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Evaluating the Behaviour of Good Governance on Enhancing Adult Literacy Rate for Renewable Freshwater Consumption in African Countries

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Abstract
*Water is renewable because it is recycled in a short period that can be useful for human-being and wildlife. Renewable water resources comprise all surface water and groundwater resources that are transformed on a yearly basis without contemplation of the capability to harvest and use this resource. The study is developed on secondary data from the world bank website from the year 1995 to 2015. Water consumption and environmental sustainability are well-connected terms that show the level of sustainability for future generations. In this paper, the author tries to examine the role of literacy and good governance on renewable freshwater consumption, which might be used for household or commercial purposes. The author divides zonal basis where Government effectiveness merge with adult literacy rate (GE*ALR) help increase the renewable water consumption level by 0.58, 1.66, and 1.57 billion cubic meters for NAZ, EAZ, and WAZ respectively. These values are statistically significant and have an impact on models. Reversely, when regulatory quality (RQ) merges with the adult literacy rate (ALR), only WAZ experiences positively. However, Rules of Law (RL) and ALR bring a good sign for NAZ among five zones. Moreover, the adult literacy rate (ALR) plays a positive and statistically significant impact on NAZ and MAZ as solely but turns negative for WAZ.*

Keywords: Renewable Water Resources, Adult Literacy Rate, Good Governance

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INTRODUCTION

Freshwater has been considering one of the most demandable and vital resources that need remarkably to accelerate the econ growth as well as to improve the livelihood pattern of individual and household level. Water, a vital natural resource has the ability to renovation during the water cycle and purify them for further reuse to fulfil demand. Human being actually depends on the renewable water supply on a long-run basis, where the water comes from the sky, seeps into the underground, and collects the water from rivers and lakes as well. Renewable is defined as the water usage that is well-rechargeable on the hydrological cycle until the amount of water is overexploited, whether non-renewable water is not refilled in a long time after it uses once. Gleick (2000) mentions the reasons behind the water crisis during the past century where a growing population and high level of industrialization causes a huge change in the water demand. The chief water-consuming sectors are agriculture, industry, domestic, and others. Urbanization in worldwide causes a huge demand for water resources where water from sewerage, storm, and saline water can be the alternative sources for water reuse after being recycled. The recycled water is almost safe for use and drinking with perfect management and treatment. Williams et al. (2014) mention that increasing drought causes wildfire recklessly in arid regions and is liable for wildlife destruction. Losses due to wildfire not only damages wildlife but also the sound ecosystems, spending billions of dollars to manage the fire control.

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The UN's Second World Water Development Report (2006) the demographic changes that affect seriously the water level in recent times, where changing the lifestyle in the economy can be a liable factor for the crisis of fresh water. Most of the African countries face a huge crisis of freshwater due to climate change and ecological imbalance, especially the Middle-east, and North African countries face water crisis, that destroys their economic spine. A report of UNEP (2006) estimates that 1.8 billion people will face scarcity of water in 2025, and nearly 1 Billion people have no access to safe water today, only 15% of the total population have easy satisfying access to water. Unsafe water might cause a huge health risk due to arsenic contamination, unsafe water can influence health-disaster on a long-term basis for human health. Arsenic contamination can bring drastic health risks to human health and the environment (Smith et al. 2000). Kinniburgh and Smedley (2001) indicate that 27% and 46% of these tube wells contain 50 and 10 mg/l ppb arsenic contamination water in 6–11 million tube wells in Bangladesh.

RESEARCH QUESTIONS (RQs)

1. How do Adult Literacy Rate (ALR) and Good Governance (GG) individually affect to consumption of renewable freshwater zonal-wise in Africa?

In the first RQ, the author tries to find the individual impact of two specific variables named Adult Literacy Rate (ALR) and Good Governance (GG) on renewable water consumption levels in Africa. It is generally considered that a literate person should be serious and water reuse and the effective policy-level of government can influence the consumption level of renewable freshwater. The indicators of GG can influence the renewable water consumption level positively.

2. How do Adult Literacy Rate (ALR) and Good Governance (GG) jointly affect to consumption of renewable freshwater zonal-wise in Africa?

In the second RQ, the author tries to measure the joint or interacted impact of good governance and adult literacy rate on renewable water consumption level. When the GG variables merge with the adult literacy rate, these can change the behavioral aspects of local people to reuse the water.

LITERATURE REVIEW

In many regions, human-being and ecosystems are being closely connected with global water demand, which is largely diversified with changing demand. Water is an essential resource to fulfil the agro-production and industrial productivity at a large level, water demand depends on efficient use of available water.

