Polytechnic Journal: Vol.8 No.3 (Aug 2018): Pp.: 76 -101
http://epu.edu.krd/ojs/index.php/Journal
https://doi.org/10.25156/ptj.2018.8.3.234

WATER RESOURCES MANAGEMENT IN KURDISTAN REGION - IRAQ
THE CASE OF DUKAN LAKE

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ABSTRACT

Water is the key for sustaining life, almost ninety seven percent of water is ocean and remaining one is for drinking water. Within that concept, the world is facing water crisis, due to rapid growth with population, continuous practicing food production, industry, infrastructure, and environmental change. The water management is the solution to these conflicts. Different water stakeholders such as farmer, domestic and household user's hydropower projects, recreational users and ecosystems can properly be managed in terms of water supply and consumption through the integrated water resources management.

This study is based on a conjoint analysis survey conducted for Dukan, a district in Kurdistan region of Iraq. The study adopted a stated preferences method, in order to elicit preferences of water consumers in Dukan toward the water management. A discrete choice models based on random utility theory with ranked order choice tasks were implemented for a representative sample of Dukan. Secondary materials were needed to supplement the field work and to get more information about management of Dukan water basins.

The secondary materials were mostly reports found through Google scholar and in scientific journals. Information about Kurdistan region was found through the Kurdistan region government's National website. The aim of this attribute was to make better access of water for

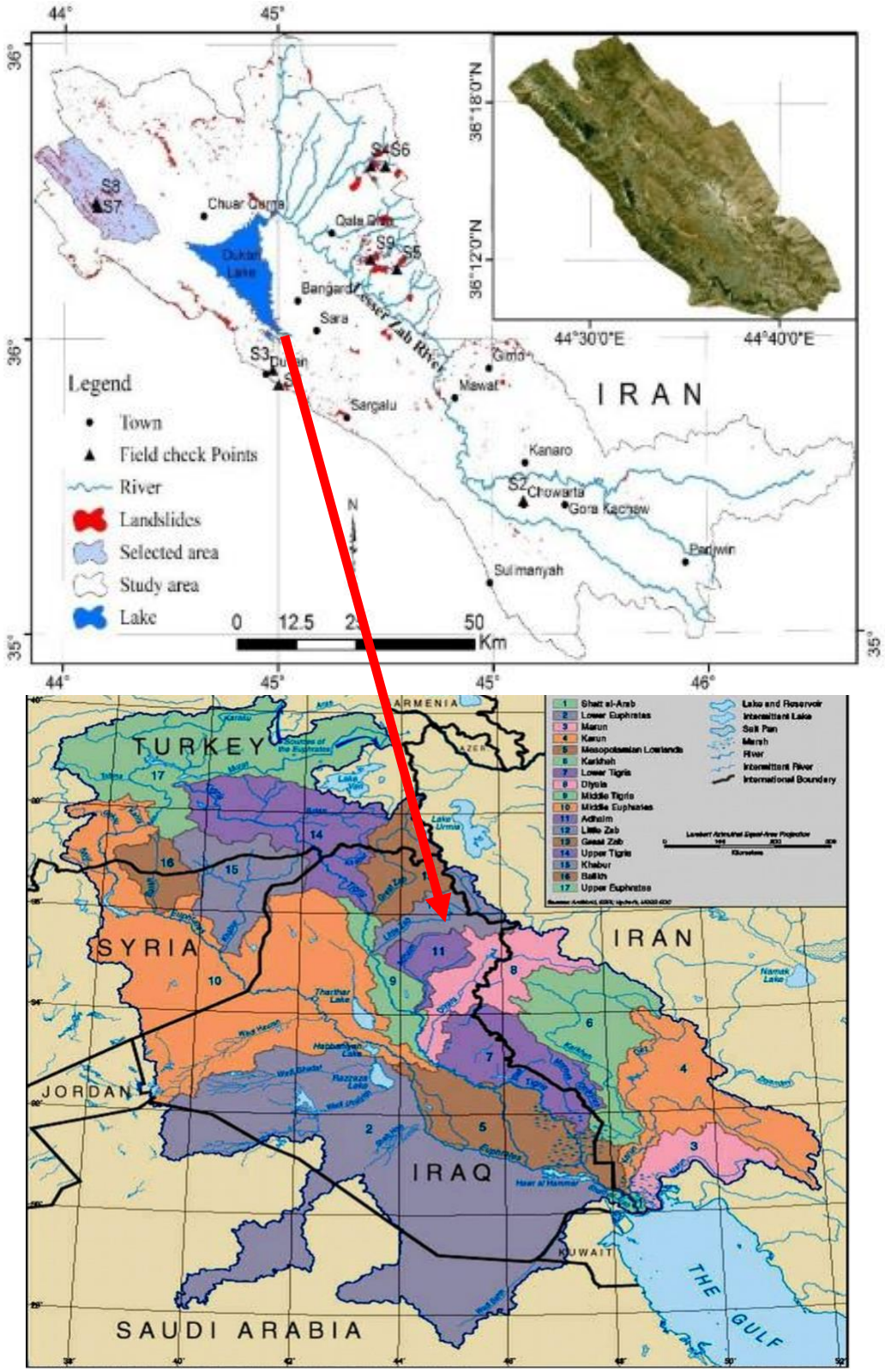
deferent uses of life. The study applied questionnaire and interview for deferent levels household, farmer and government official because each one has vital role in managing water in daily life. As result, the study found that strategy plan for 10 years, no need to reuse water, willingness for payment 5thousand or 10 thousand dinars and implementing water service by both public and private sector are most important in accordance to communities.

