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YOUTH AND WATER SECURITY IN AFRICA

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INTRODUCTION

Achieving water security is one the greatest challenges of our time particularly during the current global pandemic. 2.2 billion people lack access to safely managed drinking water services while 4.2 billion are without safe sanitation services and three billion lack basic handwashing facilities[1]. In Sub-Saharan Africa, only 24% of the population have access to safe drinking water, and 28% have basic sanitation facilities that are not shared with other households[2]. Africa is at the Centre of the world's global challenges and one of UNESCO's global priorities. UNESCO is devoted to engaging with young women and men (under 35) as knowledge holders and innovators and committed to building a future generation of leaders who recognizes the importance of harnessing the power of science for society and policy. The organization is also building a culture of science in which youth and experts use research to address global and local challenges.

Within this context, UNESCO in partnership with the International Science Council Regional Office for Africa (ISC ROA) and the African Ministers' Council on Water (AMCOW) issued a call for extended abstracts on Youth and Water Security in Africa in May 2020 with the hope that young women and men (under 35) and experts worldwide would be motivated to collaborate and curious to use science to address knowledge gaps on water security issues in Africa as well as explore its impact on the youth. Submissions were requested from youth and young researchers as authors or co-authors of articles addressing at least one of the sub-themes with a focus on Africa: Water-related Disasters and Hydrological Changes; Groundwater in a Changing Environment; Addressing Water Scarcity and Quality; Water and Human Settlements of the Future; Ecohydrology, Engineering Harmony for a Sustainable World and Water Education and Key to Water Security.

Overall, 119 extended abstracts were received globally, mainly from Africa, the Arab States and Europe. The youngest author is 17 years old and the youngest co-author is 13. Following a rigorous peer-review process with the involvement of relevant UNESCO, ISC ROA and AMCOW Programme Staff and Partners, 50 extended abstracts were shortlisted and included in this online booklet of abstracts. This booklet was prepared with the objective of encouraging the use of knowledge generated by youth to improve policy processes and governance in the water sector where possible and inspire youth to become more involved in the co-production and application of knowledge.

The authors of the top 50 abstracts were invited to submit complete manuscripts and the top 25 manuscripts will be included in a UNESCO Special Publication on Youth and Water Security. Additionally, the authors of the top 50 extended abstracts were invited to participate in an online writers' workshop in scientific writing on 30 October 2020.

