups								
Social Equality		0.224	3	4.00	0.986	0.482	0.143	rejection of the null hypothesis
Economic efficiency		0.227	3	6.00	0.945	0.489	0.066	rejection of the null hypothesis
Environmental sustainability		0.226	2	6.57	0.897	0.506	0.452	rejection of the null hypothesis

CONCLUSION:

The main objective of this study is to determine the nature of the relationship between IWRM and water security within the stations of water distribution and treatment in Khenchela province, Algeria. The results indicate that there is a statistically significant correlation between IWRM constructs and water security. Furthermore, there is a large correlation between Environmental sustainability and water security; this approves the increased interest in the ecological aspect. While, there is a small correlation between social equality and water security; this requires more social consideration in order to achieve equal access to water for all groups of society and all regions.

In addition, it was found that there is a medium correlation between economic efficiency and water security, therefore the cost of water must be reconsidered to be appropriate for the entire population.

The Implications of this study are practical. The water distribution and treatment stations in Khenchela province should put in place more effective measures to achieve water security especially in the social and economic side.

This study have some limitations related to the used methodology (ANOVA analysis), which conceder as a first generation method, while second generation could give more interesting results. Using second-generation ANOVA analysis requires a large sample which is not available in this study due to the limited area targeted at the beginning of the study (Khenchela province).

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