Keywords: ***Water resources management, conjoint analysis, farm, Household and Government official, Logit model, Kurdistan***

1. INTRODUCTION

One of the most critical natural resources worldwide is the water and its management. The developing nations suffer more than the developed ones in this regard. The developing nations are faced with a series of water related challenges such as water scarcity (for drinking and other purposes), floods, water pollution which result in water borne disease (Cohen & Davidson, 2011; Rahaman, 2005). Fresh water is necessary and irreplaceable. For some region in the world, fresh water becomes increasingly threatened. Accordingly, water turned to a crucial natural resource issue for many countries.

Population and development in the region, especially fresh water. The result of water scarcity is caused by many reasons such as, neighboring country's policies, those that share water resources with Kurdistan region, climate changes and using water for hydropower (Heshmati, 2009).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Chuar Qurna
Qala Diza
Dukan Lake
Bangard
Sara
Lesser Zab River
Dukan
Gimo
Mawat
Sargalu
Kanaro
Chowarta
Gora Karaw
Badwin
Sulmanyah
IRAN
Legend
Town
Field check Points
River
Landslides
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TURKEY
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THE GULF
ARMENIA
1 Shatt al-Arab
2 Lower Euphrates
3 Marun
4 Karun
5 Mesopotamian Lowlands
6 Karkheh
7 Lower Tigris
8 Diyala
9 Middle Tigris
10 Middle Euphrates
11 Adhaim
12 Little Zab
13 Great Zab
14 Upper Tigris
15 Khabur
16 Balikh
17 Upper Euphrates
Lake and Reservoir
Intermittent Lake
Salt Pan
Marsh
River
Intermittent River
International Boundary

Figure (1) Dukan Lake Location

The aim of this study was to discover current status of water resource management problems in Kurdistan region, and also interventions of government, private sectors and communities in making decisions to reduce the gap among them especially within communities involving farms which have very important positions in decision making. In addition, the following questions were answered:

1) Which institutions at different hierarchical levels are involved in the water management?

2) What role do they have?

3) How is the cooperation working between those institutions?

4) Does the governance involve participation for all villages and farmers?

5) How are conflicts solved in concerning the water?

This research was concentrated on water scarcity and the potential conflicts over water in the Middle East. The main goal was to identify the conflict zone with its past and present problems and offer suggestions for the future cooperation among the riparian countries and the region overall.

The result of this study will be imperative to policy and decision makers in the region toward better undemanding of the way to handle the IWRM issues and better managing the water users and stakeholders in the region.

2. MATERIAL AND METHODS

This study was based on both qualitative and quantitative method; quantitative because the research has open questioners and choice based on questioners in order to get information on deferent levels to find out solution for better resource management.