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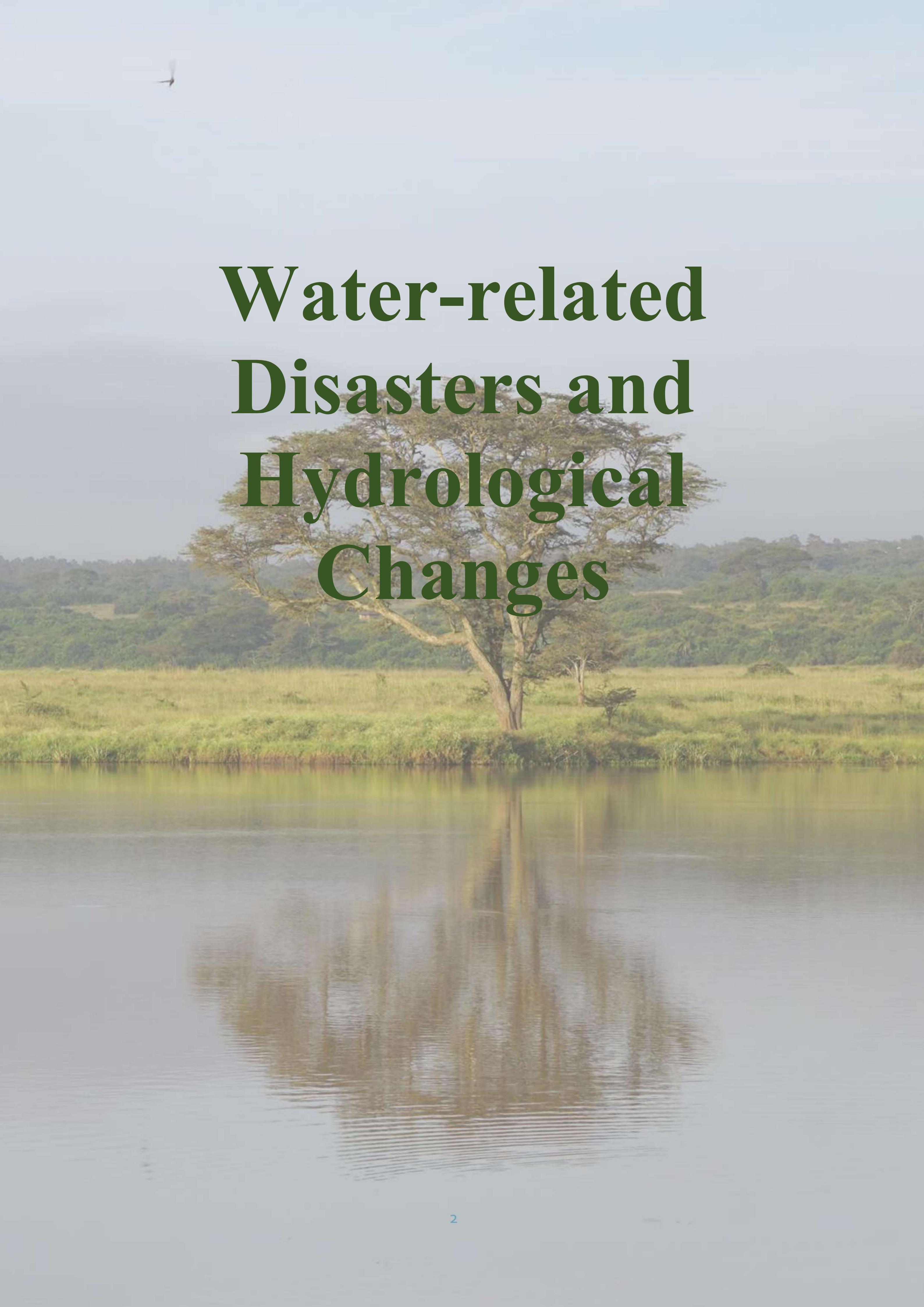
[1](2019) WHO and UNICEF launch updated estimates for water, sanitation and hygiene https://www.unwater.org/who-and-unicef-launch-updated-estimates-for-water-sanitation-and-hygiene/ (viewed 12.12.2020)

[2] UNESCO Publication on behalf of UN Water Launch of the United Nations World Water Development Report on 19 Marchhttps://en.unesco.org/news/billions-deprived-right-water 5viewed on (17.12.2020)



Water-related Disasters and Hydrological Changes

Ecohydrology, Engineering Harmony for a Sustainable World

1. Assessment of Citizen's Measurements Using Test Strips for Water Quality in Medjerda Watershed (Northern Tunisia)

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ABBREVIATIONS

CS	Citizen Science
PCC	Pearson Correlation Coefficient
SDG 6	Sustainable Development Goals 6
UN	United Nation
WQM	Water Quality Monitoring
WQS	Water Quality test Strips

INTRODUCTION

Water resources in Africa are subjected to many pressures related to urban growth and agricultural expansion which will be exacerbated by climate change (Bahri et al., 2016). These pressures jeopardise achieving the UN-Sustainable Development Goal 6 (SDG6). Efficient monitoring of water systems is pivotal for designing efficient water management strategies that alleviates aforementioned pressures (Mutambara et al., 2016). Yet, the water monitoring capacity in Africa is often very poor, in particular for Water Quality Monitoring (WQM). Citizen Science (CS) based WQM is considered as an innovative approach to strengthen the WQM capacity (Fehri et al., 2020; Njue et al., 2019; Jollymore et al., 2017). The concept of CS is based on the potential social benefits of engaging, collaborating and actively involving citizens in data collection and knowledge generation. Yet, the quality of CS-based WQM is different as compared to reference WQM. Water quality test strips (WQS) programs need therefore to be thoroughly validated. The objective of this study is to validate the use of the strip test as a low-cost yet reliable tool to evaluate water quality through nitrate content, total alkalinity and sodium chloride as CS-based WQM program for the Medjerda River in Tunisia. We engaged citizens in the observation process in order to assess the reliability of the technique when used by everyday citizens, which could suggest promising opportunities for public engagement in generating water quality data.