Winpenny (1997) defined water demand as the policy-making regarding the continuous supply of water resources and can enhance the supply level at developing new ones. Water demand management shows how much increase the water demand could be efficient and effective to meet-up current demand and able to meet-up future demand. Moreover, water demand management is considered a strategic plan to improve the equitable, efficient, and sustainable use of water usage, which determines the level of water demand (Deverill, 2001). Sustainable water management defines the way to meet up that meets current, ecological, social, and economic needs at the time of considering the fulfillment of future demand to minimize the risk of being affected by the water crisis. In addition, the effective management body help identifies the level of groundwater and use the groundwater in the current time for household demand, agro and industrial purposes.

Water is an important source of life, the important factor to ensure the survival of animal life. With the growing level of the global population, renewable water demand has been six-fold at the time of the 20th beginning century. If the water is used at less the restored level, it is not considered sustainable, sustainability means to use it as a sustainable way to stratify the demand of the present without compromising the demand for future generations. UNEP defines that some countries named Saudi Arabia, Egypt, the United Arab Emirates, Syria, Pakistan, and Libya practice the way of unsustainable water because they consume more water levels than these countries manage freshwater sources. Anderson (2000) defines the environmental benefits and water reuse in Australia and other countries. Water reuse and water preservation generate basic environmental benefits, reductions the water divisions, and being serious about the discharge of freshwater.

Bouwer (2000) defines freshwater occurs as groundwater and about 97% of water is salt water, so people cannot access the saline water easily. Bhatti and Nasu (2010) investigated water demand forecasting and changing pattern of freshwater consumption in society. This study finds that 96% of fresh water is consumed by agricultural land and the other 4% is consumed by other different sources. The per capita water consumption changes from 30 liters per capita per day to 350 liters per capita per day based on water availability. GOP (2009) defines that 49% of water is contaminated by deadly bacteria and about 71% of households consume water from fixed sources. Kahlown (2008) reported that about 45 to 50% of freshwater is contaminated with bacteria in Islamabad, Rawalpindi, Lahore, and Faisalabad during the period 2005-2006. Mohamad et al. (2020) analyzed the effect of Water Demand Estimation Based On Land Use in Putrajaya city, where the economic appeal and urban development demand more water. This study estimates that domestic water consumption multiplied 614,150 liter/day to 888,231 litre/day from 2019 to 2030 in near future.

3. METHODOLOGY AND RESEARCH DESIGN

Konstańczak (2014) developed the theory of sustainable development and its exercise in the societal arena, the global emergency is caused by the negative approach of human beings which affects environmental sustainability negatively, harms the ecosystem severely. Renewable water means to reuse the water for a hydrological cycle as long the water is overused.

Table 1: Countries Name and World Bank Code

Country Name	WB Country Code	Region
Algeria	DZA	Northern Africa (NAZ)
Egypt	EGY	
Libya	LBY	
Morocco	MAR	
Sudan	SDN	
Tunisia	TUN	
Burundi	BDI	Eastern Africa (EAZ)
Comoros	COM	
Djibouti	DJI	
Eritrea	ERI	
Ethiopia	ETH	
Kenya	KEN	
Madagascar	MDG	
Malawi	MWI	
Mauritius	MUS	
Mozambique	MOZ	
Rwanda	RWA	
Seychelles	SYC	
Somalia	SOM	
South Sudan	SSD	
Tanzania	TZA	
Uganda	UGA	

Zambia	ZMB	
Zimbabwe	ZWE	
Angola	AGO	**Middle Africa (MAZ)**
Cameroon	CMR	
Central African Republic	CAF	
Congo (Democratic)	COD	
Congo	COG	
Equatorial Guinea	GNQ	
Gabon	GAB	
Sao and Principle	STP	
Botswana	BWA	**Southern Africa (SAZ)**
Eswatini	SWZ	
Lesotho	LSO	
Namibia	NAM	
South Africa	ZAF	
Benin	BEN	**Western Africa (WAZ)**
Burkina Faso	BFA	
Cape Verde	CPV	
Cote de Ivory	CIV	
Gambia	GMB	
Ghana	GHA	
Guinea	GIN	
Guinea-Bissau	GNB	
Liberia	LBR	
Mali	MLI	
Mauritania	MRT	
Niger	NER	
Senegal	SEN	
Sierra Leone	SLE	
Togo	TGO	

Table 2. Variables Indication of Independent Variables that affect Dependent Variable