2.1.Field Survey Method

This study prepared forms for different three levels from farm, household and Government official due to important of each level as a main actor on the making decision. Furthermore, by filing the form and interview, the study will explore their opinion in water management and what is the role of levels in water resources management. The questioner was divided by three parts, with the correlation between them. Main part from form is about attributes such as (strategy plan, water reuse, proving service and willingness to pay for water) as shown in Table 1.

Table 1 Attributes and levels

Attributes	Levels
Strategic planning	10 years
	5 years
	2 years
Water re-use	Not for drinking
	Use for all purpose
	None of them
Sector to implement water management Plan	Private only
	Private public partnership
	Public only
Willingness to pay for water use	5 000 ID
	10 000 ID
	15 000 ID

2.2.Conjoint Analysis

The study was based on a conjoint analysis survey conducted for Dukan, a district in Kurdistan region of Iraq, where the biggest hydropower dam is located. The study adopts a stated preferences method, in order to elicit preferences of water consumers in Dukan toward the water management. A discrete choice model based on random utility theory with ranked order choice tasks were will be implemented for a representative sample of Dukan. Secondary materials were needed to supplement the field work and to get more information about management of Dukan water basins.

The first step in conjoint analysis was to find important attributes and level. In this study attribute like strategy plan picked with three levels for each 10 years, 5 years and 2 years.

2.3.Analysis and Modeling of Discrete Choice Approach

The discrete choice experiment was found in problematic choice theory and random utility theory. It is consistent with Lancaster's economic theory of value (Lancaster, 1966) which assumes that the utility of the consumer is derived from the underlying attributes of the goods under valuation rather than the good per se. The choice theory based on probability assumes that researchers cannot predict individual consumer's choices perfectly due to unobserved factors that are unobserved for researchers but known for individual consumer. Hence, estimated models based on the theory that try to explain consumers' choices are not identifying alternatives as the chosen option, instead they assign probabilities to them (Adamowicz, 1998).

2.4.Random Utility Model

The random utility model developed by McFadden (1973) was applied as a theoretical basis to analyze the consumer preferences using discrete choice models. The maintained assumption of the model stated that respondents choose their preferred alternatives based on utility maximization concept. The model further implies that there is a function which contains attributes of alternatives and individual's characteristics such as demographic information that help to describe the individual's utility valuation for each alternative. Accordingly, one of the requited assumptions is that each consumer perceives the utility associated with each attribute of the water management plan and choose the one with the greatest possible perceived utility.

2.5.STUDY AREA

Dukan is located close to Ranya town, in distance of 60 kilometer from northern east of Sulaimany city. In Dukan area there is the biggest reservoir in Kurdistan called Dukan Lake. The weather in this region is cool and as known as tourism place due to beauty of the place. In Dukan lake, Dukan dam was constructed during 1959s for multipurpose uses; flood control, hydropower, irrigation, increasing underground water and livelihood as well. Sulaimany city depending on this dam completely for whole life needs that is why it was considered as most important dam in Kurdistan region.

Dukan dam was the main sources of drinking water for Sulaimany city, Karkuk city, Taslwja area, Bazyan area, Dwzkhwrmatw and Jamjamal, and use for irrigation in most area such as, Karkuk and Haweja. Dukan dam accounts the fourth biggest dam in Iraq, which can hold 8 milliard tripic meters (report from General Director of dam in Kurdstan region. Figure 3 shows the location of Dukan Lake (Othman, 2013).

3. REULTS AND DISCUSSION

3.1.*Description of the data collection and correlation*

It is clearly shown that 927 forms from 261 households, 405 farms and 261 government officials were collected for evaluation. According to the questions, 423 females and 504 males participated to answer the questions from this study.

3.2.Discussions: The Result Based on the Logit Program

After conjoint analysis and using logit model, some attributes were significant and some not (Table 2). It is because of filling forms by farmers which had high impact on water resources and then household with government official. Meanwhile the result comes from different communities.