LITERATURE REVIEW

Over the last decade, numerous analytical methods have been successfully developed for WQM. Besides measurements made gravimetrically and by titrimetry, advanced instrumental methods including high performance liquid chromatography, atomic absorption spectrometry, and electrochemistry have been used for water quality analysis. These analytical techniques showed advantages of high sensitivity and accuracy, but they also showed limitations such as the need for expensive and complex pre-treatment process and highly qualified technical personnel (Cummings, 2010). WQS for on-site WQM have been widely used as an alternative in assessing water quality. WQS for WQM programs have short response time, are easy operational, have a low bio-toxicity, and a low-cost (Forest et al., 2006). WQS have been used to analyse various species of free chlorine, hydrogen sulfide and formaldehyde (Arsawiset and Teepoo, 2020), tetracycline antibiotics (Li et al., 2019), Hg (II) ions (Lan et al., 2018), Zn (II) ions (Takahashi, 2014), microcystins (Humpage et al., 2012), hypochlorite (Ballesta Claver et al., 2004), hardness (Capitán-Vallvey et al., 2003) and microorganisms (Martins et al., 1997). The reliability of WQS for WQM were assessed against laboratory-based standard methods (Naigaga et al., 2016, Mosley and Donald, 2005, Bischoff et al., 1996). However, test strips lack selectivity of detection due to the random diffusion of chromogenic reagents on the detection zone in the presence of common interfering agents (Evans et al., 2014). Given the stability and the highly portable format of WQS, they could be easily used by everyday citizens in the framework of CS based WQM (Gagnon et al., 2007). Yet, Capdevila et al., (2020) identified attributes of citizens, attributes of institutions and the interactions between citizens and institutions as additional factors determining the success of a CS-based WQM program.

METHODOLOGY

The quality of a CS-based WQM program based on WQS for the Medjerda River in Northern Tunisia (Figure. 1) was assessed. The study focused on total alkalinity, nitrate and sodium chloride content. Three citizens participated in the program. A short training was organized to ensure a good reliability of the test strips readings. Overall 96 samples were collected for water quality monitoring along 12 sampling sites on the Medjerda River. The site selection was based on the location of the volunteers and the accessibility to reference WQM stations. The main characteristics of the sampling sites are summarized in Table 1. WQM tests for wet (January-March 2020) and dry (June-July 2020) periods were performed by standard laboratory techniques titration and molecular absorption spectrometry (Rodier et al., 2009) and by test strips. The test strips were immersed for 1-second in the sampled water, then shaken- to remove the excess water. After waiting for 1 minute, the colors of the strips were compared with the color scale (Figure 2). Regression analysis, based on Pearson Correlation Coefficient (PCC), coefficient of determination (R^2), F test, and Cronbach's alpha (α_c) test were performed to statistically assess the difference between the citizens' dataset and the standard values.

FINDINGS & CONCLUSION

The results showed that sodium chloride-sensitive, test strips were the most reliable for measuring a wide range concentration (0-7510 ppm). Nitrates-sensitive test strips were moderately reliable in the 0-25 ppm range. Total alkalinity-sensitive test strips were less reliable in 3-20 °f range concentration measuring. The validity of the test strips may be affected by the relatively low level of nitrate concentrations (0-25 ppm). The highest agreement between test strips and the standard method (PCC (0.962), R^2 (0.926), and α_c (0.982)) was obtained for measuring sodium chloride (Table 2). There was also a good agreement between the citizen-based outcomes WQS and the analytical methods for the three citizens. Nevertheless, the reliability depends on the citizen and the parameter to be tested (Table 3). The rapid and simple measurements using the test strips appear suitable to be used by citizens for surface WQM of the Medjerda River if they are correctly used and the instructions strictly followed. With a more consistent training, the test strips should allow for a reliable, sensitive and precise monitoring of water quality. Results show good agreement between observations obtained from standard techniques and test strips. The observation collected by the three citizens yield acceptable outcomes, which proves that the test strips could indeed be used by non-scientists depending on consistent training and support. A larger group of citizens, from different generation and educational levels, will be engaged in the monitoring process before implementing a regional program of water quality assessment based on CS and low-cost technologies.

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DISCLOSURES

Authors received funding from the project 'Smart Medjerda', partnership between ESIM, UC Louvain, and CERTE, from the "Wallonie Bruxelles International (WBI)" and Tunisia Joint Commission 2019-2023.