Independent Variable Name	Variable Indication	Measurement Unit	World Bank Indicators	Literature References
Socio-economic Variables				
GDP per capita	**GDP**	In USD	**NY.GDP.PCAP.CD**	Murphy et al., 1983
Economic Growth	**EG**	The annual percentage growth rate of GDP at market prices based on constant local currency.	**NY.GDP.MKTP.KD.ZG**	Murphy et al., 1983
Agricultural land (sq. km)	**AL**	Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures	**AG.LND.AGRI.K2**	Fan et al, 2013
Total Population	**TP**	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.	**SP.POP.TOTL**	Fan et al, 2013
Net barter terms of trade index (2000 = 100)	**TOT**	Net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000.	**TT.PRI.MRCH.XD.WD**	Sobsey et al, 2003
Literacy Rate	**LR**	Literacy rate, adult total (% of people ages 15 and above)	**SE.ADT.LITR.ZS**	Shove et al, 2010
Gross capital formation (current US$)	**CA**	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories	**NE.GDI.TOTL.CD**	Mintz et al., 1995
Carbon Emissions	**CE**	Total greenhouse gas emissions in kt of CO2 equivalent are composed of CO2 totals excluding short-cycle biomass burning	**EN.ATM.GHGT.KT.CE**	Machingambi and Manzungu, 2003

Infrastructure Quality	**IQ**	Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)	**IQ.WEF.PORT.XQ**	Machingambi and Manzungu, 2003
Poverty headcount ratio	**PR**	Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	**SI.POV.DDAY**	Mintz et al., 1995
Urban land	**UL**	In Square Kilometres	**AG.LND.TOTL.UR.K2**	Radcliffe, 2008
Prevalence of moderate or severe food insecurity in the population (%)	**FS**	The percentage of people in the population who live in households classified as moderately or severely food insecure. A household is classified as moderately or severely food insecure when at least one adult in the household has reported to have been exposed, at times during the year, to low-quality diets and might have been forced to also reduce the quantity of food they would normally eat because of a lack of money or other resources.	SN.ITK.MSFI.ZS	Krantz (2005)
Good-Governance Variables				
Government Effectiveness	**GE**	Definition given in main text. Scaled to lie between -2.5 and +2,5 with higher values corresponding to better outcomes (Kaufmann et al. 1999a	**GE.EST**	Author's Own Compilation
Political Stability	**PS**	Definition given in main text. Scaled to lie between -2.5 and +2,5 with higher values corresponding to better outcomes (Kaufmann et al. 1999a)	**PV.EST**	Author's Own Compilation
Regulatory Quality	**RQ**	Definition given in main text. Scaled to lie between -2.5 and +2,5 with higher values corresponding to better outcomes (Kaufmann et al. 1999a)	**RQ.EST**	Author's Own Compilation
Control of Corruption	**CC**	Definition given in main text. Scaled to lie between -2.5 and +2,5 with higher values corresponding to better outcomes (Kaufmann et al. 1999a)	**CC.EST**	Author's Own Compilation
Rules of Law	**RL**	Definition given in main text. Scaled to lie between -2.5 and +2,5 with higher values corresponding to better outcomes (Kaufmann et al. 1999a)	**RL.EST**	Author's Own Compilation
Dependent Variable: Renewable internal freshwater resources Consumption, total (billion cubic meters) (RFWC)				

Source: Author Own Compilation, 2022

4. Econometric Model

The author considers 16 independent variables, where five variables indicate good governance behavior, that can influence renewable freshwater usage in different zones of Africa. The author considers the multiple regression model on a zonal basis, where the author tries to clarify the zonal-wise variation of renewable freshwater usage billion in cubic meters.

4.1 Multiple Regression Model

Model Type 1: (For Unrestricted Model)

RFWC= GDP + EG + AL + TP + TOT + ALR + CA + CE + IQ + PPD + ULA + FSL + GE + RQ + CC + RL + **u**

Model Type 2: (For Restricted Model)

RFWC= GDP + EG + AL + TP + TOT + CA + CE + IQ + PPD + ULA + FSL + RQ + CC + RL + **u**

4.2 Joint Hypothesis Testing

For analyzing the joint hypothesis testing, the author considers some good governance variables (Five variables) which do not include in the model.