Table 2 Result from Logit Program

Variable (s)	Beta (β)	Sig.
Strategy plan10	-2.263*	0.0237
Strategy plan5	0.598	0.5497
No for drink	-0.227	0.8202
No water re-use	-3.716**	0.0002
Public	1.755	0.0793
Public with private	2.07*	0.0385
Payment ID5	4.204**	0.0000
Payment ID10	8.61**	0.0000
Rank	1.438	0.1504
Member1	0.714	0.4754
Area1	-0.528	0.5974
Canal1	0.634	0.5262
Tank1	-2.05*	0.0404
Well1	-0.193	0.8469
Less 250	-1.965*	0.0494
Less 500	-1.592	0.1114
Water consumption	0.583	0.5599
Clean	-0.541	0.5887
Time of water access	-0.113	0.9101
Male	1.527	0.1269
Less 25	-1.965*	0.0494
Less 40	0.044	0.9648
Less 60	-1.054	0.2919
Illiterate	-1.818	0.069
Basic	-1.512	0.1306
High school	-3.525**	0.0004
Diploma	-2.316*	0.0205
Income	-0.254	0.7998
Farm	-1.699	0.0894
Household	-0.807	0.4196
Rank	1.386	0.1657
Member2	0.483	0.6288

Area2	-1.611	0.1072
Canal2	0.922	0.3565
Tank2	-1.652	0.0984
Well2	1.41	0.1586
Less 250	-1.572	0.1161
Less 500	-0.609	0.5427
Water consumption	1.516	0.1296
Clean	-0.691	0.4898
Time of water access	0.281	0.7787
Male	2.238*	0.0253
Less 25	-1.572	0.1161
Less 40	-1.082	0.2793
Less 60	-2.135*	0.0328
Illiterate	-1.431	0.1524
Basic	-0.964	0.3352
High school	-1.846	0.0648
Diploma	-1.812	0.0699
Income	-0.465	0.6421
Farm	-1.27	0.2041
Household	0.756	0.4499

Note: significance level; P<0.01 (**), P<0.05 (*)

Each of the study variables have been analyzed using conjoint analysis. As shown in Table 10, some of the variables were significant in Member 1, such as Strategy plan 10 (β = -2.263, P<0.05), No water re-use (β =-3.716, P<0.01), Public with private (β = 2.07, P<0.05), Payment ID5(β = 4.204, P<0.01), Payment ID10(β =8.61,P<.01), Tank1 (β =-2.05, P<0.05), Less 250 (β = -1.965, P<0.05), Less 25 (β = -1.965, P<0.05), High school(β =-3.525,P<.01), Diploma (β = -2.316, P<0.05) and in Member 2 , Male (β = 2.238, P<0.05), Less 60 (β =-2.135, P<0.05). Other variables were insignificant.

Table 3 and Figure 2, shows the attribute of strategy plan for each community of level from household, farm and government official. As result the study found that from household; the rate of ranking for 10 years plan, 5 years plan and 2 years plan was 88, 86, and 87 respectively. It shows that there is a community needed for 10 years plan from government to make better water resources management. As much there are people who want to government to make 5 years plan for the purpose of solving problems that are faced in the water management. The 2 years plan is

not far from 10 years and 5 years strategic plans because according to the forms, there is community needed only in 2 years plan. If it is not successful then government can change the plan, otherwise the plan needs to be extended. Moreover, the study is going to analyze more in the next section

Table 3 Strategy Plan and Level of Community

Level of community **Community**	**Strategy Plan**		
	10-year	5-year	2-year
Household	88	86	87
Farm	135	134	136
Government	87	87	87

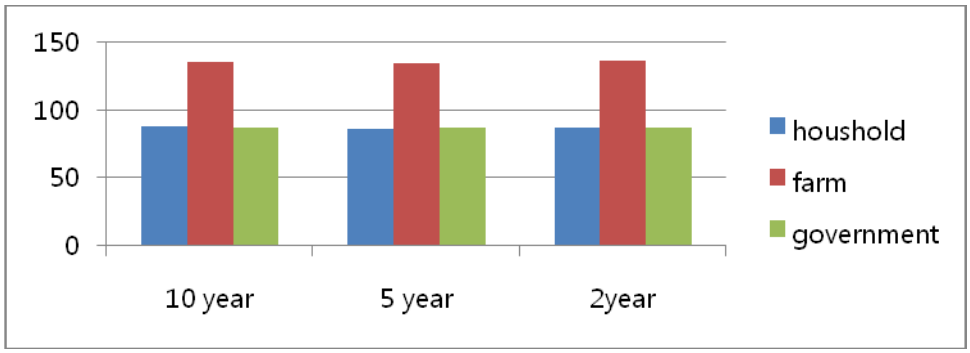

Figure 2 Strategy plan and level of community

As shown below in Table 4 and Figure 3, first is not reusing water for drinking because it is not healthy, and the last one it' is necessary to use water again after it flows out. According to the result as shown in Figure 7, the levels for water reuse of both household and government were the same: 87 people for each of the levels. Water re- use is too important for household and government official, due to human daily needs. As a result shows, people ranked not using water for drinking because until now there is no such plan to use water more than once again.