APPENDICES

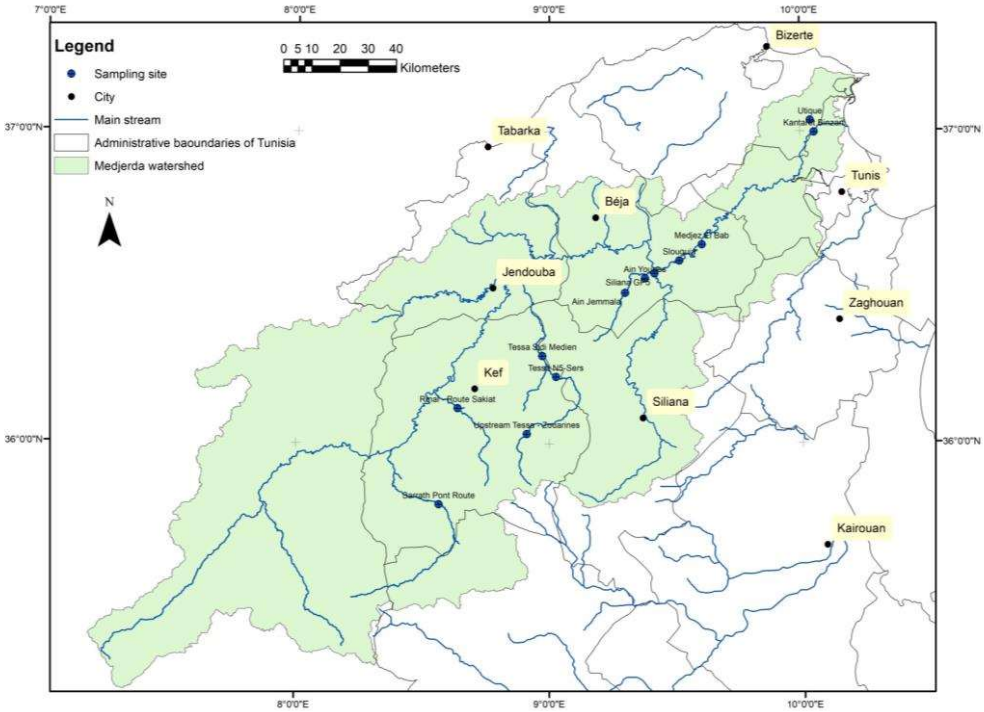

Figure 1: The study area indicating sampling sites in the mainstream of Medjerda watershed