Ho: Null Hypothesis: $GE=ALR=0$
Ha: Alternative Hypothesis: $GE \neq ALR \neq 0$

In this paper, the author tries to find out the effect of independent variables on the dependent variable named renewable freshwater usage on *zonal-wise. The author compares the two different models named unrestricted and restricted on hypothesis testing to measure the impact in zonal-basis.*

5. Result Discussion

From table 3 in the annex, the author tries to measure the impact of a set of independent variables (socioeconomic and good governance) variables on renewable freshwater consumption level in billion cubic meters.

5.1 Result Discussion for General Multiple Regression

GDP Level (GDP)

For the zone of NAZ (in model 1), if the GDP level increases by 1000 USD, the renewable freshwater consumption (RFWC) will be increased by 1 billion cubic meters. It is statistically significant at the 10 percent level. In general, cases, when a country accelerates to produce goods and services, it needs more water resources and that country tries to find out renewable sources of water. Conversely, the RFWC will be reduced by 6 and 8 billion cubic meters for EAZ and MAZ respectively holding other variables constant, with the increasing 1000 USD. Both are statistically significant at a1 percent level.

Economic Growth (EG)

If the economic growth increases by 1%, renewable freshwater (RFWC) will be reduced 0.70 and 0.90 billion cubic meters for EAZ and MAZ respectively, which is statistically significant at 1 percent and 5 percent levels holding other variables constant. However, the 1 percent increase in economic growth helped increase 1.48 billion cubic freshwater consumptions for WAZ, which is statistically significant at 1 percent level.

Agricultural Land (AL)

If the AL increases by 1,00,000 Square kilometers, then RFWC will be increased by 2 billion cubic meters, it is statistically significant at a 1 percent level for NAZ and MAZ. If the AL increases by 10,000 Square kilometers, then RFWC will be increased by 4 billion cubic meters, it is statistically significant at a 1 percent level.

Total Population (TP)

If the TP increases, then RFWC will be increased significantly for MAZ and EAZ. When the population number increases, water demand increases generally. But people will search for another source of freshwater to fulfill their daily demand.

Terms of Trade (TOT)

TOT positive means export is more than import. If the TOT index increases by 10 percent, RFWC will be reduced by 0.95, 1.72, and 3.16 billion cubic meters for NAZ, EAZ, and WAZ. These values are statistically significant at 1 percent for NAZ and WAZ, and 5 percent level for EAZ.

Adult Literacy Rate (ALR)

If the ALR increases by 10 percent for NAZ, RFWC will be increased by 2.7 cubic meters, which is statistically significant at a 1 percent level. Moreover, the ALR increases only 1 percent for MAZ, RFWC will be increased by 5.34 billion cubic meters, which is statistically significant at a 1 percent level. For WAZ, Moreover, the ALR increases only 1 percent, RFWC will be decreased by 1.38 billion cubic meters, which is statistically significant at a 1 percent level.

Capital Accumulation

Capital accumulation means the formation of capital based on capital investment in currency. CA invites positively on NAZ and acts negatively on EAZ and SAZ.

Carbon Emission

Climate change is a concerning issue that is well-connected with water resources. As the sea-level increases, saline water mix will freshwater and it destroys the quality of freshwater, which generally leads to health-cost for local livelihood. When the CE increases by 1000 metric tons, RFWC will be decreased by 2 billion cubic meters, which is statistically significant at a 1 percent level for MAZ. If the CE increases by 10,000 metric tons, RFWC will be increased by 1 billion cubic meters, which is statistically significant at a 1 percent level for SAZ. When the CE increases by 1000 metric tons, RFWC will be increased by 2 billion cubic meters, which is statistically significant at a 1 percent level for WAZ.

Infrastructural Quality (IQ)

Advanced infrastructural quality helps to increase the demand for freshwater, if the IQ index increases by 1 unit, RFWC will be increased by 6.90 billion cubic meters, which is statistically significant at a 1 percent level in NAZ. Advanced infrastructural quality helps to increase the demand for fresh water, if the IQ index increases by 1 unit, RFWC will be increased by 31.17 billion cubic meters, which is statistically significant at a 1 percent level in WAZ.

Poverty Level

In this study, the people are called poor who earn less than USD 1.90 per day according to WB. If the poverty level increased by 10 percent, RFWC will be reduced by 7.2 and 5.97 billion cubic meters in NAZ and WAZ, both are statistically significant at a 1 percent level. If the poverty level increases by 10 percent, RFWC will be increased by 2.69 percent for EAZ, and If the poverty level increases by 1 percent, RFWC will be increased by 1.16 percent for MAZ.