Ranking level for no need water re-use is 87 people in both household and government official. The aim of this level is not using water again after flow out for any purpose including drinking. People they believe that do not need to re-use water either because it is not healthy or they believe that Kurdistan have enough resource to use, the study will discover in analysis section.
For farm, 134 people ranked for not re-using water for drinking, which means they need to use water after flowing one more time because they were using more for agriculture or for watering plant and tress as well. The 140 people ranked to no need to re-use water, indicating that it is probable that the area has much water sources for continuous daily life.

Last level for water re-use is using water for all purposes, as shown in Table 3. The 131 farms have chosen it. Furthermore, farms in this area need water after recycling either because they do not have resources or they prefer to re-use water as collecting water.

The previous study stated that one of the effective factors on the answer of the responders to reuse water process and safety is self- information as reaction and behavior of consumer (Fielding, 2014).

Table 4. Re-use of Water with Level of Community

	Water Re-use		
Level of community	Not for Drinking	No need re-use	Use for all purposes
Household	87	87	87
Farm	134	140	131
Government	87	87	87

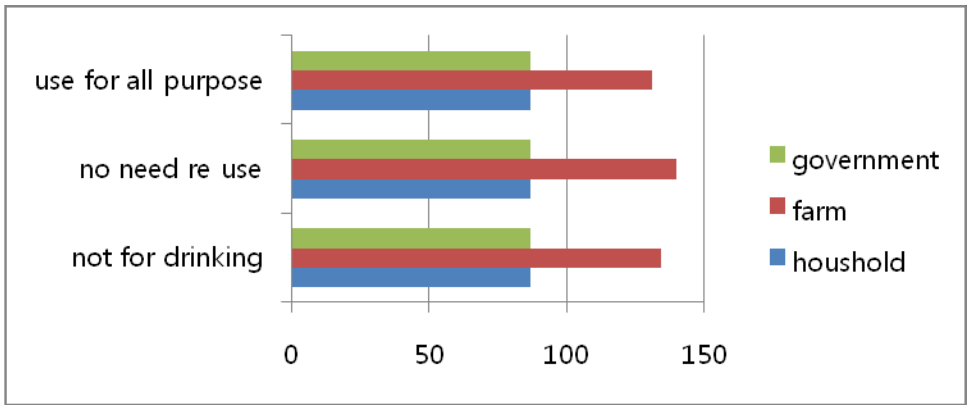

Figure 3 Strategy plan and level of community

Another attribute to improve management of water resources in the study was willingness for payment. As payment was important, the study was oriented to find out the willingness of different level of community for paying money. As Table 5 and Figure 4 show, in the community of household, the willingness for payment of 5 thousand Dinars was about 79 people. There are many explanations for people who ranked 5 thousand Dinars; in Kurdistan region they live in very low rate of money. Due to hard life, for some and getting their salaries were not enough to live on. In the other hand it may be easy to access to water in Kurdistan region and there is no law to prevent water flow continuously into their households.

The maximum ranked level in willingness for payment for water resources was 10 thousand Dinars and then 15 thousand Dinars it comes. This study chose price close to each other and not high rate of money, as the study mentioned before people used to give in low rate of money and some area like rural it is free.

For farm, the rank for payment for 5,000 ID, 10,000 ID and 15,000 ID was 134 people, 136 people and 135 people, respectively. The result shows there is same level in community of farm but they have different opinion about payment for water. Farming land according to the land they have, needed different quantity of water per day with farming animals as it is common in Kurdistan region

Government willingness for payment of water is the same for each level from 5 thousand Dinars to 15 thousand Dinars. Government use water for many purposes, which could be similar to use for daily human life or for construction and industry. After getting result from government official, the study found that the willingness for payment is 87 people for each level.