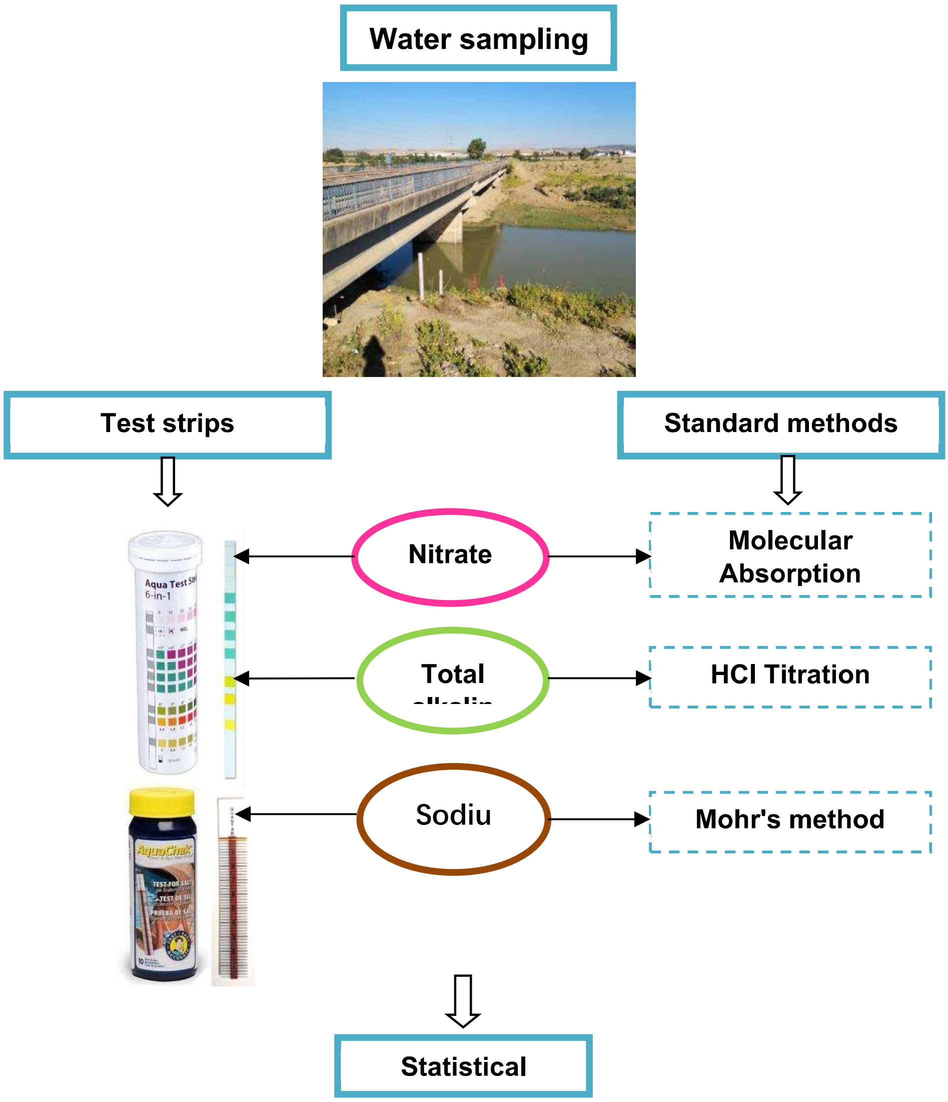

Figure 2: Methodology flowchart for test strips reliability

Table 1: Main characteristics of the sampling sites

Name	Geographic coordinates		Altitude (m asl)	Sub-watershed
	Latitude	Longitude		
Utique	37 °2'8.16"	10 °2'29.52"	28	Medjerda downstream
Kantaret Binzart	36 °59'50.54"	10 °3'22.16"	21	Medjerda downstream
Medjez El Bab	36 °38'19.32"	9 °36'26.13"	46	Medjerda Mid Valley
Slouguia	36 °38'19.32"	9 °31'26.14"	55	Medjerda Mid Valley
Siliana GP5	36 °32'45.96"	9 °25'4.45"	75	Siliana
Ain Younes	36 °31'14.28"	9 °31'0.76"	133	Khalled (spring)
Ain Jemmala	36 °29'3.12"	9 °18'4.86"	239	Khalled
Tessa Sidi Medien	36 °16'54.12"	8 °58'22.42"	299	Tessa
Tessa N5-Sers	36 °12'52.92"	9 °1'38.94"	567	Tessa
Upstream Tessa -Zouarines	36 °1'53.04"	8 °54'41.99"	657	Tessa
Rmal - Route Sakiat	36 °38'19.73"	8 °38'19.73"	357	Mellegue
Sarrath Pont Route	35 °48'20.16"	8 °33'55.65"	576	Mellegue

Table 2: Results of statistical analyses testing reliability of test strips

Parameter	Cronbach's alpha	F test	Prob	R^2	PCC	Equation
Total alkalinity	0.918	2292.60	0.000	0.694	0.833	$x=0.950y+1.000$
Nitrate	0.931	238.49	0.000	0.750	0.866	$x=0.940y-1.162$
Sodium chloride	0.982	1187.41	0.000	0.926	0.962	$x=0.970y+503.834$

Table 3: Comparison of the average and standard deviation of total alkalinity, nitrates and chlorides among three citizens (numbers between parentheses indicate the number of collected observations for each citizen)

Parameter		Citizen 1 (33)		Citizen 2 (31)		Citizen 3 (32)	
		Test Strips	Standard	Test Strips	Standard	Test Strips	Standard
Total alkalinity (°f)	Average	10.90	11.20	12.88	11.52	12.53	12.13
	Standard deviation	3.35	4.66	2.79	1.94	3.36	3.22
Nitrate (ppm)	Average	7.34	10.40	7.57	8.17	4.49	5.28
	Standard deviation	9.60	9.27	7.62	8.49	7.80	7.44
Sodium choride (ppm)	Average	1088.67	1263.56	2754.86	3475.07	3767.29	2897.70
	Standard deviation	813.33	912.34	2360.91	3006.36	3511.78	2673.44

KEYWORDS: Citizen Science; Water Quality Monitoring; Test Strips; Medjerda River; Tunisia