Urban Land

If the UL increases by 10,000 Square kilometers, it will lessen RFWC at 2, 40, and 410 billion cubic meters for NAZ, EAZ, and MAZ respectively. Conversely, if the UL increases by 10,000 Square kilometers, RFWC will be increased by 80 billion cubic meters, which is statistically significant at a 1 percent level.

Food Insecurity

Food insecurity means the percentage of the population who face the severe crisis of food. If the people of food insecurity increases by 10 percent in NAZ and EAZ, it leads to an increase in RFWC at 9.48 and 4.30 billion cubic meters, which is statistically significant at a 1 percent level. When a large number of the population face extreme food insecurity, they have to depend on ground and rainfall to water inland. Food insecurity happens due to less agro-production, climate change, unstable government bodies, military, and terrorist violence.

Government Effectiveness

The good governance variable has been measured from -2.5 to +2.5. If the value turns negative, it shows a negative approach of governmental effectiveness on renewable freshwater consumption level. If the value increased by 1 index, RFWC will be decreased by 13 billion cubic meters in NAZ, where it is 1 percent level statistically significant. On the other hand, If the value increased by 1 index, RFWC will be increased by 51.80 and 145.66 billion cubic meters in EAZ and MAZ respectively, where it is 1 percent level statistically significant.

Regulatory Quality

If the RQ value increased by 1 unit index, RFWC will be increased by 3.3 and 13.53 billion cubic meters in NAZ and EAZ, where it is statistically significant and 5 and 10 percent level. Diversely, If the RQ value increased by 1 index, RFWC will be decreased by 154.62 billion cubic meters in WAZ, where it is statistically significant at a 1 percent level.

Control of Corruption

If the CC value increased by 1 index, RFWC will be increased by 11.64, 52.29, and 64.05 billion cubic meters in NAZ and EAZ and WAZ, where it is statistically significant at 1 percent level. Diversely, If the CC value increased by 1 index, RFWC will be decreased by 90.53 billion cubic meters in MAZ, where it is statistically significant at a 1 percent level.

Rules of Law (RL)

If the RL index value increased by 1 index, RFWC will be increased by 28.96 billion cubic meters in EAZ, where it is statistically significant at 1 percent level. Diversely, If the RL value increased by 1 index, RFWC will be decreased by 45.42 billion cubic meters in WAZ, where it is statistically significant at 1 percent level.

5.2 Result Discussion for Interacted Multiple Regression

Interacted variable shows the joint effect of the model, which considers the joint or combined impact on renewable freshwater consumption level. If the GE*ALR (Government Effectiveness and Adult Literacy Rate) acts jointly, it will increase RFWC by 0.58, 1.66, and 1.57 billion cubic meters of fresh water in NAZ, EAZ, and WAZ. The values are 1 percent, 1 percent, and 5 percent level of statistically significant. In WAZ, the joint effect of RQ*ALR acts positively, if the RQ*ALR increases then RFWC will be increased by 2.36 billion cubic meters of water.

On the other hand, CC*ALR act jointly, the RFWC will be increased 1.72 billion cubic meters of water in EAZ, it is statistically significant at a 1 percent level. If the RL*ALR work jointly, the RFWC will be increased by 0.585 billion cubic meters of water, which is statistically significant at a 5 percent level. But in EAZ, the RFWC will be reduced by 0.83 billion cubic meters at the level of increasing RL*ALR.

5.3 Hypothesis Testing

From table 4 in the annex, In this analysis, GE shows the level of government effectiveness, where The government effectiveness index is an index enlarged by the World Bank Group which actions the class of public services, civil service, policy design, policy implementation, and credibility of a government's commitment to raising these abilities or possession them high. In this case, policy formulation can enhance the behavioral change of the local-level population, where a health policy can influence the public to use renewable freshwater. In the context of good-governance perspective and ALR for socio-economic vital variable, have a statistically significant impact in all zones that are considered in the study.

Policy Recommendation

In this paper, the author tries to measure the joint effect of adult literacy rate and good governance indicators on renewable freshwater consumption levels. Renewable water means to consume the water which is recycling a short-term basis and capable of reuse. In NAZ, rules of law (RL) and social policy should be adapted to develop the social rules and inform regulatory bodies to change people's behavior to water reuse and be conscious about water use. In EAZ, a social policy should be developed to enhance the literacy rate about climatic change and create awareness about water reuse. In MAZ, the CC and RL index should be improved to establish good governance and their liability on people, because the GG earns a lower score that is not efficient to improve the social conditions and change the behavior of people. For SAZ, GG variables do not affect a positive impact on RFWC where the central government should try to implement a good and effective good-governance to improve the life-standard of the general population. From the perspective of WAZ, RQ and RL scores should be increased to develop the behavior to use renewable freshwater usage in this zone.