Table 5. Willingness for Payment and Level of Community

Level of community	Willingness to pay		
	5 thousand	10 thousand	15 thousand
Household	79	95	87
Farm	134	136	135
Government	87	87	87

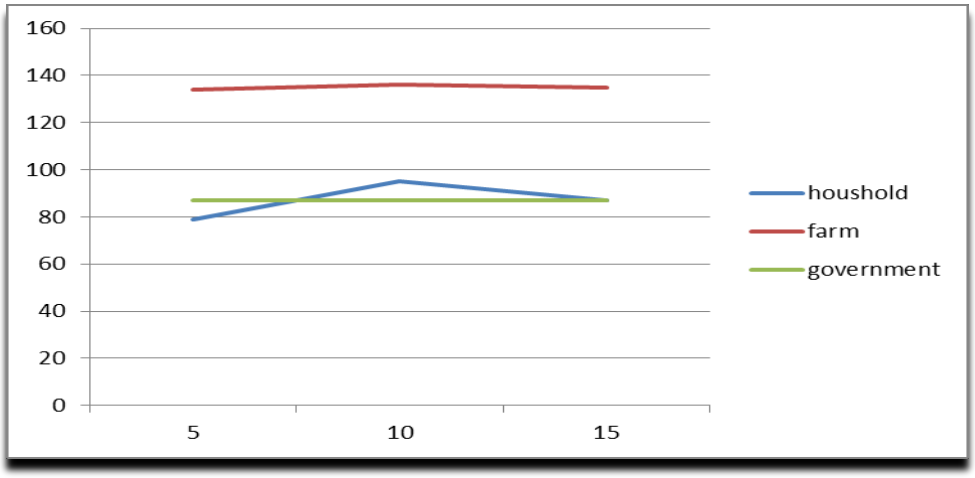

Figure 4 Levels of Community and Willingness for Payment (Unit: 1,000 ID)

Education is an important element in relation to therefore the study was involving different levels of community as shown in it are clear in the Table 6. This thesis involved three level of community household, farm and government official; the purpose was to find out at what level water resources management is important according to own opinion. Furthermore, the level of education has effect on level of community. The relation between education and community is either correlated or vice versa, by analyzing the study will discover in next section.

According to Table 6 there were different levels of education: illiterate, primary school, high school, diploma and collage. As Table 6 shows, household according to level of education indicated that 27 people finished primary school, 126 people did high school, and 27 people did diploma and 81 people did college. According to Table 6, there were no illiterate people but that does not mean that there is no illiterate people who live in the household and it happened unexpectedly.

Table 6. Education and Level of Community

Level of community	Education				
	Illiterate	Primary	High	Diploma	College
Household	0	27	126	27	81
Farm	198	153	45	0	9
Government	0	27	63	81	90

4. CONCLUSION AND RECOMMENDATION

To conclude, water has always been an important factor in determining the future of human beings. With the rise of modern society the importance of water supply increased. Additionally, one of the major problems emerged with the raised of modern societies is lack of clean water as Millions of people on earth still do not have access to. Moreover, the struggle for water especially in the developing countries is estimated to turn to struggle over water. Due to water scarcity development and democracy are likely to withhold and conflicts are likely to take place.

To better understanding of water resources management, attributes such as payment and implementing water service is important to consider. Minimum price is expectable for communities and implementing water service by government and private sector is significant. People for the two above variables strongly agree and has positive impact on water resources management. Variables such as strategy plan, government should study it better because it is communities demand. People who participate in this study they preferred not using water cycle again even although it is not supported by water resources management principle.

After evaluating the result, the study discussed about the important attributes and considering demography and self-information about different levels of communities as significant issue. In general, for better resources management government should take some steps. Establishing ministry of water resources was impressive at 2006. The water resource ministry worked for short year, due to election and structure new government some ministries including ministry of water resources had been canceled and combined with ministry of agriculture.

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APPENDIX 1 Farm Questionnaire Survey Form

Part 1

Please before answer the question, read carefully about attribute, level and description

Attribute	Level	Description
Strategic planning	10 years	Long-term strategy plan: government must have a long strategy plan for better management and implementation of the water management.
	5 years	Midterm strategy plan for 5 years to achieve governments goal regarding water management
	2 years	Short-term strategy plan for 2 years to implement government present stages.
Water re-use	Not for drinking	Re-use water for other purpose except for drinking
	Use for all purpose	Re-use water for daily life including drinking too
	None of them	No need to re-use water
Sector to implement water management	Private only	Providing service only by private sector.
	Private public partnership	Implementing by Both private and public
plan	Public only	Providing service only by public sector
Willingness to pay for water use	5 000 ID	5,oooID paid for water per month
	10 000 ID	10,oooID paid for water per month
	15 000 ID	15,oooID paid for water per month

Please rank your choice in order

1) For most preferred. 2) Less preferred than 1. 3) For less preferred than 1 and 2

Choice Set A

Attribute	Package A1	Package A2	Package A3
Strategic planning	10 years	2 years	5 years
Options for water re-use	Not for drinking	No water re- use	Use for all purpose
Which sector to implement water management	Public only	Private public partnership	Private only
Willingness to pay ID	10 000	15 000	5 000
Your ranking			

Choice Set B

Attribute	Package B1	Package B2	Package B3
Strategic planning	2 years	5 years	10 years
Options for water re-use	No water re- use	Use for all purpose	Not for drinking
Which sector to implement water management	Public only	Private public partnership	Private only
Willingness to pay ID	15 000	10 000	5 000
Your ranking			

Choice Set C

Attribute	Package C1	Package C2	Package C3
Strategic planning	10 years	2 years	5 years
Options for water re-use	Not for drinking	Use for all purpose	No water re use
Which sector to implement water management	Private public partnership	Private only	Only public
Willingness to pay ID	15 000	10 000	5 000
Your ranking			

Part 2 Please answer the below question by tick one of them:

1- Members of family in the household?

Specify ☐

2- Size of farmland?

Specify ☐

3- How do you access the water?

☐ Irrigation ☐ Tank ☐ Well

Others specify ……

4- What is the distance from the main water sources (in meter)?

☐ <250 ☐ <500 ☐ >500

5. What is your daily water consumption in liter?

Specify ☐

6. Quality of water?

☐ Clear ☐ not clear

7. Daily hours of water supply?

Specify…….

Part 3 Demographic and background information:

1. What is your gender?

Female ☐ Male ☐

2. How old are you?

☐ <25 ☐ <40 ☐ <60 ☐ <60

3. Are you educated; if yes please write your level of education?

☐ Uneducated ☐ Educated, specify……

4. How much your income monthly? Specify…….

APPENDIX 2 Household Questionnaire Survey Form

Part 1

Please before answer the question, read carefully about attribute, level and description

Attribute	**Level**	**Description**
Strategic planning	10 years	Long-term strategy plan: government must have a long strategy plan for better management and implementation of the water management.
	5 years	Midterm strategy plan for 5 years to achieve governments goal regarding water management
	2 years	Short-term strategy plan for 2 years to implement government present stages.
Water re-use	Not for drinking	Re-use water for other purpose except for drinking
	Use for all purpose	Re-use water for daily life including drinking too
	None of them	No need to re-use water
Sector to implement water management plan	Private only	Providing service only by private sector.
	Private public partnership	Implementing by Both private and public
	Public only	Providing service only by public sector
Willingness to pay for water use	5 000 ID	5,oooID paid for water per month
	10 000 ID	10,oooID paid for water per month
	15 000 ID	15,oooID paid for water per month

Please rank your choice in order 1) for most preferred.

2) Less preferred than 1. 3) For less preferred than 1and 2

Choice Set A

Attribute	**Package A1**	**Package A2**	**Package A3**
Strategic planning	10 years	2 years	5 years
Options for water re-use	Not for drinking	No water re use	Use for all purpose
Which sector to implement water management	Public only	Private public partnership	Private only
Willingness to pay ID	10 000	15 000	5 000
Your ranking			

Choice Set B

Attribute	Package B1	Package B2	Package B3
Strategic planning	10 years	2 years	5 years
Options for water re-use	Use for all purpose	Not for drinking	No water re- use
Which sector to implement water management	Public only	Private public partnership	Only private
Willingness to pay ID	15 000	5 000	10 000
Your ranking			