Conclusion

Renewable freshwater is one of the optimistic sectors which can bear positive motives to enhance their life-standard. Renewable freshwater is one of the most effective indicators that can be used further for economic growth and development. However, industrial wastage water can be recycled to water the paddy land after diminishing the topic at the time of disposal. In many countries of South-Eastern and Eastern Europe, Caucasus, and Central Asia, those countries use rain, snow, hail, dew water as renewable water that can be used for productive purposes. Most of the developing and under-developed countries can utilize renewable freshwater for commercial and household purposes.

References

Anderson, J. (2001). The environmental benefits of water recycling and reuse. *Water Science and Technology: Water Supply,* 3(4), 1–10. Retrieved from: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.597.2565&rep=rep1&type=pdf

Bhatti, A.M. & Nasu, S. (2010). Domestic water demand forecasting and management under changing socio-economic scenario. Society for Social Management Systems (SSMS2010), 1-8.

Bouwer, H. (2000). Integrated water management: emerging issues and challenges. *Agricultural Water Management,* 45, 217-228. Retrieved from: 10.1016/S0378-3774(00)00092-5

Deverill, P. (2001). Sharing It Out – Introducing Water Demand Strategies for Small Towns. Water and Environmental Health at London and Loughborough, UK

Fan, L., Liu, G., Wang, F., Geissen, V., & Ritsema, C.J. (2013). Factors Affecting Domestic Water Consumption in Rural Households upon Access to Improved Water Supply: Insights from the Wei River Basin, *China. PLOS ONE*, 8(8): 71977. Retrieved from: https://doi.org/10.1371/journal.pone.0071977

Gleick, P. H. (2000). The changing of water paradigm: a look at twenty-first-century water resources development. *Water International,* 25(1), 127-138. Retrieved from: https://www.tandfonline.com/doi/abs/10.1080/02508060008686804

Government of Punjab, 2009, Multiple Indicator Cluster Survey 2007-2008, Punjab, Pakistan.

Kahlown, M., Tahir, M. & Rasheed, H. (2007). Water Quality Status of Pakistan. *Pakistan Council of Research in Water Resources.* Retrieved from: https://pcrwr.gov.pk/wp-content/uploads/2020/Water-Quality-Reports/Water%20Quality%20Monitoring%20Report%202005-06.pdf

Kinniburgh, D. G. & Smedley, P. L. (2001). Arsenic Contamination of Groundwater in Bangladesh, 2. British Geological Survey, Department for International Development, Government of the People's Republic of Bangladesh, *Ministry of Local Government, Rural Development and Co-operatives,* Department of Public Health Engineering, Dhaka. Available at: http://www.bgs.ac.uk/ arsenic/Bangladesh.

Konstańczak, S. (2014). Theory of sustainable development and social practice, *Problems of Sustainable Development,* 9 (1), 37-46. DOI: https://www.researchgate.net/publication/260390513

Krantz, H. (2005). A matter that matters: A study of household routines in a process of changing water and sanitation arrangements, *Department of Water and Environmental Studies.* Retrieved from: http://www.diva-portal.org/smash/get/diva2:20799/FULLTEXT01.pdf

Machingambi, M., Manzungu, E. (2003). An evaluation of rural communities' water use patterns and preparedness to manage domestic water sources in Zimbabwe, *Physics and Chemistry of the Earth*, Parts A/B/C 28(20-27), 1039-1046. Retrieved from: 10.1016/j.pce.2003.08.045

Mintz, E.D., Reiff, F.M, & Tauxe, R.V. (1995). Safe Water Treatment and Storage in the Home: A Practical New Strategy to Prevent Waterborne Disease. *JAMA.* 1995;273(12):948–953. Retrieved from: doi:10.1001/jama.1995.03520360062040

Mohamad, N., Ash'aari, Z. and Kamal, I. (2020). Water Demand Estimation Based On Land Use In Urban City, *International Journal Of Scientific & Technology Research,* 9 (6). Retrieved from: https://www.ijstr.org/final-print/jun2020/Water-Demand-Estimation-Based-On-Land-Use-In-Urban-City.pdf

Murphy, M., Davis, C. and McCoy, G. (1983). Factors Affecting Water Consumption by Holstein Cows in Early Lactation, *Journal of Dairy Science*, 66(1). Retrieved from: https://www.sciencedirect.com/science/article/pii/S0022030283817500

Radcliffe, J.C. (2004). Water Recycling in Australia (Australian Academy of Technological Sciences and Engineering, Melbourne), *The Australian Academy of Technological Sciences and Engineering.* Retrieved from: http://www.atse.org.au/index.php?sectionid=597

Shove, E., Frances, R., and Morris, J. (2011). Behavioral change and water efficiency; ESRC (Economic and Social Research Council) Seminar Series – *Mapping the Public Policy Landscape.* Retrieved from: http://www.watersave.uk.net/ Links/Behavioural%20Change%20and% 20Water%20Efficiency%20Publication_tcm6- 26877.pdf

Smith, A. H., Lingas, E. O. & Rahman, M. (2000). Contamination of drinking-water by arsenic in Bangladesh: a public health emergency, *World Health Organization,* 78, 1093–1103. Retrieved from: https://www.who.int/bulletin/archives/78%289%291093.pdf

Sobsey, M.D., Handzel, T., & Venczel, L. (2003). Chlorination and safe storage of household drinking water in developing countries to reduce waterborne disease. *Water Science Technology,* 47 (3), 221–228.

WB (the World Bank) (2012) World development indicators, *The World Bank,* Retrieved from: http://data.worldbank.org/sites/default/files/wdi-2012-ebook.pdf

UN World Water Development Report (2006). Retrieved from: https://www.unwater.org/publications/water-shared-responsibility/

UNEP (2006). The Climate of Change. Retrieved from: https://wedocs.unep.org/bitstream/handle/20.500.11822/7476/-UNEP%202006%20Annual%20Report-2007755.pdf

WHO & UNICEF (2012). Progress on Drinking Water and Sanitation: 2012(Update), USA. Retrieved from: http://www.unicef.org/media/files/JMPreport2012.pdf

Williams, A.P., Seager, R., Berkelhammer, M., Macalady, A.K., Crimmins, M.A., Swetnam, T.W., & Rahn, T. (2014). Causes and implications of extreme atmospheric moisture demand during the record-breaking 2011 wildfire season in the south-western United States. *Journal of Applied Meteorology and Climatology*, 53(12). Retrieved from: https://journals.ametsoc.org/view/journals/apme/53/12/jamc-d-14-0053.1.xml

Winpenny, J. (1997, July). Water Policy Issues. Retrieved from: https://www.ircwash.org/sites/default/files/Winpenny-1997-Water.pdf

Table 3: Multiple Regression Analysis for General variables and Interacted Variables

Dependent Variable: Renewable internal freshwater resources Consumption, total (billion cubic meters) (RWFC)