Choice Set C

Attribute	Package C1	Package C2	Package C3
Strategic planning	2 years	5 years	10 years
Options for water re-use	Not for drinking	Use for all purpose	No water re use
Which sector to implement water management	Private public partnership	Only public	Only private
Willingness to pay ID	10 Thousand ID	5 Thousand ID	15 Thousand ID
Your ranking			

Part 2 Please answer the below question by tick one of them:

1. Members of family in the household?

   Specify ☐

2. Size of house land?

   Specify ☐

3. How do you access the water?

   ☐ Irrigation ☐ Tank ☐ Well

Others specify ……

4. What is the distance from the main water sources (in meter)?

   ☐ <250 ☐ <500 ☐ >500

5. What is your daily water consumption in liter?

   Specify ☐

6. Quality of water

   ☐ Clear ☐ not clear

7. Daily hours of water supply?

   Specify…….

Part 3 Demographic and background information:

1. What is your gender?

   ☐ Female ☐ Male

2. How old are you?

   ☐ <25 ☐ <40 ☐ <60 ☐ <80

3. Are you educated; if yes please write your level of education?

   ☐ Uneducated ☐ Educated, specify……

4. How much your income monthly?

   Specify…….

APPENDIX 3 Government Official Questionnaire Survey Form Part 1

- Please before answer the question, read carefully about attribute, level and description

Attribute	Level	Description
Strategic planning	10 years	Long-term strategy plan: government must have a long strategy plan for better management and implementation of the water management.
	5 years	Midterm strategy plan for 5 years to achieve governments goal regarding water management
	2 years	Short-term strategy plan for 2 years to implement government present stages.
Water re-use	Not for drinking	Re-use water for other purpose except for Drinking
	Use for all purpose	Re-use water for daily life including drinking too
	None of Them	No need to re-use water
Sector to implement water management	Private only	Providing service only by private sector.
	Private public partnership	Implementing by Both private and public
	Public only	Providing service only by public sector
Willingness to pay for water use	5 000 ID	5,oooID paid for water per month
	10 000 ID	10,oooID paid for water per month
	15 000 ID	15,oooID paid for water per month

Please rank your choice in order 1) for most preferred.

2) Less preferred than 1. 3) For less preferred than 1 and 2

Choice Set A

Attribute	Package A1	Package A2	Package A3
Strategic planning	10 years	2 years	5 years
Options for water re-use	Not for drinking	Use for all purpose	No water reuse
Which sector to implement water management	Only public	Private only	Private public partnership
Willingness to pay ID	10 000	15 000	5 000
Your ranking			

Choice Set B

Attribute	**Package B1**	**Package B2**	**Package B3**
Strategic planning	5 years	2 years	10 years
Options for water re-use	No water reuse	Not for drinking	Use for all purpose
Which sector to implement water management	Private only	Private public partnership	Only public
Willingness to pay ID	10 000	15 000	5 000
Your ranking			

Choice Set C

Attribute	**Package C1**	**Package C2**	**Package C3**
Strategic planning	2 years	10 years	5 years
Options for water re-use	Use for all purpose	No water re- use	Not for drinking
Which sector to implement water management	Only public	Private public partnership	Private only
Willingness to pay ID	5 000	10 000	15 000
Your ranking			

Part 2 Please answer the below question by tick one of them:

1. Members of family in the household?

   Specify ☐

2. Size of house land?

   Specify ☐

3. How do you access the water?

   ☐ Irrigation ☐ Tank ☐ Well

   Others specify ……

4. What is the distance from the main water sources (in meter)?

   ☐ <250 ☐ <500 ☐ >50

5. What is your daily water consumption in liter? Specify ☐

6. Quality of water?

   ☐ Clear ☐ not clear

7. Daily hours of water supply?

   Specify…….

Part 3 Demographic and background information:

1. What is your gender?

   ☐ Female ☐ Male

2. How old are you?

   ☐ <25 ☐ <40 ☐ <60 ☐ <60

3. Are you educated; if yes please write your level of education?

   ☐ Uneducated ☐ Educated, specify……

4. How much your income monthly?

   Specify…….

Thank you very much …