	Variable Name	Co-efficient Sign	1. Multiple Regression NAZ_ General Multiple Regression	2. Multiple Regression NAZ_ Interacted Multiple Regression	3. Multiple Regression EAZ_ General Multiple Regression	4. Multiple Regression EAZ_ Interacted Multiple Regression	5. Multiple Regression MAZ_ General Multiple Regression	6. Multiple Regression MAZ_ Interacted Multiple Regression	7. Multiple Regression SAZ_ General Multiple Regression	8. Multiple Regression SAZ_ Interacted Multiple Regression	9. Multiple Regression WAZ_ General Multiple Regression	10. Multiple Regression WAZ_ Interacted Multiple Regression
1	GDP	**β1**	0.001*	0.0002	-0.006***	-0.008***	-0.001	-0.008***	-0.0004	-0.001*	-0.00003	-0.010
2	EG	**β2**	0.004	0.011	-0.705***	-0.127	-0.904**	-0.309	0.051	0.039	1.488***	0.974**
3	AL	**β3**	0.00002***	0.00002***	0.0004***	0.0004***	-0.0002	-0.0004	0.00002***	0.00002***	-0.0001	-0.00001
4	TP	**β4**	-0.00000	0.00000***	0.00000***	0.00000***	0.00001***	0.00000***	0.00000	0.00000	0.00000	0.00000
5	TOT	**β5**	-0.095***	-0.057***	-0.172**	-0.357***	0.145	0.122	-0.022	-0.012	-0.316***	-0.158
6	ALR	**β6**	0.279***	0.570***	1.722	1.247	5.348***	13.874***	0.065	-0.017	-1.383***	1.256***
7	CA	**β7**	0.000***	0.000***	-0.000***	-0.000***	-0.000	-0.000	-0.000***	-0.000*	-0.000	-0.000
8	CE	**β8**	-0.00002	-0.0001***	-0.002	-0.001	-0.002***	-0.001***	0.0001**	0.00005*	0.002***	0.002**
9	IQ	**β9**	6.906***	7.557***	7.898	6.934	85.963	65.040	0.609	0.901	31.175***	36.543***
10	PR	**β10**	-0.720***	-0.483***	0.269***	0.013	1.165**	0.964**	0.027	0.002	-0.597***	-0.200
11	UL	**β11**	-0.0002**	0.0001	-0.004**	-0.003	-0.041***	0.049***	-0.00001	-0.00002	0.008***	0.003
12	FS	**β12**	0.948***	0.496***	0.430***	0.645***	-19.133	-24.693	-0.047	-0.060	0.325	0.728***
13	GE	**β13**	-13.309***	-29.183*	51.809***	52.099**	145.661***	686.581***	6.023***	29.936	14.375	-77.840***
15	RQ	**β15**	3.320**	-11.831	13.537*	-22.623	-14.250	-1,423.682***	-0.073	-28.981	-154.626***	-211.130***
16	CC	**β16**	11.642***	73.931***	52.291***	-34.440*	-90.535***	467.464***	-1.915	-40.175	64.505***	14.093
17	RL	**β17**	1.758	-39.367**	28.963***	70.530**	-28.539	-148.959	4.145	16.646	-45.428***	-49.533**
	GE*ALR			0.583***		1.663***		-8.893		-0.435		1.578**
	RQ*ALR			0.208		0.587		19.548		0.358		2.366***
	CC*ALR			-0.987***		1.729***		-7.024		0.457		0.431
	RL*ALR			0.584**		-0.834*		2.334		-0.161		0.314
	Constant		**-7.954**	**22.356*** **		**-54.508****	**158.866*** **	**126.868****	**-1.648**	**5.709**	**-30.819**	**-205.735*** **
	Observations		**222**	222	**666**	**666**	**296**	**296**	**185**	**185**	**555**	**555**
	R2		**0.863**	0.896	**0.651**	**0.686**	**0.719**	**0.741**	**0.77**	**0.978**	**0.536**	**0.641**
	Adjusted R2		**0.852**	0.886	**0.643**	**0.676**	**0.715**	**0.736**	**0.75**	**0.975**	**0.523**	**0.628**
	F Statistic		**80.575*** **	**86.983*** **	**75.829*** **	**70.416*** **	**98.209*** **	**72.982*** **	**247.281*** **	**357.159*** **	**38.889*** **	**47.670*** **
	Significance Level: *p<0.1; **p<0.05; ***p<0.01											
Source: Author's Own Compilation 2022												

Annex

Table 4: Hypothesis Testing

Null Hypothesis: GE = ALR= 0
Alternative Hypothesis: GE ≠ ALR ≠0

Model 1: Restricted Model: RFWC ~ GDP + EG + AL + TP + TOT + CA + CE + IQ + PPD + ULA + FSL + RQ + CC + RL

Model 2: Unrestricted Model: RFWC ~ GDP + EG + AL + TP + TOT + ALR + CA + CE + IQ + PPD + ULA + FSL + GE + RQ + CC + RL

Hypothesis Testing for NAZ

	Res.Df	RSS	Degree of Freedom	Sum of Square	F Statistics	Pr(>F)
1	*207*	*4587.8*				
2	*205*	*3260.9*	*2*	*1327*	*41.71*	*6.341e-16 ****

Hypothesis Testing for EAZ

	Res.Df	RSS	Degree of Freedom	Sum of Square	F Statistics	Pr(>F)
1	*651*	*1702206*				
2	*649*	*1460671*	*2*	*241536*	*53.659*	*< 2.2e-16 ****

Hypothesis Testing for MAZ

	Res.Df	RSS	Degree of Freedom	Sum of Square	F Statistics	Pr(>F)
1	*281*	*2179378*				
2	*279*	*1676701*	*2*	*502677*	*41.822*	*< 2.2e-16 ****

Hypothesis Testing for SAZ

	Res.Df	RSS	Degree of Freedom	Sum of Square	F Statistics	Pr(>F)
1	*170*	*1135.2*				
2	*168*	*1068.7*	*2*	*66.551*	*5.2311*	*0.006253 ***

Hypothesis Testing for WAZ

	Res.Df	RSS	Degree of Freedom	Sum of Square	F Statistics	Pr(>F)
1	*540*	*1553133*				
2	*538*	*1385044*	*2*	*168089*	*32.646*	*4.155e-14 ****

Significance Level: ****' 0.001 '**' 0.01 '*' 0.05*